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Digital Platform Ecosystems: Emergence and Value Co-Creation Mechanisms

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Vollständiger Abdruck der von der Fakultät für Informatik der Technischen Universität München zur Erlangung des akademischen Grades eines

Doktors der Naturwissenschaften
(Dr. rer. nat.)

genehmigten Dissertation.

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Prüfer der Dissertation:	1.	Prof. Dr. Helmut Krcmar
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Die Dissertation wurde am 10.06.2020 bei der Technischen Universität München eingereicht und durch die Fakultät für Informatik am 09.11.2020 angenommen.

Preface

As I am writing this preface, an exciting and instructive time comes to an end. While working on my dissertation, I had the chance to collaborate with outstanding researchers and practitioners on the emerging topic of digital platform ecosystems, a phenomenon that was and still is impacting the global economy. In addition, I got the opportunity to take on exciting challenges and new responsibilities, fostering my personal development. All those experiences would not be possible without the people around me that helped to find exciting paths that I could explore.

I would like to express my deepest gratitude to my doctoral supervisor, Prof. Dr. Helmut Krcmar. I first met Prof. Dr. Helmut Krcmar during the seminar *"Challenges for the [Chief Information Officer] CIO,"* where he made a lasting impression with his network of CIOs. During the course, I learned that Prof. Dr. Helmut Krcmar was instrumental in shaping the role and building the CIOs' network in Germany. Like many other courses at TUM, this experience changed my perception of scientists sitting in an ivory tower toward scientists that can have long-lasting societal impact. I am grateful for all the lessons you have taught me, for all the responsibility you have given me, for all the opportunities you have provided me with, and for all the trust that you have placed in me. Providing me the chance to join the conference committee of the 40th International Conference on Information Systems as a local arrangement chair will be, among many others, one of those extraordinary experiences that will remain particularly in my memory. I hope I will be able to pass all those lessons on to the next generation.

I was greatly influenced by the inspiring ecosystem at the chair. First, I would like to thank Dr. Markus Böhm, who always watched my back and provided me with the freedom to make my own mistakes, to follow new ideas, and to work on all my research projects. Thank you, Markus, for all your helpful insights on how to start a scientific career. I also want to thank Prof. Dr. Manuel Wiesche, and Dr. Maximilian Schreieck, who introduced me to the world of digital platforms, which have since determined my work. Thank you, Manuel and Max, for the countless paper polishing sessions when exploring this new research avenue. Last, I would like to thank Jörg, Tobias, Sebastian, Julia, David, Harry, Kai, Leonard, Barbara, Martin, and many others with whom I had inspiring discussions on my research. I was thrilled and honored working with all of you.

My research was influenced by renowned scholars such as Prof. Jason Bennett Thatcher, Prof. Philip W. Yetton, and Prof. Eric K. Clemons. Thanks to all of you for the unique insights into academia and for the fruitful discussions on paper projects. The same applies to my second supervisor Prof. Dr. Florian Matthes, who led the Living Lab Connected Mobility—my first project as a research associate at TUM. With the network Prof. Dr. Florian Matthes built, I was able to develop my first publications on mobility service platform ecosystems.

Exceptional thanks go to my family for making me the person I have become. I greatly benefitted from all the lessons you taught me, from the fruitful discussions while walking through the gardens in Munich, and from the unconditional support, you still provide me.

Munich, 01.06.2020 Andreas Hein

Abstract

Problem Statement: Digital platform ecosystems have become a ubiquitous phenomenon. In contrast to traditional companies that adhere to dyadic customer-seller relationships, digital platforms have become a structural component that helps firms to integrate an ecosystem of polyadic actors in value co-creating activities. Examples are mobile operating systems that comprise application stores, which, in turn, integrate an ecosystem of third-party developers and consumers in developing and consuming applications. As firms from different industries are adopting digital platforms based on their individual needs and business environment, the conceptual ambiguity, and complexity of the term increases. While scholars in various fields developed concepts for software platforms, product platforms, or industry platforms, the term digital platform ecosystem remains ambiguous and hard to grasp. In addition, it remains to be understood how digital platforms as a structural component came into existence and what practices platform owners employ to engage ecosystem actors in value co-creating activities.

Research Design: To address this gap, we first reviewed the literature on digital platform ecosystems in the context of the emerging Internet of things platform ecosystems. The results underpin the conceptual ambiguity of the term digital platform ecosystem. Based on those results, we broadened the scope toward a unified definition of digital platform ecosystems. The remaining publications respectively follow a qualitative research strategy with different research methods. First, we conducted five case studies to elaborate on the emergence and co-creation practices of digital platform ecosystems. Second, we carried out a fuzzy-set qualitative comparative analysis to develop a typology of different digital platform ecosystems that acknowledges their complex and interdependent nature. Last, we used a design science research approach to build an artifact that comprises actionable insights on how a digital platform ecosystem can be designed. The findings build on empirical data from 93 interviews and 261 files of secondary data.

Results: This dissertation takes a socio-technical perspective of digital platform ecosystems to provide a unified definition, to increase our understanding of how digital platform ecosystems came into existence, and to elaborate on how digital platforms co-create value with ecosystem partners. The unified definition of digital platform ecosystems comprises three core building blocks: platform owners with different degrees of centrality, complementors with different degrees of autonomy, and value-creating mechanisms that comprise transaction and innovation mechanisms. The results of platform emergence reveal two paths. The first path illustrates how native digital platform ecosystems came into existence, whereas the second path describes how incumbents need to change roles to transition toward a digital platform ecosystem. The results of value co-creation practices demonstrate a link between complementor autonomy and scalability based on the processes of standardization and residualization.

Contribution: The results contribute to the literature on digital platform ecosystems in three ways. First, the unified definition tackles the ambiguity and vagueness of the term digital platform ecosystem and provides scholars with a more nuanced conceptual understanding. Second, we reveal two paths of digital platform ecosystem emergence that contribute to the literature of co-evolution in digital platform ecosystems by adding an exogenous perspective of technological trajectories and by adding the perspective of role transitions in emerging digital platform ecosystems. Third, we reveal three core value co-creation practices that illustrate how

platform owners can engage ecosystem partners into value co-creating activities. With those practices, we provide valuable insights into the complex interactions between technical boundary resources and social ecosystem actors.

Study Limitations: The findings of this dissertation have several limitations that are subject to the ontological and epistemological assumptions, as well as the qualitative research strategy with subsequent research methods. Ontological limitations comprise that the results of this dissertation are only valid within its current economic, social, and technical presumptions, as well as that assumption of the past might convolute the interpretability of our results. Epistemological limitations refer to the stance of subjectivism and the underlying inductive mode of reasoning. In this regard, the generalizability of the results is particularly vulnerable to frequently changing conditions where uncertainty is high. Last, the findings are subject to methodological limitations that could compromise the construct validity, internal validity, external validity, and reliability. To ensure scientific rigor and to counterbalance, at least some of the limitations, we implemented measures such as introducing inter-coder reliability, data triangulation, and following established research methods.

Future Research: The dissertation yields four promising avenues for future research. First, the unified definition provides scholars with a more nuanced understanding of digital platform ecosystems. Different degrees of platform ownership centrality, for example, on consortia and decentralized peer-to-peer platform ecosystems, are only sparsely represented in research on digital platform ecosystems. Due to the ongoing effort of the European Union to establish European platform consortia, and the increasing market penetration of distributed ledger technology, research on both types of digital platform ecosystems becomes more relevant in the future. Second, we investigated two different paths of platform emergence. However, there are other potential ways of how digital platform ecosystems could come into existence. An example is that incumbents could also use mergers and acquisitions to transform toward a digital platform ecosystem. Third, we derived three core value co-creation practices that show how platform owners ensure the scalable integration of ecosystem actors. However, it remains to be understood how complementors and consumers follow and influence those processes. Accordingly, an avenue for future research would be to explore the perspective of complementors and consumers and how they engage in the value co-creation practices identified. Last, we have provided a DSR framework to design digital platform ecosystems. However, we propose to conduct a multiple-case study in a variety of different industries to make the framework accessible to a broad range of scholars and practitioners.

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List of Abbreviations

AIS	Association for Information Systems
AMICS	Americas Conference on Information Systems
API	Application Programming Interface
B2B	Business-to-Business
B2C	Business-to-Customer
BIS	Business Information Systems
CON	Conference
DSR	Design Science Research
ECIS	European Conference on Information Systems
EM	Electronic Markets
ERP	Enterprise Resource Planning
fsQCA	fuzzy-set Qualitative Comparative Analysis
G-D	Goods-Dominant
GT	Grounded Theory
HICSS	Hawaii International Conference on System Sciences
ICIS	International Conference on Information Systems
IoT	Internet of Things
JNL	Journal
Lit. Rev.	Literature Review
MaaS	Mobility-as-a-Service
MCS	Multiple Case Study
MKWI	Multikonferenz Wirtschaftsinformatik
MSP	Multi-Sided Platform
MSPE	Mobility-Service Platform Ecosystem
NR	Not Ranked
P	Publication
PACIS	Pacific Asia Conference on Information Systems
RQ	Research Question
S-D	Service-Dominant
SCS	Single Case Study
SDK	Software Development Kit
VHB	Verband der Hochschullehrer für Betriebswirtschaft
WI	Internationale Tagung Wirtschaftsinformatik

Part A

1 Introduction

> *"As a result of the rise of the platform, almost all the traditional business management practices—including strategy, operations, marketing, production, research and development, and human resources—are in a state of upheaval. We are in a disequilibrium time that affects every company and individual business leader. The coming of the world of platforms is a major reason why."* (Parker et al. 2016, 13)

Digital platforms, as stated in this quote from the book *"Platform Revolution"* of Parker et al. (2016), introduce a new era of economic and social interrelations by utilizing technological advances to integrate an ecosystem of autonomous actors into the value creation process of a firm. In this dissertation, we adhere to a socio-technical perspective to enquire about the disruptive nature of digital platform ecosystems. In particular, we develop a mutual definition, investigate paths of their emergence, and shed light on how platform owners integrate ecosystem partners into the value co-creation process.

1.1 Motivation

The creation of economic value shifted during the last decades from production within single firms to collaboration with individual customers to the co-creation of value in complex ecosystems (Skålén et al. 2015; Peppard/Rylander 2006; Prahalad/Ramaswamy 2004; Hippel/Katz 2002). Examples of the latter are digital platforms that benefit from the integration of autonomous actors that represent the supply and demand side of an ecosystem. By integrating autonomous actors, platform owners utilize external capabilities and leverage network externalities (Venkatraman et al. 2014; Parker/Van Alstyne 2017). Digital platforms are at the center of those ecosystems and act as intermediaries by matching complementors, who provide complementing products or services and consumers (Eisenmann et al. 2006; Hein et al. 2018a; Rochet/Tirole 2003). With a market value of $4.3 trillion, representing 70% of the unicorn[1] start-ups (Evans/Gawer 2016), and accounting for 20% of the Standard & Poor's 500 returns (Moazed 2019), digital platform ecosystems are starting to conquer the global market economy rapidly.

Compared to linear value chains, a key characteristic of digital platforms is that they turn the value creation process inside-out to leverage network externalities (Parker/Van Alstyne 2017). Network externalities indicate how the value for one side of the platform increases as the number of users on the other side increases (Schilling 2002). Examples to illustrate this effect are application stores such as the Apple App Store or the Google Play store. More than 2,570,000 applications on the Google Play store and 1,840,000 applications on the Apple App Store (VentureBeat 2020) and an installed base of 900 million iPhones and 2.5 billion android devices (Tung 2019) illustrate the power of network externalities as each new application increases the value for consumers. Also, each new consumer is a potential user of an application.

[1] A Unicorn defines a start-up company with a valuation of over $1 billion.

This growth in applications and, in turn, value of the digital platform is only possible due to the scalable development and integration of complementary products through boundary resources such as Application Programming Interfaces (APIs) or Software Development Kits (SDKs) (Ghazawneh/Henfridsson 2013; Eaton et al. 2015). Complementors use those resources to create new products or services based on either their individual needs or capabilities (Foerderer et al. 2019). The link between independent human agents and the use of technical resources owned by the platform shows that the socio-technical perspective is critical to understand dynamics in digital platform ecosystems (de Reuver et al. 2018). Due to this distinctive characteristic, we have chosen the socio-technical perspective as an overarching theme to guide three research questions (RQs) that will increase our understanding of digital platform ecosystems.

First, there is no unified definition of the term digital platform ecosystems, which makes the concept ambiguous and hard to grasp (de Reuver et al. 2018; McIntyre/Srinivasan 2017). Being an omnipresent phenomenon, scholars from various disciplines have adopted different perspectives on digital platform ecosystems. The fragmentation of research on digital platform ecosystems can be illustrated based on research streams such as economics (Rochet/Tirole 2003; Parker/Van Alstyne 2005), strategic management (Gawer/Cusumano 2008; Gawer/Henderson 2007), technology management (Baldwin/Woodard 2009; Schilling 2002), and information systems (IS) (Spagnoletti et al. 2015; Yoo et al. 2010). To provide a basis for future research, we adhere to a socio-technical perspective to develop a mutual definition and understanding of digital platform ecosystems. The resulting definition tackles the ambiguity and vagueness of the term digital platform ecosystem and provides scholars with a unified terminology.

Second, the literature on digital platform ecosystems mainly focuses on mature platform ecosystems (McIntyre/Srinivasan 2017; de Reuver et al. 2018) and provides little insight into how digital platform ecosystems came into existence. Despite notable exceptions that focus on capabilities (Tan et al. 2015) and technology-enabled assets (Sebastian et al. 2017), it remains unclear how firms establish a digital platform and how the emergence of native digital platforms—firms that natively adopted a digital platform as a central element to co-create value—influences incumbent companies to adopt a digital platform as well (Tiwana et al. 2010). Examining firms that natively developed toward a digital platform ecosystem and grew to industry-leading firms deepens our understanding of how digital platforms can shape the economy (Gawer/Cusumano 2002) and how incumbents can react to this new development.

Third, there is sparse research from a socio-technical perspective on how digital platforms foster the co-creation of value with an ecosystem of complementors (Foerderer et al. 2019; Ghazawneh/Henfridsson 2013). Taking the social perspective, research on digital platforms illustrates the importance of governance mechanisms such as balancing control and openness (Boudreau 2012, 2010), as well as orchestrating interactions in the ecosystem (Tiwana et al. 2010). Contrary, the technical perspective focuses on the design of boundary resources (Ghazawneh/Henfridsson 2013). To synthesize both perspectives, Eaton et al. (2015) introduced the concept of distributed tuning of boundary resources through the interaction of the platform owner and complementors. These and related results (Henfridsson et al. 2018; Karhu et al. 2018) highlight the complex and interdependent relationship between the provision of technical boundary resources and their actualization by external actors to fuel the co-creation of value. Hence, developing socio-technical practices on how the platform owner can engage ecosystem partners to co-create value provides valuable insights into the complex interactions between technical boundary resources and social ecosystem actors. In particular, the resulting value co-creation practices shed light on the process of how a digital platform can engage the supply and demand side effectively.

1.2 Research Questions

The overarching goal of this dissertation is to adopt a socio-technical perspective to increase our understanding of how digital platforms came into existence and how they co-create value with ecosystem partners. As emphasized by several research articles (cf. de Reuver et al. 2018; McIntyre/Srinivasan 2017), it is of economic and societal importance to understand the genesis of digital platform ecosystems and how the creation of value in organizations shifted from linear value chains to value co-creation (Parker et al. 2017; Parker/Van Alstyne 2017). The research design is empirically driven and utilizes literature on digital platforms and their underlying ecosystem in combination with qualitative data[2] from various digital platform ecosystem cases.

RQ1: *What are the characteristics of digital platform ecosystems?*

Due to the ambiguity of the concept of software-based platforms (Tiwana et al. 2010), industry platforms (Gawer/Cusumano 2014), platform-mediated networks (McIntyre/Srinivasan 2017), digital platforms (de Reuver et al. 2018), and the different research streams on business (cf. Moore 1997), innovation (cf. Adner 2006), service (cf. Lusch/Nambisan 2015), and platform ecosystems (cf. Gawer/Cusumano 2002), we first define the concept of digital platform ecosystems based on a socio-technical perspective. We start with an explorative literature review in the emerging field of Internet of things (IoT) platforms to show that scholars use the concept of digital platform ambiguously. Next, we use different case studies to broaden the scope of the explorative literature review by developing a unified definition of digital platform ecosystems.

RQ2: *How can digital platform ecosystems emerge?*

The literature on digital platform ecosystems mainly focuses on already established platform ecosystems (McIntyre/Srinivasan 2017; de Reuver et al. 2018) and provides little insight into how digital platform ecosystems emerged. It remains unclear how firms natively establish a digital platform and how incumbents can transition toward an organization that utilizes a digital platform ecosystem (Tiwana et al. 2010). To elaborate on those questions, we conduct several case studies (Eisenhardt 1989; Siggelkow 2007) to deepen our understanding of the emergence of native digital platform ecosystems, how native digital platform ecosystems influence incumbent companies to adopt a digital platform, and how those incumbents can transition from linear value chains to the co-creation of value in ecosystems. The resulting process models (Langley 1999) illustrate the genesis of native platforms and incumbents that transition toward a digital platform.

[2] A summary of all the qualitative data used in the embedded publications can be found in Appendix A: Supplementary Material Interviews and Data Material.

RQ3: *How do digital platforms integrate their ecosystem partners to foster value co-creation?*

A unique characteristic of digital platform ecosystems is the co-creation of value with a set of autonomous complementors compared to linear value chains, which create value in the confines of a firm (Parker et al. 2017; Parker/Van Alstyne 2017). First, we conduct a multiple-case study (Eisenhardt 1989; Eisenhardt/Graebner 2007) in the field of IoT platforms by adopting the socio-technical perspective to identify value co-creation mechanisms. Second, we show how digital platform ecosystems engage ecosystem actors in the value co-creation process by conducting a fuzzy-set qualitative comparative analysis (fsQCA) (Fiss 2011). Last, we follow Design Science Research (DSR) (Gregor/Hevner 2013; Hevner 2004) to develop a design framework that shows how the platform owner can integrate the ecosystem into the value co-creation process based on different characteristics.

In sum, we first develop a mutual understanding of the concept of digital platform ecosystems based on a socio-technical perspective. Next, we develop two different theories that help to explain the emergence and how digital platform ecosystems can integrate ecosystem partners to co-create value (Gregor 2006).

1.3 Structure

The dissertation consists of three parts (see Figure 1). Part A starts with an introduction that motivates the research field of digital platform ecosystems, summarizes the problem statement based on three research questions, and describes the structure of the thesis (see part A: Chapter 1). Next, we introduce the conceptual background of digital platforms, the literature streams on ecosystems, and how digital platforms and the literature on ecosystems can be integrated through a socio-technical perspective. We continue with a summary of the literature on the evolution and value co-creation in digital platform ecosystems (see part A: Conceptual Background 2). Part A ends with the research design consisting of the research paradigm that includes ontological and epistemological assumptions, the qualitative research strategy, and underlying research methods (see part A: Research Design 3).

Part B consists of eight published and peer-reviewed publications (P) that follow the structure of the three research questions. In the first and second publications (see part B: Chapter 1-2), we start with an explorative literature review on IoT platforms and then broaden the scope toward a unified definition of digital platform ecosystems. The remaining publications respectively focus on the emergence of digital platform ecosystems (see part B: Chapter 3-5) and the integration of ecosystem actors to foster value co-creation (see part B: Chapter 6-8).

In part C, we provide a summary of the results from the eight publications presented (see part C: Chapter 1). In addition, we discuss the findings of the articles based on the socio-technical perspective (see part C: Chapter 2), provide implications for research and practice (see part C: Chapter 3), highlight limitations of the dissertation (see part C: Chapter 4), show avenues for future research (see part C: Chapter 5), and end with a conclusion of the dissertation (see part C: Chapter 6).

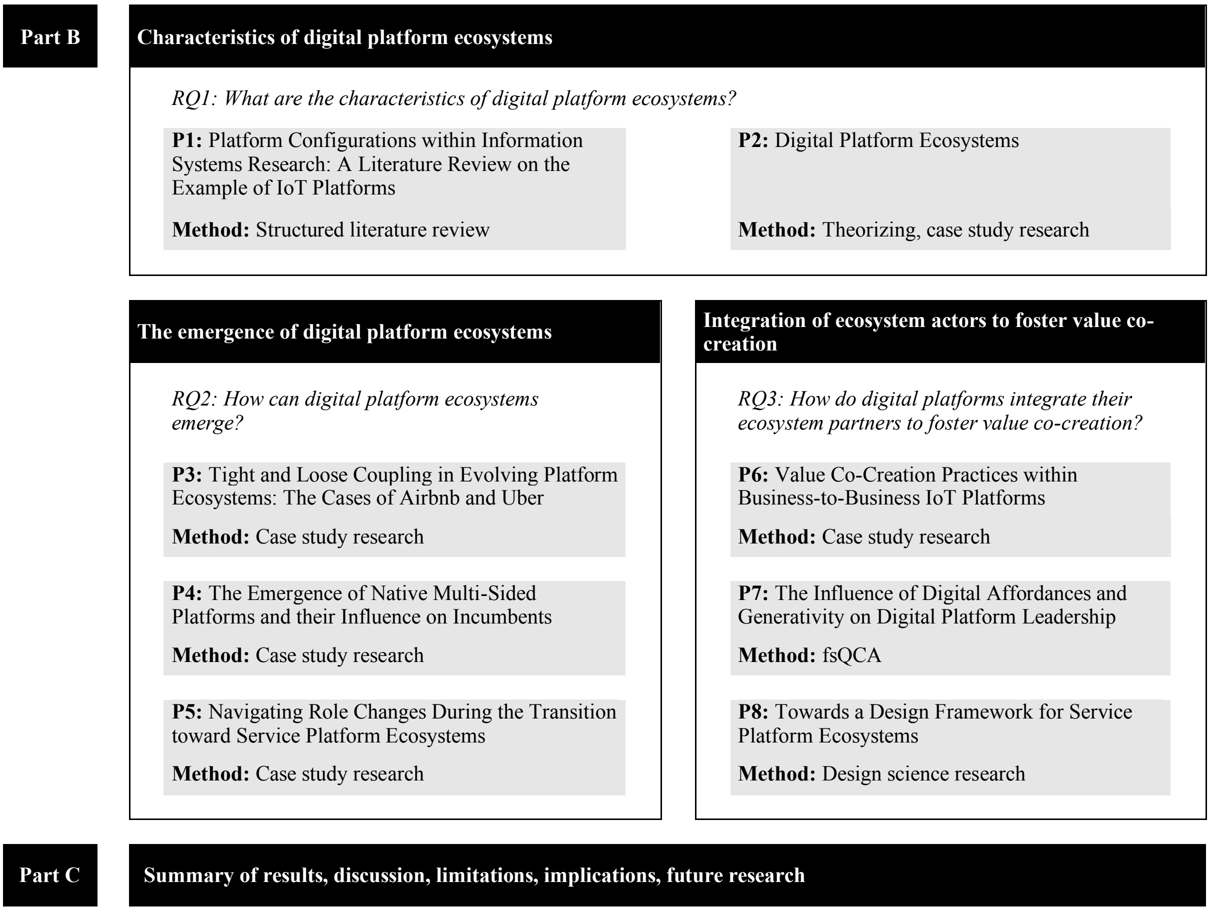

Figure 1. Structure of the Dissertation

In the following paragraphs, we summarize the eight publications embedded in part B (see Table 1). For each of the publications, we outline the research problem, the methodological approach, and the main contributions.

Table 1. Overview of Embedded Publications

RQ	No.	Authors	Title	Outlet	Type
RQ1	P1	Hein, Böhm, Krcmar	Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms	MKWI* 2018	CON (VHB: D)
	P2	Hein, Riasanow, Schreieck, Soto Setzke, Wiesche, Böhm, Krcmar	Digital Platform Ecosystems	EM* 2019	JNL (VHB: B)
RQ2	P3	Hein, Böhm, Krcmar	Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber	BIS* 2018	CON (VHB: C)
	P4	Hein, Schreieck, Wiesche, Böhm, Krcmar	The Emergence of Native Multi-Sided Platforms and their Influence on Incumbents	EM* 2019	JNL (VHB: B)
	P5	Hein	Navigating Role Changes During the Transition toward Service Platform Ecosystems	ECIS* 2020	CON (VHB: B)
RQ3	P6	Hein, Weking, Schreieck, Wiesche, Böhm, Krcmar	Value Co-Creation Practices within Business-to-Business IoT Platforms	EM* 2019	JNL (VHB: B)
	P7	Hein, Soto Setzke, Hermes, Weking	The Influence of Digital Affordances and Generativity on Digital Platform Leadership	ICIS* 2019	CON (VHB: A)
	P8	Hein, Scheiber, Böhm, Weking, Rocgniz, Krcmar	Towards a Design Framework for Service Platform Ecosystems	ECIS* 2018	CON (VHB: B)

Outlet:
BIS: Business Information Systems
ECIS: European Conference on Information Systems
EM: Electronic Markets
ICIS: International Conference on Information Systems
MKWI: Multikonferenz Wirtschaftsinformatik

Type:
CON: Conference
JNL: Journal
VHB: German Academic Association for Business Research

*all publications are published and peer-reviewed.

P1: Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms. The first contribution (Hein et al. 2018b) sheds light on the usage and application of various platform constructs in the context of IoT platforms. The motivation is that scholars and practitioners in the field of IS use the term platform frequently as an unspecific or vague construct. The vagueness of the construct results from different research streams that shape and influence the understanding of a platform. Those research streams range from economic practices such as two-sided markets to multi-sided platforms to business models to technical platform characteristics that include standardization and modularization to platform ecosystems and the construct of a digital platform that fosters the co-creation of value. In this regard, the phenomenon of IoT platforms represents a specific case to analyze what constructs IS scholars use to which extent. By conducting a structured literature review on IoT platforms, the first contribution helps IS scholars to use the construct of a platform more accurately. In addition, the results reveal the interrelatedness of platform constructs based on the example of IoT platforms. However, the review article is only a first step towards clarifying the notion of a platform due to the restricted context of IoT platforms.

P2: Digital Platform Ecosystems. The second contribution (Hein et al. 2019a) broadens the scope of platforms to a unified definition of digital platform ecosystems. Hence, the paper starts with digital platforms as a ubiquitous phenomenon that challenges incumbents by changing how we consume digital products and services. Where traditional companies create value within the confines of a firm, digital platforms use an ecosystem of autonomous actors to co-create value. Researchers from various disciplines, such as economics, technology management, and

IS, have taken different perspectives on digital platform ecosystems. Hence, the second article first synthesizes research on digital platforms and digital platform ecosystems to provide a unified definition that integrates both concepts. Second, the contribution builds on this definition to describe how digital platform ecosystems vary according to three main building blocks: platform ownership, value-creating mechanisms, and complementor autonomy. The article concludes with four research areas that connect the main building blocks: technical properties and value creation, complementor interaction with the ecosystem, value capture, and the make-or-join decision in digital platform ecosystems.

P3: Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber. The third contribution (Hein et al. 2018c) sheds light on the emergence of native digital platforms by illustrating how they use tight and loose coupling in different evolutionary phases. Successful native digital platforms such as Apple's App Store loosely integrate an ecosystem of third-party developers to foster innovation. However, it is unclear how native digital platforms establish a vibrant platform ecosystem. The third contribution provides insights into evolutionary phases and coupling mechanisms in the context of platform ecosystems. Furthermore, we show that platforms follow the evolutionary phases as proposed by Moore (1993). However, there are differences when introducing the mechanisms of tight and loose coupling. The cases of Airbnb and Uber indicate that platforms use tight coupling partnerships, in the beginning, to enhance the core service or value proposition, strengthening cross-side network externalities between the supply and demand-side. Thus, tight coupling is one promising mechanism to answer the open question of how platforms strategize to foster cross-side network externalities. Another theoretical contribution points towards the increasing role of value co-creation in more mature platform ecosystems(Lusch/Nambisan 2015). In sum, this article highlights that platforms first prepare the ecosystem and then enable third-party developers to innovate around core services actively.

P4: The Emergence of Native Multi-Sided Platforms and their Influence on Incumbents. The fourth contribution (Hein et al. 2019b) illustrates the emergence of native digital platform ecosystems and their influence on incumbents based on the literature on technological trajectories and technology diffusion. The article starts with four propositions that increase our understanding of the emergence of native digital platforms and their influence on incumbents. The propositions include the emergence of native digital platforms based on the assimilation of technologies in technological trajectories, how uncertainty influenced incumbents not to follow those trajectories, how native multi-sided platforms (MSPs) created new demand, and how this demand eventually triggered the transformation process of incumbents to transform toward a digital platform. We conducted a multiple-case study in the context of mobility services with three native digital platform firms, along with an incumbent that was transforming toward a digital platform. The resulting process model shows that native digital platforms use sense-making and bricolage to assemble a microservice architecture, contrary to the incumbent who adopts technologies according to its institutional logic to improve existing products and processes.

P5: Navigating Role Changes During the Transition toward Service Platform Ecosystems. In the fifth paper, we investigate how established incumbents can transform toward a digital platform (Hein 2020). To remain competitive, traditional incumbents need to adapt to those changing conditions. However, there has only been scarce research on an ecosystem level about how traditional incumbents should alter their dyadic business network with a Goods-dominant (G-D) logic to transition to a Service-dominant (S-D) ecosystem. We draw on a single in-depth case study within the context of a business-to-business (B2B) manufacturing company that is currently navigating a period of liminality by being betwixt and between two roles. The incumbent implemented a software platform that facilitated the transition of roles from a business network toward an ecosystem of co-creating actors. To explain this shift, we developed a process model to depict how actors in an emerging ecosystem change throughout liminality. Although the platform owner institutionalized the software platform through new incentives, existing partners either internalized a pre-defined role defined by the platform owner or self-explored new roles.

P6: Value Co-Creation Practices within Business-to-Business IoT Platforms. The sixth contribution (Hein et al. 2019d) elaborates on value co-creation patterns in digital platform ecosystems. Moving beyond value creation in individual companies, companies have integrated various parties such as customers, partners, and stakeholders in a value co-creation process. Examples are digital platforms such as Apple's App Store, where third-party developers use boundary resources provided on the digital platform to develop and share applications in an ecosystem. Whereas value co-creation on business-to-consumer (B2C) platforms is common practice, research on B2B platforms is still sparse. The goal of this article is to analyze how B2B platforms co-create value with ecosystem partners. By conducting a multiple case study in the context of emerging IoT platforms, we highlight that B2B platforms use three standardized value co-creation practices. First, the platform integrates the supply side through complementary assets, the demand-side through ensuring platform readiness, and connects both sides in the process of servitization through application enablement. In sum, we show how platforms leverage different boundary resources in the process of standardization to develop a scalable digital infrastructure that sheds light on how platforms enable value co-creation within their ecosystem.

P7: The Influence of Digital Affordances and Generativity on Digital Platform Leadership. The seventh contribution (Hein et al. 2019c) elaborates on how digital platforms achieve market leadership through the co-creation of value. Digital platforms take advantage of autonomous actors to co-create value instead of trusting solely on internal innovation capabilities. To this end, the platform owner provides digital affordances[3] in the form of boundary resources like APIs and SDKs that an ecosystem of complementors can actualize to create value-adding services. This interaction demonstrates that the platform both uses internal innovation capabilities by providing digital affordances and external innovation capabilities between complementors—referring to the generativity of the ecosystem. However, to the best of our knowledge, it remains unclear how the combination of the provision of affordances and the collaboration of complementors led to the tremendous triumph of digital platform ecosystems. This contribution adheres to a fsQCA based on a set of 47 platforms to disentangle both internal and external innovation. The results reveal four configurations of leading platforms that combine affordances of the digital platform and generativity of an ecosystem to point toward a fruitful area for future research.

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[3] The concept of digital affordances describes "what an individual or organization with a particular purpose can do with a technology" (Majchrzak et al. 2013).

P8: Towards a Design Framework for Service Platform Ecosystems. Last, the eighth contribution (Hein et al. 2018d) develops a framework that sheds light on how digital platform ecosystems can co-create value. The article builds on the ongoing shift of firms from a G-D towards an S-D logic. One crucial aspect is how society will use mobility in the future. Before, society relied on goods in the form of privately owned cars to travel from A to B. However, platforms like Uber, Lyft, and ReachNow change the way how citizens use mobility from owning a car to using Mobility-as-a-Service (MaaS). While scholars on production economics have gathered knowledge on how to optimize production processes in the G-D world, it is unclear how to design thriving platform ecosystems from an S-D perspective. The seventh article follows a DSR approach to develop a framework that helps scholars in the field of digital platforms to analyze and compare, and practitioners to design Mobility Service Platform Ecosystems (MSPEs). The article starts with a literature review to ground the artifact in the S-D and MaaS research. Next, the article illustrates the iterative development of the framework, drawing from literature and two case studies representing public and private mobility platforms. The resulting artifact is a first step to provide a structural, reproducible framework to design MSPEs, which ensures comparability along with platform ecosystems.

In addition to the eight publications embedded in this dissertation, we wrote additional articles that are indirectly related to the research questions (see Table 2). These publications—often led by co-authors—present additions to the issues discussed in the embedded publications. Related to RQ1, we developed a definition of digital platforms in the context of digitalization (Hein et al. 2018a) and conceptualized platform dominance in the context of winner-take-all markets (Hermes et al. 2020b).

Related to RQ2, we studied the development of digital platforms—among other organization forms—in the context of start-up companies in Germany (Böhm et al. 2019). The article by Weking et al. (2019 develops a taxonomy of blockchain technology as a decentralized form of digital platforms to show how technology can influence business models.

Related to RQ3, we analyzed further cases that demonstrate how digital platforms integrate their ecosystem to influence business models (Weking et al. 2018b; Weking et al. 2020; Weking et al. 2018a), how the platform owner can govern the co-creation of value with ecosystem partners (Hein et al. 2016; Schreieck et al. 2018a, 2018b; Hermes et al. 2020c), and how different user types of digital platforms influence the value creation in ecosystems (Hermes et al. 2020a).

Despite providing additional findings to the research questions, we selected the publications embedded in this dissertation (P1-P8) as the main building blocks.

Table 2. Overview of Additional Publications

RQ	Authors	Title	Outlet	Type
RQ1	Hein, Böhm, Krcmar	Digitale Plattformen	Book* 2018	Chapter (VHB: NR)
RQ1	Hermes, Pfab, Hein, Weking, Böhm, Krcmar	Digital Platforms and Market Dominance: Insights from a Systematic Literature Review and Avenues for Future Research	PACIS* 2020	CON (VHB: C)
RQ2	Böhm, Hein, Hermes, Lurz, Poszler, Ritter, Soto Setzke, Weking, Welpe, Krcmar	Die Rolle von Startups im Innovationssystem. Eine qualitativ-empirische Untersuchung. Studien zum deutschen Innovationssystem	EFI 2019	Report (VHB: NR)
RQ2	Weking, Mandalenakis, Hein, Hermes, Böhm, Krcmar	The Impact of Blockchain Technology on Business Models – A Taxonomy and Archetypal Patterns	EM* 2019	JNL (VHB: B)
RQ3	Engert, Hein, Krcmar	Partner Programs and Complementor Assessment in Platform Ecosystems: A Multiple-Case Study	AMCIS* 2020	CON (VHB: D)
RQ3	Hein, Schreieck, Wiesche, Krcmar	Multiple-Case Analysis on Governance Mechanisms of Multi-Sided Platforms	MKWI* 2016	CON (VHB: D)
RQ3	Hermes, Maier, Hein, Böhm, Krcmar	User Roles on Peer-to-Peer Sharing Platforms: A Critical Review of the Literature and Recommended Remedies	HICSS* 2020	CON (VHB: C)
RQ3	Hermes, Töller, Hein, Weking	Gaining Control over Critical Platforms: A Comparative Case Study of European Consortia	ECIS* 2020	CON (VHB: B)
RQ3	Schreieck, Hein, Wiesche, Krcmar	The Challenge of Governing Digital Platform Ecosystems	Book* 2017	Chapter (VHB: NR)
RQ3	Schreieck, Hein, Wiesche, Krcmar	Governance der Akteure einer digitalen Plattform	Book* 2018	Chapter (VHB: NR)
RQ3	Weking, Lupberger, Hermes, Hein, Böhm, Krcmar	Practices for Open Business Model Innovation – An Innomediaries Perspective	WI* 2020	CON (VHB: C)
RQ3	Weking, Brosig, Böhm, Hein, Krcmar	Business Model Innovation Strategies for Product Service Systems – An Explorative Study in the Manufacturing Industry	ECIS* 2018	CON (VHB: B)
RQ3	Weking, Böttcher, Hermes, Hein	Does Business Model Matter for Startup Success? A Quantitative Analysis	ECIS* 2019	CON (VHB: B)
RQ3	Weking, Hein, Böhm, Krcmar	A Hierarchical Taxonomy of Business Model Patterns	EM* 2019	JNL (VHB: B)

Outlet:
AMCIS Americas Conference on Information Systems
ECIS: European Conference on Information Systems
EFI: Expertenkommission Forschung und Innovation
EM: Electronic Markets
HICSS: Hawaii International Conference on System Sciences
MKWI: Multikonferenz Wirtschaftsinformatik
PACIS: Pacific Asia Conference on Information Systems
WI: International Tagung Wirtschaftsinformatik

Type:
CON: Conference
JNL: Journal
NR: Non-ranked
VHB: German Academic Association for Business Research

*all publications are published and peer-reviewed.

2 Conceptual Background

In the conceptual background, we start with a summary of integrative research that conceptualizes the technical concept of digital platforms. Next, we synthesize the concept of digital platforms with the social perspective on ecosystems toward a socio-technical perspective of digital platform ecosystems. By combining both concepts, we summarize key concepts of digital platform ecosystems, review the literature on their evolution, and introduce extant research on the concepts of value co-creation.

2.1 Digital Platforms

Integrative studies on the phenomenon of digital platforms range from software-based platforms (Tiwana et al. 2010) to technological platforms (Gawer 2014) to platform-mediated networks (McIntyre/Srinivasan 2017) to digital platforms (Constantinides et al. 2018; de Reuver et al. 2018). In this section, we summarize key concepts and illustrate mutual characteristics.

2.1.1 Software-Based Platforms

The term **software-based platform** was coined by Tiwana et al. (2010, 675) and defines *"the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate."* This definition builds on the conceptualizations of two-sided markets (Rochet/Tirole 2003; Eisenmann et al. 2006) and the technical platform architecture (Baldwin/Woodard 2009). An example of a software-based platform would be iOS, the operating system of iPhones. Built on top of software-based platforms are modules that describe *"an add-on software subsystem that connects to the platform to add functionality to the platform"* (Tiwana et al. 2010, 675). Examples of modules can be payment, navigation, or marketplace applications. Subsequently, the collection of modules based on a software-platform is then defined as a technical ecosystem. Modules in the technical ecosystem are loosely-coupled and communicate via standardized interfaces that foster modularity (Baldwin/Clark 2000) and economies of substitution (Garud/Kumaraswamy 1995). Interfaces are a specification of design rules that describe how the software-based platform and the modules interact and exchange information (Tiwana et al. 2010). Conventional technologies for interfaces are web-services that can be constructed via APIs.

The platform architecture describes *"how the [technical] ecosystem is partitioned into a relatively stable platform and a complementary set of modules that are encouraged to vary, and the design rules binding on both"* (Tiwana et al. 2010, 676). To minimize interdependence among modules, the platform architecture emphasizes the decomposition of functions into smaller, modular subsystems that follow specific design rules (Baldwin/Clark 2000). In this way, the platform owner ensures the stability of the platform codebase while increasing the versatility of modules (Tiwana et al. 2010; Garud/Kumaraswamy 1995). A platform architecture, for example, can be the Apple App Store that uses iOS as the stable platform core. Based on design rules that Apple incorporated into its development environment Xcode, complementors can build applications that they can then offer at the App Store.

Besides technical constraints, the platform owner can set-up governance mechanisms that declare who makes what decisions about the software-based platform (Manner et al. 2012, 2013). Those mechanisms include the partitioning of decision rights, formal and informal control mechanisms, and the declaration of ownership (Schreieck et al. 2016). Examples of design rules are the Human Interface Guidelines[4] or the App Store Review Guidelines[5] of Apple. The relationship between governance mechanisms and the platform architecture is subject to interdependencies (Schilling 2002) that Tiwana et al. (2010) framed as an internal fit. A change in the platform architecture can reinforce or diminish the influence of governance mechanisms and vice versa. An example is that new modules such as ARKit[6] on iOS can be seen as design rules to provide third-party developers with new opportunities to create applications that were not possible. Thus, a co-evolution between the platform architecture and governance mechanisms is needed to cope with interdependencies and nonlinear effects caused by evolutionary dynamics.

Lastly, there are environmental dynamics such as changing technological trajectories (Henfridsson/Yoo 2014), multihoming costs (Caillaud/Jullien 2003), and the influence exerted by complementors that impact the evolution of a software-based platform (Zhu/Liu 2018). Subsequent to the discussion about the internal fit, environmental dynamics also affect and are affected by internal decisions of a software-based platform. The more decomposable a technical ecosystem is, the higher is the diversity and speed of complementors engaged in developing new modules or applications (Tiwana et al. 2010; Simon 2002). The consequence is that higher diversity is more likely to yield evolutionary variants with higher fitness.

2.1.2 Technological Platforms

Gawer (2014) bridges dominant theoretical perspectives in the field of industrial economics and engineering design toward a unified framework for research on **technological platforms**. In contrast to software-based platforms, the work of Gawer (2014) focuses on organizational aspects of actors that interact with a technological platform. In this sense, she describes technological platforms as evolving organizations composed of agents who can innovate and compete within and across platforms. Those evolving organizations *"(1) federate and coordinate constitutive agents who can innovate and compete; (2) create value by generating and harnessing economies of scope in supply or/and in demand; and (3) entail a modular technological architecture composed of a core and a periphery"* (Gawer 2014, 1240). In this sense, a technological platform is an endogenous variable determined by the interactions and agency between underlying agents.

A core notion is the degree of openness of interfaces and, therefore, the autonomy of agents capable of interacting with the technological platform. Depending on the degree of openness, the organizational form can range from a closed internal platform to a tightly-coupled and contractually controlled supply-chain to loosely-coupled and open interactions between agents based on an industry platform (Gawer 2014). An example of a closed platform is an enterprise social network, where usage is restricted to employees. Contrary, open platforms foster

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4 See https://developer.apple.com/design/human-interface-guidelines/

5 See https://developer.apple.com/app-store/review/guidelines/

6 ARKit provides developers in the iOS ecosystem with new functionality to show and track augmented reality content: https://developer.apple.com/augmented-reality/arkit/

interactions between autonomous agents, who are not affiliated with the platform owner, such as in the case of the social network Facebook.

Another perspective is the degree of competition that is not only being limited to platform-to-platform competition (Eisenmann et al. 2006) but also includes competition within the platform. The competition can be between complementors such as in the case of vendors that sell similar products on Amazon and between the platform and complementors such as in the case of Amazon's basic products competing against products of complementors. Most importantly, agents in a platform ecosystem have agency. As a result, actors do not have fixed roles, such as being either a user or a complementor, but they can play both roles. An application developer can both consume and develop applications and is not restricted to one role. In addition, those roles can evolve from being cooperative to being competitive and vice versa. Thus, the agency of actors in the ecosystem describes the structure of the emerging platform organization.

Gawer (2014) develops a theoretical perspective to explore the intricate patterns of innovation and competition within and across technological platforms. She reveals the interdependence between innovation and competition in evolving platform ecosystems. Taking the example of application stores, platform owners need to decide whether they want to compete with complementors. An example is Google that launched Google photo and, hence, got in direct competition with already existing applications (Foerderer et al. 2018). However, Gawer (2014 also emphasizes that it is still unclear what patterns lead to the emergence and co-evolutionary behavior of platform ecosystems.

2.1.3 Platform-Mediated Networks

McIntyre/Srinivasan (2017 refer to **platform-mediated networks** where users place a higher value on platforms with a more extensive installed base of users. They use the three research streams of industrial organization economics, strategy management, and technology management to propose an agenda for future research. The agenda focuses on influences from network externalities, the platform quality, drivers of indirect network externalities, the nature and attributes of complementors, and how to leverage complementor dynamics for competitive advantage.

Industrial organization economics scholars view platforms as interfaces that mediate transactions between two or more sides. Those sides can, for example, represent a network of buyers and sellers or users and complementors (Gawer/Cusumano 2002; Eisenmann et al. 2006; Rochet/Tirole 2003). The fundamental assertion within industrial organization economics is that positive feedback loops influence actors in the form of network externalities (Katz/Shapiro 1994). Those network externalities can be either direct or indirect and influence actors or nodes in an independent network of actors (Farrell/Saloner 1985; Katz/Shapiro 1986). Direct network externalities can be illustrated in the case of Facebook, where each new user joining the platform increases the value for all existing users. Indirect network externalities can be shown in the case of application stores, where each new application increases the value for users, and each new user increases the potential usage of applications (Eisenmann et al. 2006). Additionally, the installed base of a platform represented by the number of active users influences the choice of complementors to develop complementary goods (Venkatraman/Lee 2004). The limitation of this perspective is that network externalities are considered as exogenous and constant factors. Also, studies consider the relationship between complementors and firms based on indirect network externalities as a *"black-box,"* excluding the option of strategic positioning. This shortcoming leaves the question unanswered of how to design platforms for success.

The strategy management view focuses on firm dynamics by which the platform achieves competitive advantage (Eisenmann et al. 2006). The central argument opposed to traditional strategic management is that platforms utilize network externalities. In this respect, there is an ongoing discussion on entry timing to quickly build a broad network of users versus ensuring a high quality of goods on the platform to reduce switching costs (Venkatraman/Lee 2004; Cennamo/Santalo 2013). In addition, the review points out that most studies focus on individual users but not on the effective management of complements. A limitation of the strategy management view is that prior studies largely adopted a static or cross-sectional view, not accounting for dynamic interactions and evolution between the platform owner and complementors in the ecosystem.

Lastly, technology management scholars extend the platform's role as an intermediary with the notion of complementary innovation (Gawer/Cusumano 2002; Gawer/Henderson 2007). Their focus is on platform design and its impact on the generation of network externalities. The central concept is the integrative perspective of platforms as a technology platform (Gawer 2014) to facilitate innovation. In this regard, technology platforms rely on technical architecture and governance mechanisms to facilitate innovation (Tiwana et al. 2010). The main limitation of technology management is that there is relatively little understanding of platform dynamics and their evolution when treated as systems.

McIntyre/Srinivasan (2017) conclude that each stream has been relatively confined to specific aspects of platform-mediated ecosystems, where each of them lacks a broader view of strategic considerations. Research on platforms would benefit from greater integration of insights from multiple research streams and levels of analysis to foster synergies that include market, firm, and complementor dynamics.

2.1.4 Digital Platforms

The fourth integrative review conducted by de Reuver et al. (2018) differentiates between non-digital platforms such as the technology platform (Gawer 2014) and **digital platforms** that build on the notion of software-based platforms (Tiwana et al. 2010). The concept of a digital platform combines a technical perspective on software-based platforms (Tiwana et al. 2010) with a sociotechnical view that accounts for organizational processes and standards (Tilson et al. 2012). Furthermore, digital platforms facilitate the exchange of digital products and services.

In contrast to physical complements, digital complements allow for a separation of form and function, where new features can be added even after the product has been designed and produced (Yoo et al. 2010). Complementors can use platform boundary resources such as SDKs (Ghazawneh/Henfridsson 2013; Eaton et al. 2015) in combination with other data derived from a variety of publicly accessible APIs to create digital complements not conceived by the platform. In addition, digital complements are not only more versatile than their physical counterparts but also product-agnostic (Yoo et al. 2010) in that their functionality is not predetermined but makes the main product more effective and useful. For example, Google Maps, as a digital complement, makes smartphones more useful and attractive. Lastly, the operation in a digital space allows the digital platform to remove constraints on location for completing a process. The result is the distribution of information and expertise across geographical and organizational boundaries resulting in unprompted innovations driven by an ecosystem of actors—referred to as generativity (Constantinides et al. 2018; Yoo et al. 2010).

The underlying dynamics represented by the recombinability of digital complements raised a paradoxical relationship of change and control, where different control arrangements can both hinder and fuel generativity (Tilson et al. 2012). One way to channel the generativity is to reduce the structural complexity of the technical platform architecture (e.g., through a modular architecture) to cope with the complexity of digital products, while also governing the social behavior of actors (e.g., through design rules) in the ecosystem to reduce the behavioral complexity (Tiwana 2014). To sustain the desired level of generativity, the platform owner departs from ownership-centric views of traditional innovation management to the use of boundary resources provided by the platform owner to organize and manage an ecosystem of autonomous agents (Iansiti/Levien 2004; Eaton et al. 2015).

2.2 Digital Platform Ecosystems

This chapter provides a thorough understanding of the genesis of business ecosystems, innovation ecosystems, and service ecosystems (Shipilov/Gawer 2020), as all three literature streams share essential characteristics for the concept of digital platform ecosystems.

2.2.1 Business Ecosystems

The ecosystem perspective on digital platform ecosystems is rooted in the theory of business ecosystems (Moore 1993, 1997). In turn, the literature on business ecosystems is shaped by influences from the field of Anthropology and co-evolution (Bateson 1979), and Biology and natural ecosystems (Gould 2002). The concept of co-evolution emphasizes that interdependent actors, or in the case of biology species, evolve in reciprocal cycles. Thus, the evolution of one species can influence the natural selection of another in the same ecosystem and the other way around. As a consequence, natural ecosystems respond with sensitivity to environmental change (cf. Gould 2002; Bateson 1979). Moore combines aspects of natural selection and co-evolution to describe how businesses evolve under ever-changing environmental influences in an ecosystem of partners, suppliers, and customers.

Later work (cf. Brandenburger/Nalebuff 1996) builds on Moore's concept of the business ecosystem and provides strategic advice to the management of organizations on interdependencies and strategic alignment between the firm and its ecosystem of external actors. In this context, Iansiti/Levien (2004, 8) describe the term ecosystem as *"a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival."* Hence, the success of one participant ties to the success of other participants in the ecosystem. To influence the success of the ecosystem, partners can either interact through cooperation, competition, or co-competition (Gnyawali/Park 2011). However, the broad scope of business ecosystems makes it almost impossible to go beyond the statement that a firm's fate depends not only on its industry but on the ecosystem of partners (Shipilov/Gawer 2020).

2.2.2 Innovation Ecosystems

In response, the research stream on innovation ecosystems moves the *"focal value proposition"* of the customer to the center of an ecosystem (Adner 2006). Defining an innovation ecosystem as *"a set of actors that contribute to the focal offer's user value proposition."*, Kapoor (2018, 2) builds on new types of actors, such as complementors that impact the enterprise and its focal product or service (Teece 2007). This and related work (cf. Adner 2006) illustrates the importance of complementary innovation and how companies can use the innovative power of complementors to prosper.

Based on the focal value proposition in an ecosystem, Adner (2017, 40) coined the term ecosystem-as-a-structure as *"the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialise."* In this definition, ecosystem actors are not necessarily linked through existing partnerships but need to be matched in the process of coordinating different demands, interests, and perspectives. The core belief is that a focal actor relies on the coordination of an ecosystem of autonomous actors leading to interdependencies between the focal actor and agents in the ecosystem. This mutual relationship can be explained according to economic and structural components (Kapoor 2018; Adner 2017).

Economic components emphasize how complementary products or services of complementors are linked to the focal actor's value proposition. Jacobides et al. (2018) differentiate between unique and supermodular complementarities, which characterizes the relationship between a focal actor and autonomous actors in the ecosystem. Unique complementarity describes that Product A does not function without Product B or more generally that the value of Product A is maximized in combination with Product B. In addition, the complementarity can be one or two-way. One-way means that Product A requires a particular Product or Service B, where two-way means that Products A and B both require one other (Teece 1986). In turn, supermodular complementarity emphasizes that an increased amount of Product A makes Product B more valuable. However, the assumption that Product A and B are different products or services needs to be met.

Structural components describe how actors in an ecosystem interact during the process of value creation. In this regard, recent conceptual work (Kapoor 2018; Adner 2017) focused on activities, actors, and architecture as distinct structural elements of ecosystems. First, activities are actions that describe how value is co-created in a business ecosystem. Activities can, for example, include the integration of new complements (Kapoor 2018). Second, actors represent agents who produce different offers based on distinct activities. On the supply-side, some complementors provide complements to contribute to a focal actor's value proposition. Contrary to a firm-supplier relationship, where the firm exerts decision rights regarding the cooperation, complementor autonomously decides if they want to join an ecosystem or not (Kapoor 2018). On the demand-side, some consumers contribute to the focal actor's value proposition by providing insights on the usage of complements (Lusch/Nambisan 2015). Third, there is the architecture that defines technological interactions that orchestrate interactions between the supply and demand-side of the ecosystem (Faber et al. 2019). Based on the architecture, the ecosystem can be either platform- or product-based. Whereas platform-based ecosystems build on autonomous agents, product-based ecosystems entail only interactions between the focal actor and consumers (Kapoor 2018).

As value is no longer solely created in the confines of a firm, the perspective on innovation ecosystems is strongly linked to the concept of value co-creation in service ecosystems, where value is co-created within complex constellations of actors and resources (Vargo et al. 2008).

2.2.3 Service Ecosystems

The research stream of service sciences and marketing introduced the S-D logic (cf. Vargo/Lusch 2008; Vargo et al. 2008) that emphasizes the importance of value co-creation in service ecosystems. Like in a business ecosystem, actors in the service ecosystem co-evolve their roles and skills in mutual dependency to thrive (Moore 1993; Adner 2006). In this sense, service ecosystems are a self-adjusted, self-contained system of regularly loosely coupled economic and social actors (Vargo/Lusch 2011). Also, service ecosystems connect a variety of actors through services that foster the co-creation of value based on a shared institutional logic. In contrast to innovation ecosystems, the focus is not on the focal offer's value proposition and customer, but on the value that is co-created by polyadic relationships between actors in the ecosystem. Service ecosystems need to provide structural flexibility and integrity, offer a shared worldview, and provide a stable architecture of participation to be successful (Lusch/Nambisan 2015).

First, structural flexibility refers to the ease of how actors can collaborate in an ecosystem. As an example, knowledge boundary resources such as documentation and how-to guides can help actors to collaborate (Foerderer et al. 2019). Hence, structural flexibility governs business agility (Tilson et al. 2010). Next, structural integrity describes the relationship between the actors within a service ecosystem based on their degree of coupling and serves as an indicator for ecosystem engagement (Lewicki/Brinsfield 2009). In this sense, the coupling can range from tight, strategic coupling in strategic partnerships to a loose coupling with a low dependency between actors (Orton/Weick 1990; Weick 1976).

Second, a service ecosystem needs to offer a shared worldview to bridge the cognitive distance between actors in the ecosystem (Hendriks-Jansen 1996; Weick 1995). A shared worldview can be the institutionalization of standards or a shared institutional logic to ensure that actors align more quickly on resource integration and exchange. Third, the service ecosystem needs to provide a stable and scalable architecture of participation. This architecture facilitates the interaction between actors in the service ecosystem (Lusch/Nambisan 2015).

Besides business ecosystems that focus on mutual dependency and co-evolution, innovation ecosystems that put a focal value proposition to center, and service ecosystems that emphasize the importance of value co-creation, there is a fourth research stream of platform ecosystems that assembles around a core technology.

2.2.4 Platform Ecosystems

The literature on platform ecosystems is rooted in the book of Gawer/Cusumano (2002), who illustrate the case of so-called platform leaders. Based on the examples of Microsoft, Intel, and Cisco, the authors demonstrate how each of the companies uses their ecosystem to drive innovation around a core platform technology. In this sense, the work on platform ecosystems is different from work on innovation-based ecosystems that focus on the focal offer's value proposition. Furthermore, the platform ecosystems differ from service ecosystems that emphasize value co-creation solely. Instead, platform ecosystems focus on the integration of complementary products or services from an ecosystem of autonomous complementors through standards and interfaces to trigger network externalities (Parker et al. 2017; Parker/Van Alstyne 2017; Teece 2018).

A fundamental characteristic of a platform ecosystem is its generativity (Henfridsson/Bygstad 2013; Yoo et al. 2010; Nambisan et al. 2019), where generativity is defined as the *"overall capacity to produce unprompted changes driven by large, varied, and uncoordinated audiences"* (Zittrain 2005). Building on the standards and interfaces—also referred to as boundary resources—provided by the platform owner, ecosystem actors fuel generativity with their innovation capabilities (Nambisan et al. 2019; Boudreau 2012). For example, complementors can share knowledge in the ecosystem to come up with new ideas of value-adding complements. The combination and utilization of ideas in the ecosystem, in turn, increases the generativity of the ecosystem (Dokko et al. 2014). This effect can be illustrated based on the application development industry, where more external developers in a platform ecosystem lead to a greater variety and more applications (Boudreau 2012).

As the integration of complementary products or services into a platform is at the center of research on platform ecosystems, the type of complementarity is of particular importance. In this regard, the type of complementarity between the platform and complements can be unique and supermodular (Jacobides et al. 2018). Taking iOS as an example of a platform and the application store as a complement that is integrated into the platform, both the platform and the complement have unique complementarity in the sense that the application store cannot function without iOS. Furthermore, a supermodular complementarity exists between the application store and applications from third-party developers as more applications increase the value of the application store (Jacobides et al. 2018).

2.2.5 Toward an Integrated Concept of Digital Platform Ecosystems

The ambiguity of technically oriented concepts such as software-based platforms (Tiwana et al. 2010), industry platforms (Gawer/Cusumano 2014), platform-mediated networks (McIntyre/Srinivasan 2017), and digital platforms (de Reuver et al. 2018), and the variety of literature streams on social aspects on business (Moore 1997), innovation (Adner 2006), service (Vargo et al. 2008), and platform ecosystems (Gawer/Cusumano 2002) highlights that there is no integrated concept of digital platform ecosystems.

Table 3 summarizes the core concepts and descriptions of the integrative reviews on technical aspects of (digital) platforms (Tiwana et al. 2010; Gawer 2014; McIntyre/Srinivasan 2017; Constantinides et al. 2018; de Reuver et al. 2018) and social characteristics of ecosystems (Shipilov/Gawer 2020; Lusch/Nambisan 2015). Each of the core concepts in Table 3 combines concepts of the reviewed integrative studies such as modules (Tiwana et al. 2010) and digital applications (de Reuver et al. 2018).

Table 3. Core Concepts of a Digital Platform Ecosystem

Core concepts	Description	Sources
Digital Applications	Digital applications are executable pieces of software that can be offered, for example, in the form of apps, services, or systems to end-	(Tiwana et al. 2010; de Reuver et al. 2018)

	users. Besides, digital applications are referred to as *modules* provided and developed by complementors.	
Boundary Resources	(1) Refer to *interfaces* provided by the platform owner that enable actors to co-create applications and to exchange information such as Application Programming Interfaces (APIs). (2) Refers to *resources* provided by the platform owner that facilitate the arm's length relationship between the actors such as Software Development Kits (SDKs).	(Tiwana et al. 2010; de Reuver et al. 2018)
Digital Platform Architecture	A conceptual blueprint that describes how the technical ecosystem is partitioned into a stable platform core and a flexible periphery of complementary modules that are encouraged to vary and the design rules binding on both.	(Tiwana et al. 2010; de Reuver et al. 2018; Gawer 2014; McIntyre/Srinivasan 2017)
Digital Platform	Digital platforms comprise technical platform architecture and socio-technical platform governance. (1) Technical: An extendable codebase to which complementary third-party modules can be added. The perspective includes the concepts of d*igital applications*, *boundary resources*, and *platform architecture*, referring to a *software-based platform*. (2) Sociotechnical: Includes the use of *boundary resources* and governance mechanisms that facilitate the value co-creation process between *agents* on the platform.	(Tiwana et al. 2010; de Reuver et al. 2018; Gawer 2014; McIntyre/Srinivasan 2017; Constantinides et al. 2018)
Agents	Autonomous agents interact with other agents based on a digital platform. Agents can also interact within and across platforms. An agent can play the role of a complementor and user in non-separable ways and can evolve. (1) A *complementor* co-creates complementary goods. This also refers to collaborative innovators. (2) A *user* or consumer is the beneficiary of a complementary good. (3) The *platform owner* ensures the stability of the platform architecture while increasing the versatility of digital applications. Furthermore, the platform owner sets up governance mechanisms.	(Gawer 2014; McIntyre/Srinivasan 2017; Tiwana et al. 2010; Lusch/Nambisan 2015)
Platform Ecosystem	Platform ecosystems describe the interaction of co-evolving autonomous agents or resources affiliated with a digital platform. (1) Technical: the collection of the technical *digital platform* and value-adding *applications* with supermodular complementarity. (2) Organizational: loosely coupled autonomous *agents* with shifting association pattern from collaboration to competition and vice versa.	(Tiwana et al. 2010; de Reuver et al. 2018; Gawer 2014; McIntyre/Srinivasan 2017; Jacobides et al. 2018)

2.3 The Evolution of Digital Platform Ecosystems

The literature on the evolution of digital platform ecosystems is still in its infancy (Gawer 2014). However, it is vital to understand how digital platform ecosystems came into existence to be able to predict future implications. In an effort to structure the landscape on digital platform ecosystem evolution, Staykova (2019, 21-31) conducted a structured literature review and identified four relevant perspectives: growth, co-evolution, strategic, and life-cycle.

The growth perspective focuses on the formation and development of digital platform ecosystems through the investigation of growth patterns (Staykova 2019, 22). In the launch phase, a digital platform ecosystem starts to onboard the two sides of the ecosystem (Evans 2009; Evans/Schmalensee 2010). When the platform owner established a critical mass, the digital platform ecosystem ignites (Evans 2009), referring to the self-reinforcing effect of network externalities (Tiwana et al. 2010; McIntyre/Srinivasan 2017). A key challenge is to overcome the chicken & egg problem (Caillaud/Jullien 2003), where the platform owner needs both sides to utilize cross-side network externalities (Eisenmann et al. 2006). After the ignition phase, a digital platform ecosystem can enter the phase of self-sustained growth (Evans/Gawer 2016). In this phase, the platform owner needs to mitigate constraints such as pricing or value capture strategies (Casey/Töyli 2012; Vogelsang 2010) to sustain positive cross-side network externalities. Last, digital platform ecosystems can grow to digital platform leaders (Gawer/Cusumano 2008; Gawer/Cusumano 2002) by reaching market equilibrium or even by fostering “winner-takes-all” scenarios (Noe/Parker 2005).

The co-evolution perspective illustrates interdependencies and changes between the technical architecture, the platform governance, the ecosystem of actors, the platform owner, and the environment (Staykova 2019, 28; Riasanow et al. 2020). In their early work, Tiwana et al. (2010) depict that the technical architecture in the form of modularity, design rules, and decomposition co-evolves with the platform governance in the form of decision rights, control mechanisms, and the status of ownership. Later work focuses on the flexible periphery that consists of boundary resources and control mechanisms that are interdependent (Eaton et al. 2015; Ghazawneh/Henfridsson 2013). This interaction of boundary resources at the core and platform control, in turn, directly influences the variety of complements on the periphery of the digital platform (Tiwana 2014)[7]. However, recent studies show that more boundary resources at the core do not necessarily lead to a higher variety of complements (Um/Yoo 2016). In addition, complementors who are present from the beginning create more complements in comparison to latecomers, who orient themselves often toward already existing complements on the platform (Boudreau 2012). In turn, an increased variety of complements is not always beneficial as it can create tensions between complementors and between complementors and the platform owner (Cennamo/Santalo 2013; Foerderer et al. 2018; Koh/Fichman 2014)[8]. Besides, ecosystem partners can co-evolve dependent on one another (Riasanow et al. 2019a) based on asymmetric cross-side network externalities (Song et al. 2018)[9]. Another factor is the platform owner perspective, where IS capabilities and corresponding strategies co-evolve dependent on the evolutionary stage (Tan et al. 2015). Last, digital platform ecosystems can also co-evolve with the environment (Tiwana et al. 2010), such as in the competition with other platform companies, where the platform owner tries to regulate the access to its architecture (Ojala/Lyytinen 2018).

The strategic perspective deals with the question of how the platform owner can steer the evolution of the digital platform and the ecosystem (Staykova 2019, 26). A strategic goal that was also discussed early on in the platform literature is to achieve a critical mass of consumers and complementors (Evans 2009). Strategies that can be adopted is to subsidize actors in the

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[7] Examples are application stores, where more boundary resources such as SDKs lead to more applications of external developers. In addition, control in the form of censorship or regulatory processes can influence what applications are allowed on the platform and what applications are not.

[8] Examples are merchant platforms like Amazon or Alibaba, where more complements lead to higher competition between complementors in the ecosystem (Gawer 2014). Another example is that more complements can lead to tensions between the platform owner and complementors, as illustrated in the case of Android’s Play Store, where Google developed a photo app on its own, getting in direct competition with existing complements on the platform (Foerderer et al. 2018).

[9] An example is the co-evolution of consumers and application developers based on governance mechanisms implemented by the platform owner (Song et al. 2018).

ecosystem that are quality or price-sensitive or to secure *"marquee"* users that exclusively participate in the platform ecosystem (Eisenmann et al. 2006). Another strategy is to offer a compelling value proposition by leveraging depth (e.g., the addition of more functionality) and breadth (e.g., offer new functionalities) of the platform ecosystem (Hagiu 2009). Last, there are coring and tipping strategies (Gawer/Cusumano 2007). Coring is the creation of a standalone value proposition based on a platform technology. Contrary, tipping refers to the bundling, envelopment, and offering of unique features to prevail over competitors (Eisenmann et al. 2011).

Last, the perspective on life-cycle evolution focuses on evolutionary paths and life-cycle models (Staykova 2019, 27). This perspective is influenced by the work of Moore (1993) and adopted by the platform literature (Huang et al. 2009), who depicts business ecosystems based on four life-cycle stages: birth, expansion, coordination/maturity stage, and evolution or death. During the stages, a platform needs to first focus on the diversification of offerings to grow the installed base of users. Second, the platform owner needs to establish coordination mechanisms to mitigate the lemons market problem[10]. Third, the platform owner needs to adopt new technologies, features, and actors to remain competitive and to react to changing market conditions (Huang et al. 2009). In contrast to the life-cycle model by Huang et al. (2009), the evolution of a digital platform ecosystem can also be illustrated based on the business model according to the stages of embryonic, emerging, identifying business model, and maturity (Muzellec et al. 2015). Alternatively, Han/Cho (2015) illustrates that the platform KakaoTalk followed the three phases of (1) preparation that represent the launch of the digital platform, (2) spread that illustrates the offering of unique content and bundled services, to (3) the evolution that ends in the market dominance.

The different perspectives illustrate that extant literature on digital platform ecosystem emergence has focused primarily on established digital platform ecosystems and how they evolve. However, it is not clear how digital platforms came into existence in the first place. Besides notable exceptions that focus on capabilities during the genesis of digital platform ecosystems (Tan et al. 2015) and technology-enabled assets of companies with an established business model that transition toward a digital platform (Sebastian et al. 2017), it is unclear how digital platform ecosystems came into existence and how companies with established businesses can transform toward a digital platform ecosystem.

2.4 Value Co-Creation in Digital Platform Ecosystems

During the last decades, the creation of value has shifted from the production in the confines of a firm to the co-creation of value with a variety of actors in complex ecosystems (Skålén et al. 2015; Prahalad/Ramaswamy 2004). Scholars in the field of marketing and service sciences acknowledged this transition by adjusting the goods-dominant (G-D) logic with a focus on physical goods to an S-D logic that puts the mutual co-creation process in service ecosystems at the center (Vargo/Lusch 2008; Vargo et al. 2008).

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[10] The Lemon Market Problem in the context of digital platforms describes that a lack of information enforces costs on complementors, which can result in extreme cases in a market breakdown (Evans 2012). An example is the Atari game market, where a massive increase in games combined with no possibilities to assess the quality of games (e.g., through peer reviews) led to the breakdown of the market.

The G-D logic is a theoretical framework that describes effects like specialization and standardization on tangible products to benefit from control and efficiency (Vargo/Lusch 2008, 2004). According to this logic, traditional firms engage in dyadic relationships with suppliers that are based on fixed contractual agreements and terms. Internally, those firms use specialization of labor to take advantage of economies of scope and scale (Vargo/Lusch 2008). Hence, firms that follow a G-D logic keep control of the production process in the firm with the overarching goal to increase efficiency and throughput. When taking a supply chain, as an example, the focal firm uses its network of suppliers to obtain production material just in sequence to increase the throughput and efficiency. This example illustrates that firms that follow a G-D logic optimize production processes by separating the control of actors (Vargo/Lusch 2008, 2004). Besides, the focal firm needs to foster customer engagement by establishing opportunities through clearly defined tasks (Bowen/Jones 1986; Steers/Porter 1974).

In opposition, the S-D logic emphasizes that value is not created by one firm in isolation but results from the exchange of services in complex ecosystems. In those ecosystems, one actor uses a set of skills and capabilities to benefit another actor and vice versa (Vargo et al. 2008). The dominant means of interaction are digital platform ecosystems, where the digital platform provides the core functionality to enable co-creating activities of actors in the ecosystem (de Reuver et al. 2018; Lusch/Nambisan 2015). Actors in the ecosystem can use the boundary resources provided by the digital platform to co-create value (Eaton et al. 2015; Ghazawneh/Henfridsson 2013). In turn, the interaction of actors with boundary resources unleashes generativity through resource liquefaction and resource density (Lusch/Nambisan 2015; Vargo/Lusch 2008). In this regard, resource liquefaction refers to the decoupling of information from its physical representation (Normann 2001, 31-33; Tilson et al. 2010).

An example is a physical book that can be digitized into a digital archiving system, which allows it to be shared. Resource density describes the reconfiguration of resources around the dimensions place, time, possession, and form. An example is IKEA, where the timing to assemble furniture was changed after the purchase took place by involving the customer (Lusch et al. 2010; Normann 2001, 27). Additionally, the generativity of a digital platform ecosystem can result from the variety of actors in the ecosystem, where each of them uses different skills to contribute to spillover effects (Boudreau 2012; Parker et al. 2017).

Lusch/Nambisan (2015) contextualized the S-D logic based on the context of digital platform ecosystems along with three fundamental building blocks: service ecosystem, service platform, and value co-creation. First, a service ecosystem is a self-adjusted, self-contained system of regularly loosely coupled economic and social actors (Vargo/Lusch 2011). In this ecosystem, a focal actor or technology connects autonomous actors through core services that foster the co-creation of value with a shared institutional logic. Second, the service platform enables resource liquefication and resource density to facilitate an efficient and effective exchange in the ecosystem. The service platform can be a digital infrastructure (Tilson et al. 2010) that provides boundary resources such as APIs and SDKs that enable resource liquefication and density (Ghazawneh/Henfridsson 2013). Third, the co-creation of value that describes the process of value creation between actors within a service ecosystem based on a service platform. In this process, actors can take different roles, such as the service offered and the service beneficiary. The more actors interact in this process, the more they learn from each other. Through this process, actors learn what they can do in their current role (Schreieck/Wiesche 2017). In addition, the co-creation process needs to be aligned with organizational structures, roles, and intra-organizational processes (Lusch/Nambisan 2015).

To understand the value co-creation process between digital platforms and their ecosystem of autonomous actors, recent contributions in IS proposed to focus on boundary resources as a level of analysis, as those connect the technical platform with the social ecosystem (de Reuver et al. 2018). Research on boundary resources in digital platform ecosystems adopted the concept of boundary objects (Leigh Star 2010) to explain the arms-length relationship between the digital platform and its ecosystem. In this regard, boundary resources help to understand how the platform owner can govern its ecosystem (Ghazawneh/Henfridsson 2013) or how boundary resources can emerge and evolve based on interactions in the ecosystem (Eaton et al. 2015). In addition, boundary resources can enhance the scope and diversity of a digital platform in a process that is also referred to as resourcing (Ghazawneh/Henfridsson 2013). Resourcing is best illustrated when taking the example of the iOS ecosystem that provides a new SDK like ARKit, which, in turn, enables the ecosystem of third-party developers to create applications based on augmented reality technology. Another characteristic of boundary resources is that the platform owner can use them to increase the control over existing services in the process of securing (Ghazawneh/Henfridsson 2013). More recent research on digital platforms emphasizes the design of boundary resources to support the scope and scale of managing knowledge according to the practices broadcasting brokering and bridging (Förderer et al. 2018).

Apart from the findings of the paragraph above, there is sparse knowledge on the process of how actors create, capture, and consume value (Ceccagnoli et al. 2012; Lusch/Nambisan 2015; Schreieck et al. 2017). This is particularly evident when taking the building blocks of value co-creation in digital platform ecosystems as a foundation. Exceptions can be found in the discipline of service sciences that focus on other contextual settings such as healthcare ecosystems with no central service platform (Frow et al. 2016) or B2B ecosystems where value co-creation activities are carried out via e-mail or telephone (Breidbach/Maglio 2016). However, to the best of our knowledge, there is only sparse research on the value co-creation process in digital platforms that provide boundary resources to an ecosystem of autonomous actors (cf. Eaton et al. 2015; Foerderer et al. 2019; Ghazawneh/Henfridsson 2013).

3 Research Design

In this section, we elaborate on the research paradigm that consists of ontological and epistemological assumptions, as well as the overall research strategy with subsequent research methods (Guba 1990, 17). In the subsequent chapters, we reflect on the research paradigm to study how digital platforms emerged and how they integrate ecosystem partners to co-create value.

3.1 Research Paradigm

The research paradigm is a framework that consists of ontology that defines what the nature of reality is, an epistemology that defines what can be known about the nature of reality, and methodology, which defines how reality can be analyzed (Denzin/Lincoln 2005, 11). In this dissertation, we adhere to a constructionist paradigm based on ontological critical realism and epistemological subjectivism (Levers 2013). For the methodology, we follow a qualitative research strategy (Gephart Jr 2004).

When it comes to the question of the nature of reality, ontological critical realism assumes that there is an observable and independent world that is socially co-constructed by thinking human beings (Danermark et al. 2002, 200). However, this independent reality cannot be accessed in its entirety but only through observation of phenomena that describe partial fragments of reality (Letourneau/Allen 1999; Levers 2013). In this regard, meaning is created based on the interaction of the interpreter and the phenomenon (Crotty 1998, 11), where the interpreter is separate from the phenomenon. As a result, the interpreter's observations are shaped only by the phenomenon and social influences. When taking the perspective on the phenomenon of digital platform ecosystems, it becomes evident that social actors with agency (Gawer 2014) co-construct the ecosystem in the process of co-evolution (Song et al. 2018). Hence, the stance of ontological critical realism (Danermark et al. 2002, 200) allows us to take the social influences and co-evolutionary aspects between actors in the digital platform ecosystem into account.

For epistemology, or what can be known about reality, we use the stance of subjectivism, where knowledge is *"filtered through the lenses of language, gender, social class, race, and ethnicity"* (Denzin/Lincoln 2005, 21). Whereas a solely technical perspective on a digital platform architecture would allow us to take a more objectivist, postpositivist view (Guba/Lincoln 1994, 109-110), the social aspects of ecosystems and the interaction of individual agents within is calling for a more subjectivist epistemology (Guba/Lincoln 1994, 110-111). Hence, the focus on a socio-technical perspective justifies the choice of epistemological subjectivism as digital platform ecosystems always involve social actors. Also, knowledge from those actors is always value-laden, which also calls for a subjectivist view (Levers 2013).

In sum, the reason why we have chosen the constructionist paradigm is due to the focus on the socio-technical perspective of digital platform ecosystems. By selecting the constructionist paradigm, we can also take intangible and socially constructed realities of digital platform ecosystems, as well as co-evolutionary aspects and individual actors with agency into account.

3.2 Qualitative Research Strategy and Research Methods

The last part of the research paradigm is the qualitative research design, which consists of multiple methods that use an interpretive, naturalistic approach to discover knowledge (Denzin/Lincoln 1994, 3; Gephart Jr 2004). The combination of a phenomenon-driven research paradigm (Levers 2013) and a qualitative research strategy is particularly fruitful when the aim is to study social actors in their natural environment (Denzin/Lincoln 1994, 2). According to Denzin/Lincoln (2005, 3), qualitative research can create an understanding of how different representations of the world come into existence. Also, qualitative research allows us to enquire about the nature of reality more holistically and is, hence, useful when the phenomenon of interest cannot be reduced to a few variables (Gephart Jr 2004). Due to this fit, we adopted a qualitative research strategy that takes the high complexity and interdependencies between the technical architecture and social actors (Tiwana 2014), as well as the agency of autonomous actors (Gawer 2014) in a digital platform ecosystem into account.

Based on the qualitative research strategy, we have drawn on different research methods to enquire about the research questions. First, we used structured literature reviews in stand-alone studies and as a secondary method to rigorously structure and process extant literature on a phenomenon in a transparent and reproducible way (Webster/Watson 2002). Second, we used two different case study designs—single and multiple case studies—to describe and set the boundaries of the phenomenon (Yin 2014, 50) of digital platform ecosystems. Third, we use DSR to build an actionable design artifact that can be used by scholars and practitioners alike (Gregor/Hevner 2013; Hevner 2004). Fourth, we employ fsQCA to develop a typology of different digital platform ecosystems that acknowledges their complex and interdependent nature (Fiss 2011; Ragin 2009, 88). Table 4 shows the overall mapping of all publications in this dissertation and the underlying research methods.

Table 4. Overview of Research Methods Applied in the Embedded Publications

No.	Publication	Lit. Rev.	SCS	MCS	DSR	fsQCA
1	Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms	●				
2	Digital Platform Ecosystems	○		●		
3	Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber	○		●		
4	The Emergence of Native Multi-Sided Platforms and their Influence on Incumbents	○		●		
5	Navigating Role Changes During the Transition toward Service Platform Ecosystems	○	●			
6	Towards a Design Framework for Service Platform Ecosystems	○	○		●	
7	Value Co-Creation Practices within Business-to-Business IoT Platforms	○		●		
8	The Influence of Digital Affordances and Generativity on Digital Platform Leadership	○				●

Legend:
● Primary method used in the publication
○ Secondary method used in the publication
Lit. Rev.: Literature Review
SCS: Single Case Study
MCS: Multiple Case Study
DSR: Design Science Research
fsQCA: fuzzy-set Qualitative Comparative Analysis

Structured Literature Review

Literature reviews are one of the essential methods of a scientific scholar to make sure that extant research on a topic of interest is identified and extracted in a structured and replicable way (Webster/Watson 2002; Cooper 1988; Vom Brocke et al. 2009). Several articles provide guidelines on how to conduct a structured literature review rigorously (cf. Vom Brocke et al. 2009; Webster/Watson 2002). First, scholars need to define the scope of the literature review by defining databases that include relevant outlets and a set of keywords that describes the phenomenon of interest. Next, scholars use the initial data set to check if the articles are relevant or not by scanning the title and the abstract (Vom Brocke et al. 2009). The resulting set of articles is then the basis for the second step, which consists of a forward and backward search. Whereas the forward search targets all sources that cited the article, the backward search identifies relevant articles that the authors cited in the article (Webster/Watson 2002).

To synthesize the final set of articles, scholars can adhere to structured coding processes such as the Grounded Theory (GT) coding approach proposed by Strauss (1987, 55 ff.). In this approach, scholars use the concepts of open, axial, and selective coding. First, open coding is either used in a word-by-word or sentence-by-sentence manner to identify relevant concepts of interest. Second, the axial coding establishes relationships between open concepts and structures the open codes. Last, the concept of selective coding identifies broad schemes that help to structure axial codes. During all coding steps, emerging codes and concepts are compared continuously with existing codes to ensure that new categories are robust and consistent (Glaser/Strauss 2017, 101). Through the structured identification of related work, scholars are also able to incorporate their findings into the current body of knowledge (Iivari et al. 2004) and, hence, can connect and synthesize the related work effectively with the results and discussion within an article (Bem 1987, 193).

Besides using literature reviews as a secondary method to ensure the structured identification and synthesis of extant research, the method can also be used as a primary method to synthesize and theorize on the literature of a specific topic (Leidner 2018; Paré et al. 2015). When applied as a primary method, literature reviews can be categorized based on different categories in a taxonomy (Cooper 1988), in different types in a typology (Paré et al. 2015), or by the polylithic nature of reviews according to their focus and research objective in a framework (Leidner 2018). Especially the polylithic framework of review and theory development papers (see Figure 2) provides a useful synthesis of all prior conceptual contributions on literature reviews and the intersection between theory development and review papers. In the subsequent dissertation, we will use the polylithic framework (Leidner 2018) to position the literature reviews of the embedded publications.

In the embedded publication *“Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms”* (P1), we conducted an organizing review (Leidner 2018) of the literature on IoT platforms to identify how scholars in the field of IoT platforms use the concept of a platform. As a result, we found out that scholars in the field of IoT platforms use the concept of platforms ambiguously and inconsistently. This insight, in turn, motivated us to develop a broader definition of the term digital platform ecosystem (P2) through a specific theorizing review (Leidner 2018), where we combined findings of the literature of digital platforms and ecosystems with contemporary cases of digital platform ecosystems. Besides, we carried out complementary literature reviews as a secondary method in all of the remaining embedded publications to ensure a structured process in identifying related publications.

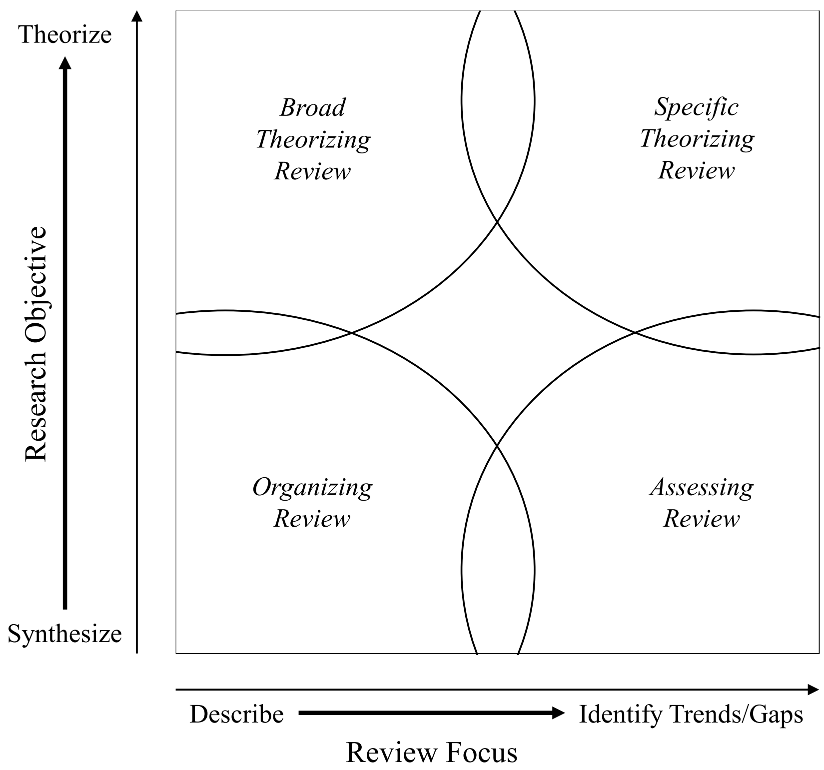

Figure 2. Polylithic Framework of Literature Reviews (Leidner 2018)

Case Study Research

Case studies are not a methodological choice, but a selection of the phenomenon that is subject to inquiry and its boundaries to the environment (Stake 1994, 236). Hence, a case study is the selection and investigation of *"a contemporary phenomenon (the 'case') in depth and within its real-world context [...]"* (Yin 2014, 16). To inquire about a contemporary phenomenon, Yin (2014, 1) developed an iterative six-step approach that ensures repeatability and scientific rigor (see Figure 3).

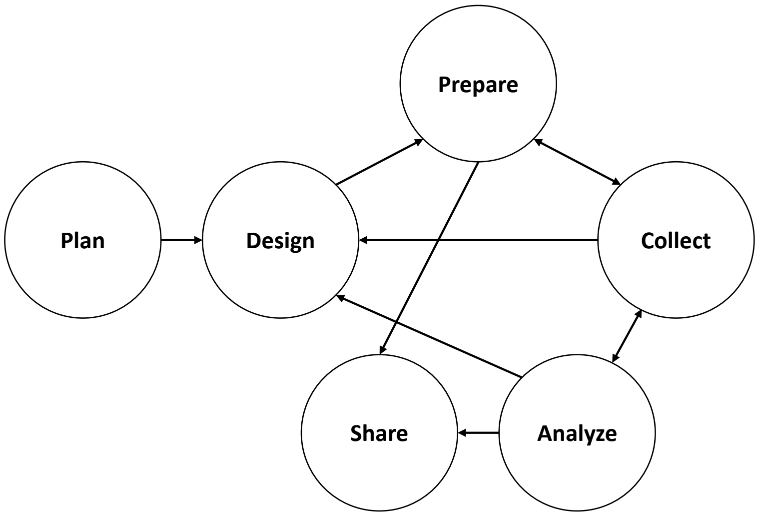

Figure 3. Case Study Research Approach (Yin 2014, 1)

In the planning phase, scholars need to evaluate the appropriateness of case study research (Yin 2014, 10-14). Benbasat et al. (1987) provide three guidelines to evaluate the appropriateness of case study research. First, it is crucial to determine if the phenomenon of interest needs to be observed in a context-dependent environment or if it can also be observed from an external perspective. An example is the introduction of the end-user computer, which could only be understood by talking to people in companies. Second, through this interaction between the researcher and the context-dependent phenomenon, the case study method allows also to enquire on the how and why questions, for example, how and why companies use the end-user computers (Benbasat et al. 1987). Third, case study research is suitable when the phenomenon of interest is contemporary, and only a few previous studies have been conducted so far. In sum, a relevant case needs to cover a phenomenon that is unique in either the nature of the case, the historical background, the physical setting, contextual factors such as economic, politic or legal, other cases that contrast the phenomenon or the informants or sources that provide knowledge about the phenomenon (Stouffer 1941; Stake 1994, 238).

In the design phase, scholars define a research design as a logical plan for getting from the research questions to a set of conclusions about the questions (Yin 2014, 28). Hence, essential components of a case study research design are the research question(s), underlying propositions, the unit(s) of analysis, the logic that links the data to the propositions, and the criteria to interpret the results (Yin 2014, 29). According to Wittgenstein, *"[properties] are first represented by propositions — first formed by the configuration of objects."* (Wittgenstein 1922, 27). Hence, a proposition posits a statement about the nature of reality that provides an answer to *"how"* and *"why"* questions (Yin 2014, 30). In turn, the level of analysis describes what the researchers want to analyze and can range from individual persons (cf. Bromley 1986, 1) to digital platform ecosystems that have several embedded units of analysis such as complementors, consumers, and the platform owner. The linking of the data to the propositions describes the coding process[11]. An example is the GT coding process described earlier (Strauss 1987, 55 ff.). Last, it is essential to define criteria to validate the robustness of the findings (Yin 2014, 36). Criteria are the construct validity that describes the correct operationalization of measures, internal validity that describes that inferences about causality are valid, external

[11] An example of the coding process can be found in Appendix A: Data Representation and Coding.

validity that covers the generalizability with other, similar phenomena, and reliability that aims to ensure reproducibility of results (Yin 2014, 45-49). Based on the components of a case study research design, there are four basic types of designs for case studies (see Figure 4).

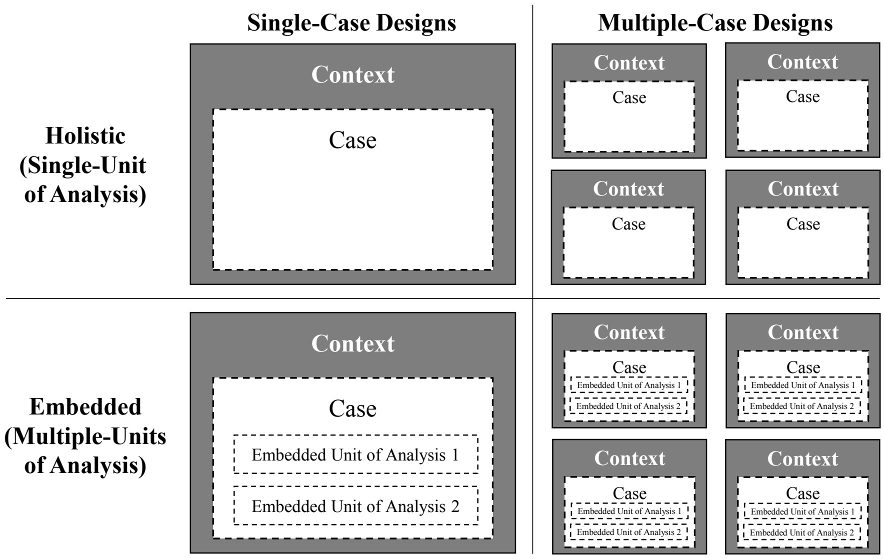

Figure 4. Different Case Study Designs (Yin 2014, 50)

In the preparation phase, the main goal is to develop a sampling strategy to determine data sources for the case and potential embedded unit(s) of analysis and to prepare the data collection process (Yin 2014, 71). Even though the context of the phenomenon is defined, researchers need to also decide on the data sources that help to inquire about the research questions. In this regard, choices need to be made about which persons, places, events, and documents should be observed, interviewed, or gathered (Stake 1994, 244).

In the data collection phase, the main goal is to collect a variety of data sources to verify the repeatability of observations within the case, which is also referred to as data triangulation (Flick 1992). In sum, three data types are relevant for qualitative research in general, and case study research in particular: interviews (Fontana/Frey 1994, 361), observations (Adler/Adler 1994, 377), and archival data (Hodder 1994, 393). When preparing interviews, the interviewer should pay attention to four guidelines (Merton/Kendall 1946). First, non-direction, which refers to starting with unstructured questions and transitioning to structured questions. Second, flexibility, where interviewers are open for new cues and potential avenues for investigation given by the interviewee. Third, specificity, which encourages retrospective inspection by confirming answers to questions. Last, range, where interviewees are allowed to introduce new topics. Each of those guidelines aims to increase the robustness and value of results (Flick 2009, 150; Merton/Kendall 1946). For observations, it is crucial to select the setting in the case and to ensure allowance for formal entrée during the observation (Adler/Adler 1994, 381). Last, archival data that can take the form of documents or physical clues can be of interest. In this regard, the researcher needs to prepare and investigate potential sources for archival data that can, in turn, increase the reliability of results (Hodder 1994, 393-394).

In the data analysis phase, the main goal is to ensure rigor through construct validity, internal validity, and reliability. To achieve those goals, Yin (2014, 136) differentiates between four general strategies. The first strategy reflects on the theoretical propositions that guide the research question. In this strategy, the theoretical propositions guide the analysis of the case study and help to explain contextual conditions and explanations (Yin 2014, 136). The second strategy—working the data from the *"ground up"*—neglects propositions but encourages to *"play with the data"* to derive patterns and structure that, in turn, helps to describe the phenomenon of interest (Yin 2014, 136-137). Third, the strategy of developing a case description aims to organize the case according to a descriptive framework. Hence, this strategy can be seen as an addition to other strategies to increase construct validity by explaining the context and mechanisms of the phenomenon (Yin 2014, 139). Last, there is the strategy of examining plausible rival explanations. Like the third strategy, this strategy can also be seen as addition by developing and testing alternative explanations for the phenomenon (Yin 2014, 140-141). Besides choosing appropriate strategies, the analysis of data is vital to ensure reliability and to convince the reader of the internal validity of the case. In this regard, we adhere to the GT coding process of interview transcripts, archival data, and field notes of observations described earlier (Strauss 1987, 55 ff.).

Last, in the sharing phase, it is crucial to report the findings based on the demand and expectations of the targeted outlet and audience (Yin 2014, 177). For example, data structures can help to visualize the connections between quotes, open codes, axial codes, and selective codes to create transparency about the empirical data (see Appendix A: Data Representation and Coding), which, in turn, increases the trustworthiness and rigor of the results (Gioia et al. 2013). In addition, a case description strategy embeds the reader into the context of the phenomenon and, hence, provides guidance and structure (Yin 2014, 139).

In the embedded publication *"Digital Platform Ecosystems"* (P2), we use a holistic multiple-case design of different digital platform ecosystems. We illustrate how digital platform ecosystems build on different building blocks such as the ownership status, which can range from a decentralized organization to a consortium to a centralized platform owner. The embedded publication *"Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber"* (P3) adheres to an embedded multiple-case design, where we compare the genesis of the ecosystem that consists of the platform and partners based on the cases Airbnb and Uber. Similarly, the embedded publication *"The Emergence of Native Multi-Sided Platforms and their Influence on Incumbents"* (P4) follows an embedded multiple-case design represented by the cases Uber, BlaBlaCar, Flixbus and an incumbent that was transitioning toward a digital platform. In the embedded paper *"Navigating Role Changes During the Transition toward Service Platform Ecosystems"* (P5), we conducted an embedded single-case study of a heating manufacturing company that was transitioning toward a digital platform. The platform owner and different complementors represent the embedded units of analysis. Last, the embedded publication *"Value Co-Creation Practices within Business-to-Business IoT Platforms"* (P7) follows a holistic multiple-case study with three different platform owners in the IoT industry.

Fuzzy-set Qualitative Comparative Analysis

As a methodology, fsQCA has its roots in qualitative comparative analysis (Ragin 2009, 3) that, in turn, dates back to systematic comparative procedures (cf. Linnaeus 1753). The logical foundation is based on the groundwork of Hume (1758) and the work of Mill (1967 [1843]), who described the methods of agreement and difference in his five canons of logical induction. Methods of agreement focus on the logical intersection of sets and describe that a phenomenon is caused by a circumstance when it can be deduced to only one circumstance in common. If five students caught the flu and the only common circumstance is that they went by public transportation, then the method of the agreement would propose that going by public transportation was the cause that triggered the flu. Contrary, methods of difference describe a phenomenon based on the absence of a common cause. Again, there are two groups of students where one group caught the flu, and the other stood healthy. If all else being equal and the only difference was that the healthy students washed their hands, methods of difference would propose that the cause of staying healthy is washing hands. Both examples illustrate that systematic comparative procedures use logic to systematically match and contrast cases to identify common causal relationships by excluding all other possibilities (Ragin 2009, 2).

Building on systematic comparative procedures, fsQCA represents a novel methodology for modeling and interpreting complex and causal relations that can be understood in terms of set-theoretic relations rather than correlation (Fiss 2007). Compared to qualitative comparative analysis on crisp sets that use binary values such as a student that can be either healthy or sick, fuzzy sets follow a more fine-grained logic that can incorporate ordinal and continuous values (Ragin 2009, 89; Fiss 2011). In this regard, fuzzy sets are not restricted to either being one or zero, stating that the case is in a set or not; they allow researchers to capture a more nuanced perspective of the phenomenon. An example is that students may wash their hands more than once a day, which, in turn, provides more details on when this mitigation strategy is successful prevention to catch the flu (e.g., 1 = more than five times a day; 0.66 = more than three times a day; 0.33 = one time a day; 0 not at all). To develop meaningful thresholds, researchers need to follow a calibration process that requires profound knowledge about the case (Fiss 2011).

Basurto/Speer (2012) provide a stepwise approach to calibrate knowledge about the case through qualitative data by starting with the operationalization of conditions, development of anchor points, conduction of content analysis, summarizing of the coded data, and determining and assessing the fuzzy-set scale. First, during the operationalization of conditions, researchers gather qualitative data to determine conditions based on the case and the growing contextual knowledge. Second, the researchers need to define anchor points. As a starting point, there are three basic values: 0 as full-non membership, 0.5 as maximum ambiguity, and 1 as full membership (Ragin 2009, 90; Fiss 2011), which can be refined after collecting knowledge about the case. Third, the qualitative data needs to be analyzed, e.g., through the GT coding process (Strauss 1987, 55 ff.). Fourth, the codes need to be summarized and ordered according to a specific scale. For example, when interviewing students about how and if they wash their hands, additional factors such as the use of antiseptics and the number and time of day might be important. Last, the researcher needs to determine the fuzzy-set scale dependent on the level of detail of the qualitative data. The more nuanced and detailed the data, the more fine-grained, researchers can design the scale. In addition, researchers need to assess the scale by cross-case comparison of causal conditions and cases (Basurto/Speer 2012).

Based on the identified causal conditions and the calibrated fuzzy sets, the fsQCA proceeds with a three-step approach (Fiss 2007). In the first step, researchers need to construct a truth table. Each row includes zero to many cases that illustrate all logically possible combinations of causal conditions (e.g., washing hands) toward an outcome variable (e.g., getting sick). Next, the researchers need to minimize the truth table. Minimization is the simplification of a Boolean function based on logic and the application of De Morgan's laws. After minimizing the truth table, the minimum number of cases and the required minimum consistency level[12] need to be defined. Consistency measures the degree to which cases share similar causal conditions in the truth table compared to the outcome variable (Ragin 2006). In the last step, researchers need to calculate the coverage that determines the proportion of instances of the outcome variable that can be explained according to a combination or a single causal condition (Ragin 2006). The final set of configurations can then be explained based on core conditions that represent necessary conditions for an outcome variable and peripheral conditions for which the evidence for a causal relationship is weaker (Fiss 2011).

In the embedded publication *"The Influence of Digital Affordances and Generativity on Digital Platform Leadership"* (P8), we follow a fsQCA (Fiss 2011) to identify configurations of internal innovation capabilities represented by digital affordances and external innovation capabilities represented by generativity on digital platform leadership.

Design Science Research

In DSR, *"the fundamental principle [..] is that knowledge and understanding of a design problem and its solution are acquired in the building and application of an artifact."* (Hevner/Chatterjee 2010, 5). Following this principle, the artifact is at the center of the DSR paradigm and is both useful and fundamental to acquire new knowledge and to understand the initial problem (Hevner/Chatterjee 2010, 5). Of particular interest are so-called wicked problems (Rittel/Webber 1973) that can be characterized by unstable requirements, complex interactions in the context of the phenomenon, exposure to structural changes over time, and a critical dependence upon social and cognitive abilities to produce effective solutions (Hevner/Chatterjee 2010, 11). In this regard, digital platform ecosystems can be seen as a wicked problem as they comprise co-evolutionary behavior on different levels (Tiwana et al. 2010), that, in turn, yield high complexity between different actors as a result of their autonomy, agency, and social as well as cognitive abilities (Gawer 2014).

To identify solutions for wicked problems, Hevner (2007) proposes three iterative cycles of design science research (see Figure 5). First, there is the relevance cycle where researchers motivate the research endeavor by proposing a new and innovative artifact and how it can be designed (Simon 1996, 9). In this regard, the environment provides requirements as inputs and defines acceptance criteria for the evaluation. Second, the rigor cycle, where researchers link design activities with the knowledge base that includes related theoretical work, experience and expertise, and related artifacts that are already grounded in the literature (Iivari 2007). Third, the design cycle, where researchers iteratively develop and evaluate the design artifact based on constant input from the relevance and rigor cycle (Hevner 2007).

[12] The formula of calculating consistency is: $(Y_i \leq X_i) = \frac{\sum(min(X_i, Y_i))}{\sum(Y_i)}$, where X_i represents membership scores in a combination of conditions, Y_i represents membership scores in the outcome variable.

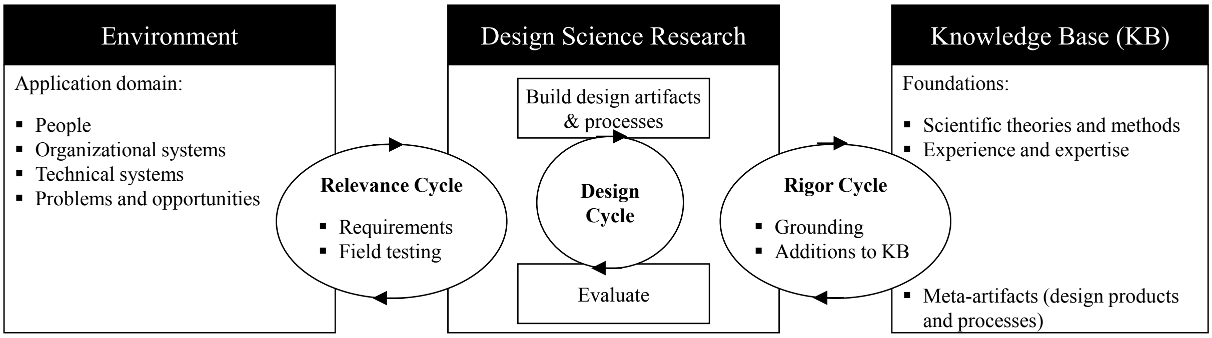

Figure 5. Design Science Research Cycles (Hevner 2004; Hevner/Chatterjee 2010)

To ensure scientific rigor, Hevner (2004) suggests seven guidelines of effective DSR in the field of information systems. First, the design should be an artifact that produces a viable artifact in the form of a model, method, or instantiation. Second, DSR needs to develop a technology-based solution that is important and relevant to a specific business problem. Third, the design must be rigorously evaluated based on the utility, quality, and efficacy of the artifact. Fourth, the DSR must contribute toward advancing the knowledge base and explaining as well as evaluating the design artifact. Fifth, DSR must rigorously demonstrate the methodology of constructing and evaluating the design artifact. Sixth, the design artifact must satisfy the context of the environment. Seventh, the design artifact must be presented effectively to both management- and technology-oriented audiences (Hevner 2004).

In the embedded publication *"Towards a Design Framework for Service Platform Ecosystems"* (P6), we use the three iterative cycles (Hevner 2007) and adhere to the seven guidelines of effective DSR (Hevner 2004) to develop a design artifact that represents a structural and reproducible framework to design digital platform ecosystems.

Part B

1 Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms

Table 5. Fact Sheet Publication P1

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Publication	Multikonferenz Wirtschaftsinformatik (MKWI), 2018
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Analysis, Interpretation, Reporting

Abstract. This contribution aims to shed light on the usage and application of different platform constructs within the context of IoT platforms. The motivation is that Information Systems (IS) scholars and practitioners use the term platform frequently as an unspecific or vague construct. Different research streams shape and influence the understanding of a platform. They range from economic practices like the Two-Sided Market (TSM), Multi-Sided Platform (MSP) or platform business models, to technical platform aspects including standardization and modularization, to the platform ecosystem and the construct of an IS platform fostering value co-creation. Within those constructs, the upcoming phenomenon of IoT platforms represents a specific case to analyze what constructs are used to which extent. Thus, the study helps future IS scholars to use the term platform more precisely and reveals the interrelatedness of the identified constructs. However, the literature review is only a first step towards demystifying the phenomenon of a platform, due to the limited context of IoT platforms.

2 Digital Platform Ecosystems[13]

Table 6. Fact Sheet Publication P2

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Publication	Electronic Markets (EM), 2019
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Abstract. Digital platforms are an omnipresent phenomenon that challenges incumbents by changing how we consume and provide digital products and services. Whereas traditional firms create value within the boundaries of a company or a supply chain, digital platforms utilize an ecosystem of autonomous agents to co-create value. Scholars from various disciplines, such as economics, technology management, and information systems have taken different perspectives on digital platform ecosystems. In this Fundamentals article, we first synthesize research on digital platforms and digital platform ecosystems to provide a definition that integrates both concepts. Second, we use this definition to explain how different digital platform ecosystems vary according to three core building blocks: (1) platform ownership, (2) value-creating mechanisms, and (3) complementor autonomy. We conclude by giving an outlook on four overarching research areas that connect the building blocks: (1) technical properties and value creation; (2) complementor interaction with the ecosystem; (3) value capture; and (4) the make-or-join decision in digital platform ecosystems.

3 Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber

Table 7. Fact Sheet Publication P3

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Publication	Business Information Systems Conference (BIS), 2018
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Abstract. The emergence of digital platforms changes the way how companies interact with their ecosystem. Successful platforms like Apple's App Store utilize an ecosystem of third-party developers to drive innovation. Those platforms are expanding the sphere of influence beyond internal resources and capabilities by taking advantage of a scalable ecosystem of external developers. However, until now it is unclear on how those companies establish a platform ecosystem. This article draws on two case studies in the form of ridesharing and accommodation platforms to illustrate how they transitioned through four evolutionary phases with the help of tight and loose coupling partnerships.

4 The Emergence of Native Multi-Sided Platforms and their Influence on Incumbents[14]

Table 8. Fact Sheet Publication P4

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Publication	Electronic Markets (EM), 2019
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Abstract. Multi-sided platforms (MSPs) are one of the dominant designs of the digital age. However, prior research focuses mainly on established MSPs, leaving little insight into their emergence. We use the literature on technological trajectories and technology diffusion to derive four propositions that increase our understanding on the emergence of MSPs. The propositions include the emergence of native MSPs based on the assimilation of technologies in technological trajectories; how uncertainty influences incumbents not to follow those trajectories; how native MSPs create new demand; and how this demand eventually triggers the transformation process of incumbents to transform toward an MSP provider. We conduct a multiple-case study in the context of mobility services with three native MSP companies along with an incumbent that is transforming toward an MSP provider. The resulting process model shows that MSPs follow a process of sense-making and bricolage to assemble a service-oriented architecture, contrary to the incumbent who adopts technologies according to its institutional logic to improve existing products and processes.

5 Navigating Role Changes During the Transition toward Service Platform Ecosystems

Table 9. Fact Sheet Publication P5

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Publication	European Conference on Information Systems (ECIS), 2020
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Abstract. In recent years, software platforms and their ecosystems have transformed entire industries, created new ones, and eradicated others. To remain competitive, traditional firms need to adapt to those changing conditions. However, there has only been sparse research on an ecosystem level about how firms with a Goods-Dominant logic that fosters value-in-exchange based on sequential value-add in dyadic business networks transition toward a Service-Dominant ecosystem that builds on value-in-use by integrating multiple actors into value co-creating activities. This study draws on a single in-depth case study within the context of a manufacturing company that implemented a software platform to facilitate the transition of roles from a business network toward a service ecosystem. We develop a preliminary process model that builds on the concept of liminality—being between an old and a new role—and role changes to illustrate how firms steer this transition. The results indicate that the manufacturer institutionalizes pre-defined roles for partners by incentivizing the adoption of the software platform. However, existing partners do not necessarily internalize pre-defined roles as expected, but also self-explore new roles based on the affordances of the software platform. This study provides first results on role transitions in emerging ecosystems via control and exploration.

6 Value Co-Creation Practices in Business-to-Business Platform Ecosystems[15]

Table 10. Fact Sheet Publication P6

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Publication	Electronic Markets (EM), 2019
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Abstract. Moving beyond value creation in individual companies, firms have integrated customers, partners, and stakeholders in a mutual value co-creation process. Examples are platforms such as Apple's App Store, where external developers use boundary resources provided on the platform to develop and share applications in an ecosystem. While value co-creation on business-to-consumer platforms is common practice, research on their business-to-business (B2B) counterparts is still sparse. The goal of this paper is to analyze how B2B platforms utilize value co-creation practices. We conduct a multiple case study in the context of emerging Internet of things (IoT) platforms highlighting that B2B platforms follow three standardized value co-creation practices. The platform encourages the supply side through the (1) integration of complementary assets, the demand-side through (2) ensuring platform readiness and connects both processes by (3) servitization through application enablement. We show how platforms leverage different boundary resources in a process of standardization to develop a scalable infrastructure that explains how platforms enable value co-creation within their ecosystem.

7 The Influence of Digital Affordances and Generativity on Digital Platform Leadership

Table 11. Fact Sheet Publication P7

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Publication	International Conference on Information Systems (ICIS), 2019
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Abstract. The rising importance of digital platforms is undisputed. Digital platforms integrate and orchestrate an ecosystem of autonomous actors to co-create value instead of relying on internal innovation capabilities. To do so, the platform owner provides digital affordances through boundary resources that an ecosystem of complementors can use to create value-adding services. To enhance the generativity of the platform, the digital platform combines internal innovation capabilities by providing digital affordances and external innovation capabilities of complementors. However, it remains unclear how the provision of digital affordances and the interaction of external complementors led to the tremendous success of digital platforms. To disentangle both internal and external innovation capabilities, we adhere to a fuzzy-set qualitative comparative analysis based on a set of 47 digital platforms. Preliminary results reveal three configurations of leading digital platforms that combine internal affordances with external generativity and point toward a fruitful area for future research.

8 Towards a Design Framework for Service Platform Ecosystems

Table 12. Fact Sheet Publication P8

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Publication	European Conference on Information Systems (ECIS), 2018
Status	Published
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Abstract. The emergence of digital platforms disrupts the way we communicate, interact, and utilize services. We increasingly find ourselves in a world shifting away from Goods-Dominant (G-D) toward Service-Dominant (S-D) logic. One crucial aspect of this is the way we will use mobility in the future. In the past, we relied on goods in the form of privately owned cars to travel from point A to point B. However, platforms such as Uber, Lyft, DriveNow, and car2go change the way we use mobility from owning a car to using mobility as a service (MaaS). Although we have gathered knowledge about how to optimize production processes in the G-D world, how to design thriving platform ecosystems from an S-D perspective is unclear. In this article, we took a design science research approach to developing a framework that helps scholars to compare systematically, and practitioners to design, a mobility service platform ecosystem (MSPE). First, we started with a literature review to ground the artifact in S-D and MaaS research. We then developed the framework iteratively, drawing from literature and two case studies representing a public and private mobility platform. The resulting artifact is a first step toward providing a structural, reproducible framework to design MSPEs that ensures comparability across platform ecosystems.

Part C

1 Summary of Results

Based on the eight embedded publications, we address the research questions of first establishing a unified definition, second describing the emergence, and third identifying value co-creation mechanisms of digital platform ecosystems. In the remainder of this chapter, we summarize the results for each of the three research questions.

RQ1: *What are the characteristics of digital platform ecosystems?*

A unified definition of digital platform ecosystems. In an initial literature review ***(P1)***, we show that scholars in the field of IoT platforms use the concept of digital platforms ambiguously and on different levels of analysis. An example is that IoT platforms can be described based on a technical, ecosystem, and a combination of technical and ecosystem configuration. Within those configurations, there are different levels of analysis that range from the digital architecture to the organization to a market perspective. Based on those findings, we broadened the scope from IoT platforms to digital platform ecosystems to develop a unified definition ***(P2)***. We synthesize the literature on digital platforms and ecosystems to carve out three core building blocks of digital platform ecosystems: platform ownership, value co-creating mechanisms, and complementor autonomy (see Figure 6).

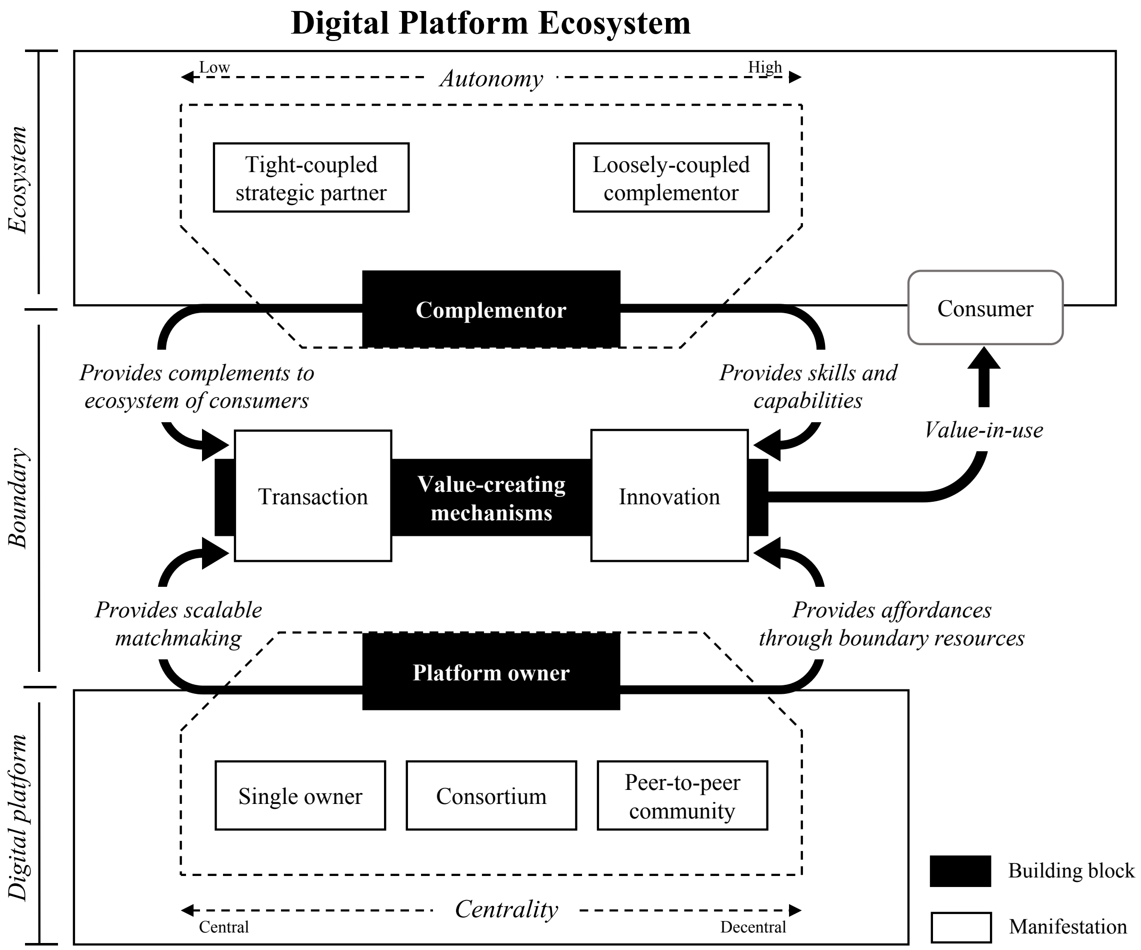

Figure 6. Building Blocks of Digital Platform Ecosystems (Hein et al. 2019a)

In addition to the literature review, we use several case studies to show how different digital platform ecosystems have implemented the key characteristics. For platform ownership, we show centralized digital platform ecosystems such as Apple's iOS, versus decentralized platform ecosystems that are built on blockchain technology. For value co-creating mechanisms, we highlight transaction and innovation-based mechanisms. Transaction mechanisms can be illustrated by the case of Airbnb that mainly orchestrate supply and demand. Contrary, application stores use external innovation capabilities to increase the generativity of the digital platform ecosystem in combination with transaction mechanisms to match applications with consumers. Last, we show that the autonomy of complementors can range from tight-coupled strategic partners with low autonomy to highly autonomous, loosely coupled actors. Based on those findings, we propose the definition:

> *"[A] digital platform ecosystem comprises a platform owner that implements governance mechanisms to facilitate value-creating mechanisms on a digital platform between the platform owner and an ecosystem of autonomous complementors and consumers."* (Hein et al. 2019a, 4)

In sum, we show that scholars use the concept of a digital platform ambiguously and on different levels of analysis ***(P1)***. Based on those findings, we broaden the scope of the literature review to develop a unified definition of digital platform ecosystems ***(P2).*** The findings of RQ1 are illustrated in Table 13.

Table 13. Overview of Key Results of Research Question 1

P	Findings
P1	▪ Initial literature review on IoT platforms reveals the ambiguity and interrelatedness of the concept of digital platforms. ▪ The initial literature review illustrates different digital platforms in the IoT industry based on three configurations with different levels of analysis. ▪ The technical configuration analyzes digital platforms from an architecture level of analysis with a focus on standardization and modularization. ▪ The ecosystem configuration focuses on the organizational level of analysis and value co-creation in ecosystems with different IoT devices. Besides, the ecosystem configuration includes the market level of analysis and network externalities in machine-to-machine partnerships. ▪ Last, there is the combination of technical and ecosystem perspective that focuses on both the architecture and organization to illustrate how different technical protocols lead to adoption and participation in the ecosystem or how IoT business models are technically realized to enable value co-creation and network externalities.
P2	▪ Develops a unified definition of digital platform ecosystems according to three core building blocks, that can be implemented in varying degrees: - platform ownership describes the distribution of power in the ecosystem that can manifest as a centralized single-owner to a consortium to a decentralized peer-to-peer community; - value-creating mechanisms can be the facilitation of transactions between supply and demand and the provision of boundary resources that enable complementors to innovate; - complementor autonomy describes the degree of autonomy that ranges from tight-coupled, low autonomy strategic partners to highly autonomous complementors that are loosely coupled. ▪ Based on those findings, the paper ends with four fruitful avenues for future research that range from technical properties and value creation to value capture in digital platform ecosystems to complementor interactions to make-or-join decisions.

RQ2: *How can digital platform ecosystems emerge?*

Emergence as a native digital platform ecosystem. When it comes to the emergence of digital platform ecosystems, we illustrate how native digital platforms integrate actors in the ecosystem dependent on the life-cycle phase and varying degrees of autonomy ***(P3).*** In particular, we show that Airbnb and Uber take control over the ecosystem through tight coupling, low autonomy partnerships in the birth and expansion life-cycle phase. This tight coupling enhances the core service and value proposition, which, in turn, strengthens cross-side network externalities between loosely coupled and highly autonomous complementors and consumers. After that, the platform owner fosters a more open strategy that emphasizes the increasing importance of engaging loosely coupled, autonomous actors in more mature, leadership, and self-renewal life-cycle phases. Next, we contribute to the co-evolution perspective on digital platform ecosystems by focusing on environmental externalities in the form of technological trajectories that led to the emergence of native digital platform ecosystems ***(P4).*** In this regard, we illustrate how Uber, BlaBlaCar, and Flixbus used and altered technological advances and new market demands to build their digital platform ecosystem. The resulting process model illustrates that native digital platforms follow a different institutional logic and, hence, adopted technological advances such as Web 2.0 technology, mobile devices, cloud computing, and big data analytics, and in a different way compared to incumbents in the same industry. For instance, incumbents use mobile devices to increase the productivity of their production capabilities. In contrast, native digital platforms use the technology to foster co-creating activities such as the development of location-based solutions that help to orchestrate drivers and passengers.

Transition from an established toward a digital platform ecosystem. Another way of digital platform emergence is the transition of established companies toward a digital platform ecosystem. From a theoretical perspective, the transition represents the co-evolution of an established company that takes the new role of a platform owner. In this new role, the platform owner needs to co-evolve existing partners to engage them in value co-creating activities ***(P5).*** We illustrate this process in the context of a manufacturing company that introduced a software platform to engage existing partners in value co-creating activities. In particular, we illustrate how the new platform owner increased the legitimacy of its new role based on the institutionalized through new incentives. As a result, existing partners needed to make sense of the new autonomy and flexibility when interacting with the digital platform. Hence, they either internalize a pre-defined role defined by the new platform owner or self-explore new roles in the emerging ecosystem.

In sum, we demonstrate that digital platform ecosystems can either emerge as native digital platform ecosystems ***(P3, P4)*** or by transforming from an incumbent toward a digital platform ecosystem ***(P5).*** The findings for RQ2 are summarized in Table 14.

Table 14. Overview of Key Results of Research Question 2

P	Findings
P3	▪ Illustration of how native digital platforms integrate actors in the ecosystem dependent on the life-cycle phase and varying degrees of autonomy: - during the birth and expansion life-cycle phase, digital platforms take control of the ecosystem by tight coupling of partners that strengthen the core value proposition; - during the leadership and renewal life-cycle phase, digital platforms open the ecosystem by integrating loosely coupled autonomous actors that increase the generativity of the ecosystem and to foster cross-side network externalities.
P4	▪ Emerging native digital platform ecosystems assemble new technologies to create a technical architecture of servitization (e.g., microservice architecture). ▪ In contrast, incumbents routinize the same technologies based on their institutional logic to optimize their own products or services. ▪ Evolving native digital platforms routinize the architecture of servitization to create a new trajectory of mass servitization (e.g., the gig or sharing economy). ▪ Incumbents recognize the new trajectory of mass servitization but hesitate to follow due to uncertainty. ▪ New technologies help incumbents first to make sense and then to assimilate the trajectory of mass servitization.
P5	▪ Incumbents that transition from a business network toward a service ecosystem need to change their own role and the role of existing partners. ▪ The incumbent institutionalizes the use of the digital platform to trigger the process of self-exploration and internalization. ▪ Self-exploration describes that the incumbent, as well as existing partners, use the digital platform according to their own needs, which, in turn, increases the generativity in the ecosystem. ▪ Internalization describes that the incumbent and existing partners transition from their ex-role toward their new role. When completed, the new role triggers new behavior that is externalized. ▪ Last, externalization describes that the incumbent and actors express their new role in the process of value co-creation.

RQ3: *How do digital platforms integrate their ecosystem to foster value co-creation?*

Value co-creation practices to establish digital platform ecosystems. When it comes to value co-creation practices, three standardized practices are necessary to establish a digital platform ecosystem ***(P6).*** First, the digital platform follows the standardized process of enabling a self-service integration of autonomous partners through documentations, how-to-guides, APIs, and SDKs. In the case of IoT platforms, this means that partners can embed their devices and services autonomously on an opt-in basis. Besides, the supply side can also be integrated through more tightly integrated residual processes such as integration through abstraction or strategic integration. Integration through abstraction describes that the platform owner uses applications provided by customers to make them available to the whole ecosystem. An example is that a customer uses the boundary resources provided by the platform to develop a geo-fence application. In turn, the platform owner can make the application less specific to a distinct use case, which, in turn, increases the applicability to the whole ecosystem. Strategic integration describes the collaboration between the platform owner and strategic, more tightly integrated partners to develop vertical solutions. For the demand-side, the digital platform embeds the standardized process of ensuring self-service readiness. Similar to the supply-side process, customers can use the platform autonomous in a plug and play manner to consume applications and services. Besides, the platform owner offers supported readiness with the help of consulting agencies. This process is especially useful if the customers lack the technical knowledge to use the digital platform. Last, the digital platform connects the supply and demand side with the process of servitization through application enablement. In this regard, the platform provides customers with applications, devices, and services that are made available by ecosystem partners.

Value co-creation practices that lead to digital platform leadership. In addition to practices that help to establish digital platform ecosystems, the platform owner can use different configurations of internal and external innovation practices to become platform leaders ***(P7)***. Internal innovation practices refer to the provision of digital affordances, where the platform owner provides boundary resources like APIs and SDKs. In turn, the ecosystem follows external innovation practices by applying different skills to actualize the affordances. This process increases the generativity and leads to value co-creation between the platform owner who provides boundary resources and the ecosystem who actualizes affordances. The results reveal four configurations of leading platforms that combine affordances of the digital platform and generativity of an ecosystem. First, innovation platforms that rely both on internal innovation capabilities and external innovation capabilities, as illustrated in the example of application stores. Second, technology platforms such as platforms that aid ecosystem partners to create applications for individual use depend solely on internal innovation capabilities. Third, transaction platforms such as Airbnb that rely mostly on external innovation capabilities of the ecosystem. Fourth, integration platforms that act as meta platforms that aggregate data and, hence, rely solely on external innovation capabilities.

Design science framework on how digital platform ecosystems co-create value. As a last result, we focus on the three central dimensions of a service ecosystem, service platform, and value co-creation to develop a framework to design value co-creation in digital platform ecosystems ***(P8)***. First, the service ecosystem dimension focuses on the characteristics of actors and includes attributes such as the generic role in the ecosystem, the customer segment, or the motive of joining the ecosystem. Second, the value co-creation dimension includes characteristics that describe the transaction service, as well as the value creation and value capture mechanisms. Last, the service platform dimension includes characteristics like governance mechanisms and the architecture of the digital infrastructure. In sum, the dimensions and underlying attributes subsume a framework that provides guidance for scholars in the field of digital platform ecosystems to analyze and compare, and practitioners to design digital platform ecosystems. Therefore, the artifact is a first step to provide a structural, reproducible framework to design digital platform ecosystems.

In sum, we first identify essential value co-creation practices that are necessary to establish a digital platform ecosystem ***(P6)***. In addition, we show how the interplay of internal and external innovation practices in a digital platform ecosystem can lead to platform leadership ***(P7)***. Last, we design a framework that helps scholars and practitioners alike to design digital platform ecosystems based on value co-creation practices ***(P8).*** The findings for RQ3 are summarized in Table 15.

Table 15. Overview of Key Results of Research Question 3

P	Findings
P6	▪ We identify three standardized practices that are necessary to establish a digital platform ecosystem. ▪ Supply-side processes describe the standardized process of self-service integration of autonomous actors and the residual processes of integration through abstraction and strategic integration for less autonomous actors. ▪ Demand-side processes describe the standardized process of self-service readiness of autonomous actors and the residual process of supported readiness for less autonomous actors. ▪ The digital platform connects the supply and demand side with the process of servitization through application enablement.
P7	▪ Identification of four digital platform ecosystem configurations based on internal and external innovation capabilities: - innovation platforms that rely both on internal innovation capabilities and external innovation capabilities; - technology platforms that rely only on internal innovation capabilities; - transaction platforms that rely mainly on external innovation capabilities of the ecosystem; - integration platforms that rely solely on external innovation capabilities. ▪ Operationalization of internal innovation capabilities as digital affordances and external innovation capabilities as generativity.
P8	▪ Design science framework on how digital platform ecosystems can co-create value with a focus on central dimensions of the service ecosystem, value co-creation, and service platform: - the service ecosystem dimension includes characteristics of the actor that includes the market segment, the role, and the motive; - the value co-creation dimension includes characteristics about the transaction services such as openness, the service pattern or the scope; about the value creation mechanism such as the for, cooperation channel and intensity; and about the value capture mechanism such as the source and value stream; - the service ecosystem dimension includes characteristics about the governance that includes the structure and control mechanisms, as well as the technical architecture that includes information about modules, the focus, and implemented resources.

2 Discussion

Based on the findings of this dissertation, we describe how we contribute to the literature stream of digital platform ecosystems. First, we illustrate based on eight embedded publications how a unified definition of digital platform ecosystems can help scholars and practitioners alike to capture different facets of the phenomenon of digital platform ecosystems. Second, we explain the two paths of how native digital platforms emerge and how incumbents can transition toward a digital platform ecosystem. Third, we show how digital platforms accelerate standardized value co-creation practices that help to shift the value creation process outside to an ecosystem of complementors and consumers. In addition, we illustrate how different value co-creation practices can lead to platform leadership.

2.1 A Unified Definition of Digital Platform Ecosystems

The remarkable efforts of different conceptualizations of digital platforms such as software-based platforms (Tiwana et al. 2010), technological platforms (Gawer 2014), digital platforms (Constantinides et al. 2018; de Reuver et al. 2018) and platform-mediated networks (McIntyre/Srinivasan 2017) have significantly advanced our understanding of digital platforms. In addition, a growing research stream on different ecosystem perspectives (Adner 2017; Jacobides et al. 2018; Kapoor 2018; Shipilov/Gawer 2020) is finding its way as a new scientific research paradigm (Jacobides et al. 2018). Due to the conceptual overlap, ambiguous use, and the added complexity as a result of different levels of analysis (de Reuver et al. 2018; McIntyre/Srinivasan 2017), the construct of a digital platform ecosystem is still intangible and hard to grasp. To mitigate this problem, we contribute with a unified definition of digital platform ecosystems. The definition builds on the synthesis of the literature on digital platforms as well as the literature on ecosystems and comprises three building blocks of platform ownership, complementor autonomy, and value-creating mechanisms. In the remainder of this paragraph, we illustrate how each of the three building blocks can expand our understanding of digital platform ecosystems.

First, we emphasize the **perspective of platform ownership** based on different degrees of centrality (see Figure 7). When reviewing the literature on digital platform ecosystems, the predominant part of the research is subject to centralized, single platform owners (Hein et al. 2016; Schreieck et al. 2016; Tiwana 2015). In those ecosystems, there is a central platform owner that has full authority to implement and change governance mechanisms (Schreieck et al. 2016; Tiwana et al. 2010). However, there are also centralized platform consortia that can be found in the field of open source software such as CloudFoundry (Jansen/Cusumano 2013). In those ecosystems, a variety of tightly coupled platform owners need to align on governance mechanisms that are then implemented and on further actions that will shape the digital platform ecosystem. Besides, there are more decentralized platform consortia that build on distributed ledger technology (Khan et al. 2017). An example is Ethereum, where developers can be promoted to core developers by contributing to the source code. Last, there are decentralized peer-to-peer platform ecosystems such as District0x, where all users have voting rights on the implementation of new governance mechanisms (Riasanow et al. 2018). All those examples illustrate that different forms of platform ownership have different implications on who can implement what governance mechanisms and, hence, change the strategic course of a digital platform ecosystem. In total, the unified definition provides a more nuanced understanding that goes beyond centralized single platform owners.

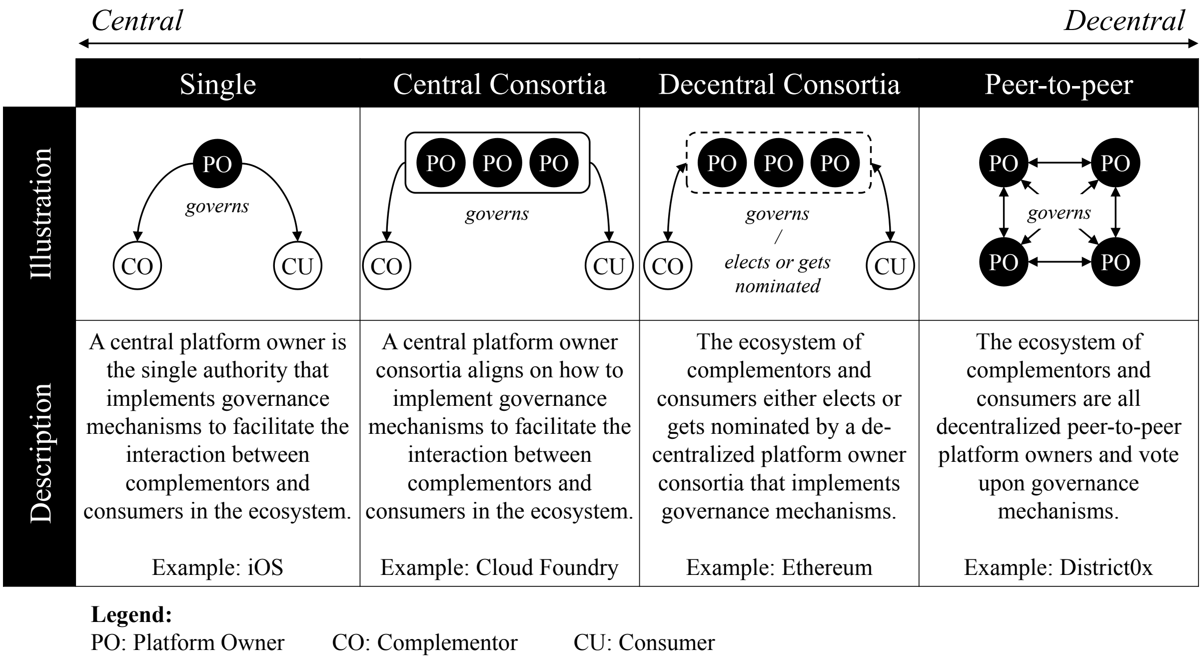

Figure 7. Degrees of Platform Owner Centrality in Digital Platform Ecosystems

Second, we shed light on the **perspective of complementor autonomy** according to the principles of tight and loose coupling (see Figure 8). Our research illustrates that most digital platform ecosystems are built on both tightly coupled strategic, less autonomous partnerships, and an installed-base of loosely-coupled highly autonomous consumers and complementors ***(P3, P4, P6)***. First, tightly coupled strategic partners can be firms that are market leaders in their industry and, hence, have in-depth knowledge of best practices. Those strategic partnerships often have a contractual basis with clearly defined goals. In this regard, the platform owner can exert a high degree of control by defining the terms and conditions of the partnership. Tightly coupled strategic partners can contribute to the stable platform core, as illustrated in the example of the Open Handset Alliance and Android. They can also contribute to the flexible periphery, which can be illustrated by an original equipment manufacturer with profound insights on the design of supply-chains that cooperates with an IoT platform to develop vertically integrated services ***(P6)***. Contrary, loose-coupling partnerships are highly autonomous and interact through boundary resources. Hence, the only way for the platform owner to exert control over the behavior of those complementors is through boundary resources. Like tightly-coupled strategic partners, also loosely-coupled autonomous complementors can contribute to both the stable core and the flexible periphery. An example of contributions to the stable core can be illustrated based on the example of Ethereum, where everyone can commit new changes that are then reviewed by more experienced core developers. Autonomous complementors that contribute to the flexible periphery can be found in a variety of digital platform ecosystems such as iOS and Android that build mainly on the contribution of third-party application developers. In sum, our research shows that platforms use both coupling mechanisms to thrive. In earlier phases, digital platform ecosystems tend to utilize strategic partnerships more thoroughly to ignite the platform and to strengthen the core, whereas they open up and utilize loosely coupled partnerships in later stages ***(P3)***.

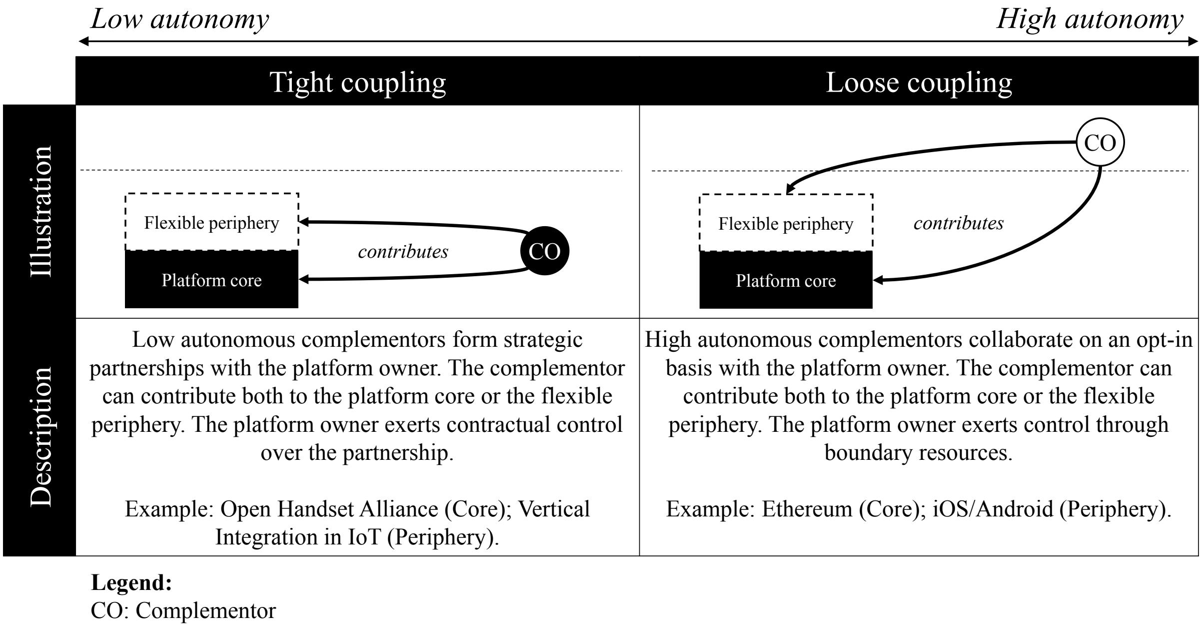

Figure 8. Degrees of Complementor Autonomy in Digital Platform Ecosystems

Third, we point out differences and the interplay of **transaction and innovation value-creating mechanisms** (see Figure 9). First, transaction value-creating mechanisms refer to the orchestration and matchmaking abilities of digital platforms. Digital platforms that utilize only transaction value-creating mechanisms offer generic services that complementors can use to provide complements. Those complements, in turn, can then orchestrated with the demand-side of the ecosystem where consumers consume the complements provided. A typical example is Airbnb, where hosts can post and offer short-term lodging opportunities that potential guests from all over the world can use. Besides, digital platforms can also rely on innovation value-creating mechanisms. In those settings, the digital platform provides affordances in the form of boundary resources such as APIs and SDKs that an ecosystem of complementors can use. However, those complementors develop applications primarily for their own use and do not share the complement with the digital platform ecosystem. An example is ERP systems, where users customize the system to build solutions that fit their individual needs. However, those solutions are too generic to be of any value for other customers. Last, there are digital platform ecosystems that combine both transaction and innovation value-creating mechanisms. In those ecosystems, the platform owner uses innovation value-creating mechanisms by providing affordances that an ecosystem of complementors can use. In turn, the complementors develop new complements not primarily for their own use but to offer the complement to an ecosystem of users. The platform owner then facilitates and orchestrates those transactions. In ecosystems that utilize both transaction and innovation mechanisms, we differentiate between internal and external innovation mechanisms. Internal innovation mechanisms include the provision of affordances in the form of boundary resources. Contrary, external innovation mechanisms describe the composition of the ecosystem, including different skills and capabilities of complementors. An example that illustrates the interplay of both mechanisms is Apple's provision of ARKit to its ecosystem, where developers used a variety of different skills to create new applications dependent on their skills and needs ***(P7)***.

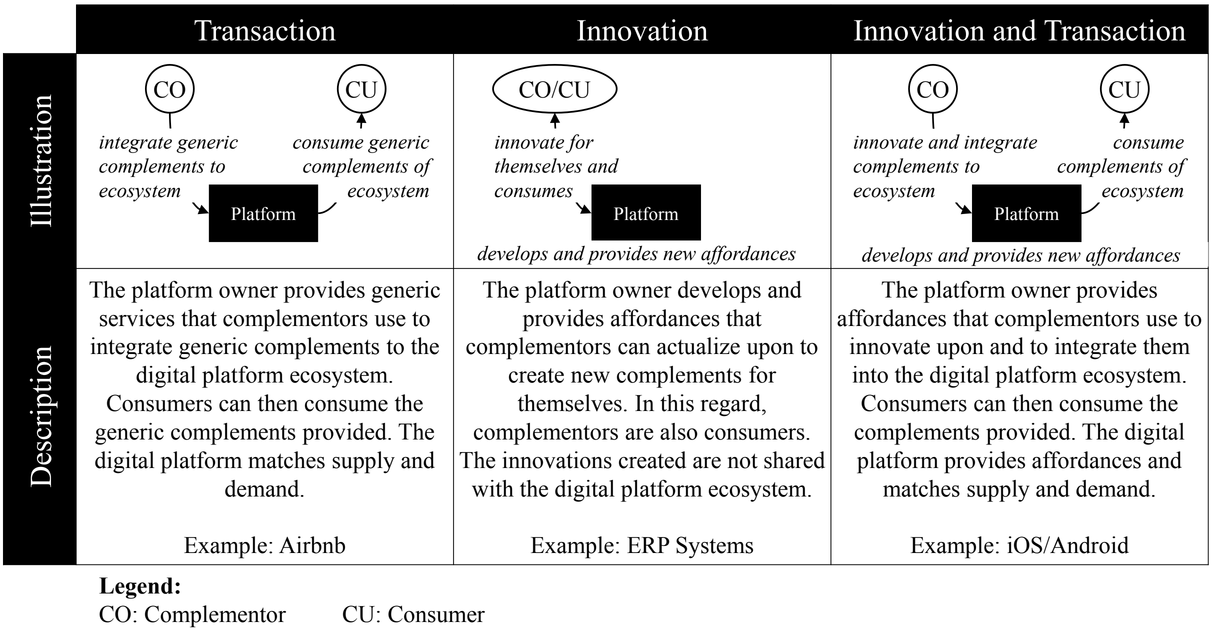

Figure 9. Value Creation Mechanisms in Digital Platform Ecosystems

2.2 Different Paths of Digital Platform Ecosystem Emergence

When it comes to platform emergence, we contribute to the growing body of digital platform ecosystem evolution (Staykova 2019, 21) by illustrating two different paths of digital platform ecosystem emergence. First, we elaborate on the emergence of native digital platform ecosystems based on exogenous technological trajectories ***(P4)*** (Dosi 1982) and by combining growth patterns of integrating ecosystem actors in different life-cycle phases ***(P3)*** (Moore 1993). Second, we show how incumbents with an existing business model can transform toward a digital platform ecosystem ***(P5)***. We use the concept of liminality (Conroy/O'Leary-Kelly 2014; Turner 1969, 359) to show how an incumbent separates from its old G-D identity, transitions through a state of being caught between two identities toward incorporating a new S-D identity as a focal actor in a service ecosystem. Both paths of digital platform emergence illustrate how either newly emerging digital platforms or transitioning incumbents adopt a new institutional logic of digital platform ecosystems. We discuss this contribution based on examples of native digital platform ecosystems ***(P3, P4)***, and on incumbents that transformed toward a digital platform ecosystem ***(P4, P5)***.

Emergence as Native Digital Platform Ecosystems

The first path illustrates how newly founded companies that we refer to as native digital platform ecosystems came into existence. Related literature on platform emergence focused on capabilities during the genesis of a digital platform ecosystem (Tan et al. 2015) and on structural perspectives of emerging digital platform ecosystems (Basole/Karla 2012; Faber et al. 2020). We contribute to this research by illustrating how emerging native platforms use different coupling mechanisms (Weick 1976) to engage ecosystem partners to become platform leaders

(P3). Besides, we show how native digital platform ecosystems came into existence by utilizing exogenous technological trajectories (Dosi 1982) based on their institutional logic of providing services to develop a technical digital platform ***(P4)***. We discuss the findings of ***P3*** and ***P4*** along with three out of the four relevant perspectives of the digital platform evolution of Staykova (2019, 21-31): growth patterns, co-evolution perspective, and life-cycle phases.

First, the **growth perspective** investigates the formation and development of digital platform ecosystems through the use of growth patterns (Staykova 2019, 22). We illustrate, based on the examples of Uber and Airbnb, that both native digital platform ecosystems took advantage of tight coupling strategic partnerships in the early birth and expansion phase to increase the core value proposition of the digital platform. For example, Airbnb cooperated with professional photographs to ensure that the quality of accommodations on the platform reflect the reality. In later phases, both companies opened up the digital platform to engage loosely coupled autonomous actors into the innovation process. An example is Uber that took advantage of the ecosystem by providing a TripExperience API that allowed ecosystem partners to develop services. In this regard, Uber utilized the generativity of the ecosystem to strengthen the core ride-hailing service ***(P3)***. We contribute to the growth pattern perspective by showing that tight coupling can be used to strengthen the core value proposition. In addition, the tight coupling could be used to overcome the chicken & egg problem by ensuring a high quality of products and reducing information asymmetry (Caillaud/Jullien 2003). In turn, the loose coupling can be a growth pattern for igniting a digital platform ecosystem (Evans 2009) by taking advantage of the generativity of the ecosystem to ensure self-sustained growth (Evans/Gawer 2016; Nambisan et al. 2019).

Second, we contribute to the **co-evolution perspective** (Staykova 2019, 28; Riasanow et al. 2020) by illustrating interdependencies and changes between the technical architecture, the platform owner, and the environment. In particular, we use the cases of Uber, BlaBlaCar, and Flixbus to show how the adoption of new technologies as an environmental externality led to a new technological trajectory (Dosi 1982) of mass servitization. Those emerging native platforms adopted upcoming technology such as Web 2.0, smartphones, cloud computing, and big data analytics to strengthen their core value proposition of providing mobility services. For example, BlaBlaCar used Web 2.0 technology to enable interactions between drivers and passengers on websites. Building on those first websites, BlaBlaCar took advantage of new smartphone technology to add location-based services and to develop applications that increased the market reach and availability. Last, BlaBlaCar adopted cloud technology to ensure scalable services in combination with big data analytics to optimize routing processes. In contrast, incumbents in the mobility industry used those technological advances almost exclusively to optimize production processes ***(P4)***. The adoption and assembly of new technologies remind of the concept of *"bricolage"* (Lévi-Strauss 1962), where firms or individuals use *"whatever is at hand"* (Baker/Nelson 2005) to achieve a value proposition. By acting as a bricoleur, native platform companies assembled upcoming technologies according to their institutional logic of providing mobility services as effective and efficient as possible. This assembly of technologies led to the co-evolution of microservice architectures that caused a new technological trajectory of mass servitization. In sum, the findings help to understand how native digital platforms could emerge by adopting and combining upcoming technology in a unique way to develop an architecture of mass-servitization that reflects their institutional logic of providing mobility services.

Third, we contribute to the **life-cycle perspective** (Han/Cho 2015; Huang et al. 2009) by combining the concept of technological trajectories (Dosi 1982) with technology diffusion (Rogers 2003, 5; Zhu et al. 2006) to derive three phases and four propositions that explain the emergence of native digital platform ecosystems and the impact of their emergence on incumbents (see Table 16). In the first phase, native digital platforms act as risk-taking actors that adopt and assemble new technologies to support their core value proposition of orchestrating services for a supply and demand side (e.g., mobility services between drivers and passengers) (Amini et al. 2017). Contrary, incumbents are stuck in an Innovator's Dilemma (Christensen 2016, 225), where they adopt technologies according to their institutional logic of manufacturing goods and services. In the next phase, native digital platforms begin to routinize (Zhu et al. 2006) the adopted technologies toward a microservice architecture that enables mass servitization. An example is the bundling of services such as planning trips, navigating routes, ordering drivers based on location data, payment, and the subsequent rating of the ride. The convenient access and broad availability led to new demand that manifested in the emancipation of service workers through increased flexibility. This demand is reflected in the gig or sharing economy (Gerwe/Silva 2018). Consequently, incumbents in the mobility sector became aware of this new demand and tried to make sense of the new technological trajectory. In sum, the two life-cycle phases take an industry perspective of exogenous factors in the form of technological advances and new demand to help scholars and practitioners alike to understand better how digital platform ecosystems came into existence ***(P4)***. In addition, we contribute to the phases proposed by Moore (1993) complementing it with tight and loose coupling mechanisms in the context of the emergence of native digital platform ecosystems ***(P3)***.

Table 16. Life-cycle Phases on the Emergence of Native Platform Companies (P4)

Life-cycle phase	Proposition	Example
The emergence of native digital platform ecosystems	***P1.*** Risk-taking actors emerge as digital platform ecosystems by assembling and tinkering technologies toward an architecture of servitization.	Native digital platform companies combined Web 2.0 technology, smartphones, cloud computing, and big data analytics in a unique way to create and support the orchestration of supply and demand.
	P2. Incumbents are stuck in an Innovator's Dilemma that restricts the adoption of upcoming technologies to their dominant institutional logic.	Incumbents use Web 2.0 technology, smartphones, could computing, and big data analytics to support production processes instead of providing mobility services.
Impact of native digital platform companies on incumbents	***P3.*** Evolving native digital platforms routinize new technologies toward a micro-service architecture that enables mass servitization.	Native digital platform companies begin to routinize different technologies and evolve their technical infrastructure from monolithic to a microservice architecture.
	P4. Incumbents become aware of the new technological trajectory of mass servitization but hesitate to follow to it due to uncertainty.	Incumbents recognize mobility service platforms such as Uber as a new threat. However, they are not sure if this trend is going to last and, hence, hesitate to follow this trend.

The transformation from Incumbent to Digital Platform Ecosystem

The second path illustrates how incumbents, that became aware of the new technological trajectory, transition toward a digital platform ecosystem. From a theoretical perspective, the question is strongly linked to the digital transformation literature (Matt et al. 2015; Riasanow et al. 2019b). However, besides a notable exception that focuses on technology-enabled assets to guide the transformation (Sebastian et al. 2017), there is sparse research on how incumbents can transition toward a digital platform ecosystem. We contribute to this research stream by focusing on a co-evolution perspective on how an incumbent can co-evolve itself and its established business network that adheres to a G-D logic toward a service ecosystem following a S-D logic ***(P5)***. In addition, we illustrate how the standardization of value co-creation practices can be used as a growth pattern to transform and sustain a digital platform ecosystem ***(P6)***.

Related research on the transformation of incumbents to digital platform ecosystems focused on the **co-evolution** of strategic decisions and technology-enabled assets (Sebastian et al. 2017). We contribute to this emerging research stream by focusing on the co-evolution of the transitioning platform owner and its business ecosystem toward a digital platform ecosystem. In particular, we illustrate how the incumbent introduced a digital platform to transition from a G-D logic of being a manufacturing company with a business network toward also becoming a service provider with a more loosely coupled ecosystem that follows an S-D logic. During this co-evolution, the incumbent, as well as the partners in the business network, transitioned through a period of liminality (Henfridsson/Yoo 2014; Turner 1969). Liminality refers to being between their old role as a manufacturing company and their new role of also being a service provider. During this phase, the manufacturer and the business network are exposed to heightened reflexivity, which allows them to dissociate themselves from their prior role to explore new roles based on the affordances provided by the digital platform. For example, the manufacturing company illustrates that new services such as remote maintenance provided by the digital platform allowed the incumbent to connect partners in the ecosystem in new ways ***(P5)***. This example illustrates that the concept of liminality complements the co-evolution perspective by linking the digital affordances of the digital platform with the self-exploration of new roles in the ecosystem. Hence, we provide unique insights on how incumbents can transition their own and the role of ecosystem actors toward a digital platform ecosystem following an S-D logic (Lusch/Nambisan 2015).

From a **growth perspective**, we describe practices that are necessary to transform and grow a digital platform ecosystem. When technology companies adopted an IoT platform, they needed to engage an ecosystem of autonomous actors into the value co-creation process in a scalable way. Examples for ecosystem partners are sensor manufacturers, software developers, industry clients with a variety of production landscapes, and consulting firms that are all contributing to the IoT platform. To get them involved in value co-creating activities, emerging IoT platforms tried to provide standardized practices that ecosystem actors needed to comply with. As a standardized practice for the supply side, the incumbents provide APIs and SDKs that ecosystem partners can use to self-integrate their hardware or software. This practice illustrates that the effort to integrate is shifted to ecosystem partners, which, in turn, enables a scalable integration process. However, the results of ***P6*** also indicate that not all partners were willing to comply with this process. For instance, some partners may only want to develop software for their own use, which stops network externalities from unfolding. To mitigate this issue, the platform owner implemented a residual practice by abstracting the software to make it available to all partners in the ecosystem. This example illustrates that residual processes can help to trigger network externalities. However, they also come at the cost of limiting the scalability as the platform owner needs to abstract every application. As a result, we demonstrate that the standardization of value co-creation practices is an important growth mechanism for practices to ensure scalability and network effects. In this regard, the process of standardizing value co-creation practices is a novel growth pattern of how incumbents that transform and digital platforms, in general, can establish a critical mass in a scalable way (Evans 2009).

2.3 Scalability of Transaction and Innovation Value-Creating Mechanisms

Last, we contribute to the literature of value co-creation practices (Ceccagnoli et al. 2012; Lusch/Nambisan 2015) and platform leadership (Gawer 2014). In particular, the growth patterns of ***P6*** indicate a direct link between the scalability of standardized and residual practices and transaction and innovation value co-creation mechanisms in digital platform ecosystems (see Table 17). In addition, we discuss how different value-creating mechanisms are employed by different types of digital platform ecosystems ***(P7)***.

Table 17. Scalability of Value Co-Creating Mechanisms of Digital Platform Ecosystems

Practice	Transaction	Innovation	Description
Standardized: self-service integration	Ecosystem partners integrate	Ecosystem partners innovate	The platform shifts transaction and innovation mechanisms to complementors. High scalability.
Residual: integration through abstraction	Platform owner integrates	Ecosystem partners innovate	The platform owner needs to integrate specialized applications developed by complementors. Medium scalability.
Residual: strategic integration	Platform owner integrates	Platform owner innovates	The platform owner is involved in innovation and integration activities. Low scalability.
Standardized: self-service readiness	Ecosystem partners integrate	NA	The platform owner shifts transaction mechanisms to the consumer. High scalability.
Residual: supported readiness	Intermediary integrates	NA	The platform owner shifts transaction mechanisms to a boundary spanner (e.g., consultancy). Medium scalability.
Residual: integration through platform owner	Platform owner integrates	NA	The platform owner is involved in integration activities. Low scalability.

When it comes to **highly scalable** value co-creation practices, we identify two standardized transaction and innovation mechanisms. First, there is the practice of self-service integration where the platform owner shifts both the effort to integrate complements into the digital platform and also the effort to innovate to partners into the ecosystem. An example in the context of IoT platforms is that complementors can develop data analytics applications that they subsequently integrate into and offer to an ecosystem of consumers ***(P6)***. To engage ecosystem partners in this self-service integration, the platform owner provides knowledge boundary resources (Foerderer et al. 2019), such as documentation and how-to guides in combination with APIs and SDKs. The documentation and how-to guides provide a shared-worldview (Lusch/Nambisan 2015) between the external ecosystem partner and the process of how new complements can be integrated. In turn, APIs and SDKs provide complementors with affordances to develop innovative applications (Nambisan et al. 2019; Bondel et al. 2020) and also with a standardized work process (Lusch/Nambisan 2015) to ensure technical compatibility. Second, there is the practice of self-service readiness, where the platform owner shifts the effort to use the digital platform to consumers in the ecosystem. In this practice, consumers use knowledge boundary resources provided to make sure they comply with the standards of the platform owner. Again, this practice scales to the end of the platform owner as the effort is shifted to consumers ***(P6)***. In sum, we demonstrate that standardized high scalable value co-creation practices engage autonomous ecosystem actors. To engage autonomous actors, the platform owner provides boundary resources that increase the interpretative flexibility of ecosystem actors to comply with platform standards (Eaton et al. 2015; Ghazawneh/Henfridsson 2013). However, ***P6*** further reveals that not all actors in the ecosystem have the required skills or capabilities to comply with standardized processes.

To account for less autonomous ecosystem actors, platform owners provide residual practices with **medium scalability** that are less scalable compared to standardized practices. The residual practice of integration through abstraction describes that innovation mechanisms are shifted to the ecosystem partner, while the integration effort remains with the platform owner. An example is that complementors can develop specialized applications that restrict the usage of applications to a few or only one use case. In this regard, the innovation is carried out by the complementor but not of any use to other actors in the ecosystem. To mitigate this problem, the platform owner abstracts the specialized application to make it applicable to a broader range of use cases. The example illustrates that the platform owner cannot shift all the effort to ecosystem partners, hence, limiting the scalability. Another practice with medium scalability is supported readiness. In this practice, consumers want to join the digital platform ecosystem but fail to do so due to a lack of capabilities or skills ***(P6)***. To mitigate this problem, platform owners take advantage of boundary spanners (Levina/Vaast 2005) in the form of consultancies that bridge the gap between consumers and the standards of the digital platform. In this way, the platform owner takes advantage of a third-party in the ecosystem that bridges the low structural flexibility of not being able to self-integrate. In sum, we demonstrate that platform owners take advantage of residual medium scalable value co-creation practices to engage less autonomous ecosystem actors ***(P6)***. In particular, we show that the platform owner uses its own resources to make innovations of complementors available or involves boundary spanners that bridge the gap between (Eaton et al. 2015; Ghazawneh/Henfridsson 2013; Foerderer et al. 2019).

Furthermore, there are **low scalable** residual value co-creation practices. First, the residual practice of strategic integration comprises transaction and innovation mechanisms that both require effort by the platform owner. An example is the practice of strategic integration, where the platform owner co-innovates vertical solutions to provide end-to-end support to consumers with the help of a strategic partner. During this process, the platform owner and a strategic partner are physically co-located to work toward a mutually aligned goal ***(P6)***. Hence, the partnership is characterized by a low degree of autonomy as both partners follow a pre-defined goal (Steensma/Corley 2000). In addition, strategic integration hints toward the fact that loosely coupled relationships are not sufficient to standardize the complexity of vertical solutions (Schermuly et al. 2019). Second, there is the residual practice of integration through the platform owner, where the effort to integrate consumers is shifted to the platform owner. An example is the integration of early adopters by the platform owner to demonstrate the applicability of an IoT platform through proofs-of-concept. In this regard, the platform owner gathers the requirements of the consumer to demonstrate the usefulness of the application with a proof-of-concept ***(P6)***. Both residual processes illustrate that the manual effort required by the platform owner leads to low scalability compared to practices that utilize boundary resources and engage ecosystem actors (Eaton et al. 2015; Ghazawneh/Henfridsson 2013).

Last, we discuss the applicability of scalable value co-creation practices and innovation and integration mechanisms on four different **types of digital platform ecosystems *(P7)***. First, there are innovation platform ecosystems such as iOS and the accompanied App Store. Innovation platforms rely both heavily on scalable transaction and innovation value-creating mechanisms. The example of the App Store illustrates that a broad majority of applications stems from the broad ecosystem of developers who self-integrate and self-innovate around SDKs and APIs (Appfigures/VentureBeat 2020). Second, there are technology platform ecosystems such as Face++[16] that provides facial recognition algorithms that can be used by an ecosystem of autonomous actors. In this regard, ecosystem actors can use the underlying

[16] More information can be found at https://www.faceplusplus.com/

technology to create specific applications for their own use. However, those applications are not mirrored back into the ecosystem but need to be, upon the decision of the platform owner, abstracted to more general services that can be used by other actors in the ecosystem. Third, there are transaction platform ecosystems such as Airbnb that rely on scalable transaction value-creating mechanisms. Transaction platforms take advantage of self-service integration practices that help consumers to book apartments and complementors to post new listings. Last, we identify integration platform ecosystems such as moovel[17] that acts as a meta platform that tightly integrates partners to offer consumers with multimodal mobility services (Amini et al. 2017; Faber et al. 2018). The example illustrates that integration platforms do not utilize self-service integration practices but adhere to strategic partnerships to control and direct value co-creation activities. In sum, we show that platform owners within each of the four different types utilize different value co-creation practices ***(P7)***. While this first mapping of value co-creation practices to different types of digital platform ecosystems can only be the first effort to illustrate causal patterns, it strengthens the external validity and applicability of the value co-creation practices identified before.

[17] More information can be found at https://www.moovel.com/en/our-products/for-mobility-service-providers

3 Implications

The findings of this dissertation have implications for both theory and practice. In the subsequent paragraphs, we first describe how this thesis helps to synthesize the literature on digital platforms and ecosystems. Second, we integrate findings of the emergence of native digital platform ecosystems and the transformation of incumbents toward a digital platform into the literature of platform evolution. Third, we contribute to the literature stream on value co-creation by combining transaction and innovation value-creation mechanisms with complementor autonomy toward scalable value co-creation practices. Last, we provide practitioners with a design science framework that enables the structural and reproducible design of digital platform ecosystems.

3.1 Implications for Theory

First, we contribute with a **unified definition of digital platform ecosystems** to the synthesize of conceptualizing research on digital platforms (Constantinides et al. 2018; de Reuver et al. 2018; Gawer/Cusumano 2014; McIntyre/Srinivasan 2017; Tiwana et al. 2010) and ecosystems (Adner 2017; Jacobides et al. 2018; Kapoor 2018; Shipilov/Gawer 2020). With the building block of the platform owner, we offer a conceptualization of different degrees of centrality that ranges from centralized ownership to consortia to decentral ownership in peer-to-peer communities. In this regard, we complement the literature on platform governance (Eisenmann et al. 2006; Schreieck et al. 2016) by showing that a different degree of ownership can influence relationships among partners, value co-creation and value capture activities, as well as the perception of ecosystem actors ***(P2)***. A centralized platform owner, for example, can set-up and define platform governance mechanisms autonomously (Hein et al. 2016). Contrary, a decentralized type of ownership enforces the democratization of governance mechanisms where every ecosystem actor is allowed to vote (Riasanow et al. 2018). Those different approaches, in turn, have a direct impact on value co-creation and value capture activities (Schreieck et al. 2017) and the perception, for example, in terms of market dominance, of ecosystem actors (Cennamo/Santalo 2013). Besides, we complement the partitioning of decision rights in digital platform ecosystems (Tiwana et al. 2010) by the ownership mode of consortia, where a set of stakeholders jointly defines, establishes, and maintains governance mechanisms. Last, we complement the literature on focal ecosystem actors that are the center of value-creating activities (Adner 2017; Kapoor 2018) by complementing decentralized and consortia modes of ownership.

With the building block of value-creating mechanisms, the unified definition provides differentiation between transaction and innovation mechanisms. The distinction between transaction and innovation value-creating mechanisms is a crucial characteristic to differentiate between different types of digital platform ecosystems (Evans/Gawer 2016). In particular, we complement the literature on different types of digital platform ecosystems (Evans/Gawer 2016; Gawer/Cusumano 2014; Jacobides et al. 2018) and the literature on digital infrastructures (Constantinides et al. 2018; Henfridsson/Bygstad 2013; Tilson et al. 2010) through the disentanglement of transaction and innovation value-creating activities employed by the platform owner and actors in the ecosystem. One the one hand, we show that transaction mechanisms aim to facilitate transactions in an ecosystem. In this regard, the platform owner utilizes the scalability and modularity of a digital infrastructure to foster economies of scale and substitution (Garud/Kumaraswamy 1995) in the sense that new complements increase the value of the digital platform without compromising the whole system. On the other hand, we show that complementors can contribute generic assets such as new accommodations in supermodular complementarity (Jacobides et al. 2018). Hence, each new complement makes the digital platform more valuable. When it comes to innovation mechanisms, we illustrate that the platform owner can implement affordances such as APIs and SDKs to increase the generativity of the ecosystem (Henfridsson/Bygstad 2013; Nambisan et al. 2019; Zittrain 2005; Bondel et al. 2020). In turn, complementors can increase the generativity through a more diverse set of skills and capabilities. In conclusion, the unified definition of digital platform ecosystems provides a more nuanced understanding of value-creating mechanisms. We demonstrate the applicability of the two value-creating mechanisms in P7, where we identify four different types of digital platform leaders that utilize a different set of value-creating mechanisms.

Last, we build upon the building block of complementor autonomy to contribute to the platform ecosystem literature (Adner 2017; Jacobides et al. 2018; Kapoor 2018; Shipilov/Gawer 2020). Research on complementor autonomy in ecosystems mainly focused on the focal actor or platform owner perspective (Boudreau 2012; Tiwana et al. 2010). We know, for example, that platform owners take advantage of boundary resources (Eaton et al. 2015; Ghazawneh/Henfridsson 2013) and governance mechanisms (Song et al. 2018; Tiwana et al. 2010) to engage ecosystem actors in the value co-creation process. However, apart from notable exceptions (Ye/Kankanhalli 2018), we know little about how complementors can contribute to the value co-creation process in digital platform ecosystems (Selander et al. 2013). In this regard, the unified definition reveals that digital platform ecosystems can consist of both highly autonomous loosely coupled partners such as application developers and tightly coupled low autonomy strategic partners. Android, as an example, combines tight coupling low autonomy partners in the form of the open handset alliance[18] with loose coupling high autonomy partners in the form of third-party developers. Furthermore, we underpin that both ways of integrating ecosystem partners are necessary for a digital platform to thrive ***(P3)***. Hence, we contribute to the boundary resource literature in that tight coupling partners can help to develop boundary resources and set them as an industry-standard (Backhouse et al. 2006). In turn, the boundary resources can then be accessed and tuned by loosely coupled partners (Eaton et al. 2015). When it comes to the platform governance literature, the differentiation between high and low autonomy further contributes toward a more nuanced understanding of platform governance mechanisms (Schreieck et al. 2016). An example is that the platform owner can exert control on tightly coupled strategic partners through a service-level contractual agreement (P6), whereas low autonomy actors require a more technical control and restriction through the implementation of design rules in boundary resources (Ghazawneh/Henfridsson 2013; Tiwana et al. 2010).

In summary, we contribute to the literature of digital platform ecosystems (Constantinides et al. 2018; de Reuver et al. 2018; Gawer/Cusumano 2014; McIntyre/Srinivasan 2017; Tiwana et al. 2010) with a unified definition that combines the technical aspects of digital infrastructures with the social perspective of an ecosystem. This synthesis can be illustrated based on the

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[18] More information can be found at https://www.openhandsetalliance.com/

example of a platform owner, that can vary in the degree of centrality, which provides affordances such as APIs and SDKs to enhance the digital platform. In turn, complementors with varying degrees of autonomy can either contribute by providing new affordances in the case of strategic partnerships or by developing supermodular complements that increase the value of the digital platform. The resulting definition provides scholars with a more nuanced understanding of the phenomenon to tackle the ambiguity and vagueness of the term digital platform ecosystem.

Second, we contribute with two paths of **digital platform ecosystem emergence** to the literature on platform evolution (Staykova 2019, 21). To the best of our knowledge, and called for by other scholars (de Reuver et al. 2018), it is still unclear how digital platform ecosystems emerge. In addition, it remains to be explored how environmental dynamics exogenous to ecosystems can influence the evolution of digital platform ecosystems (Tiwana et al. 2010). Hence, we provide scholars with two paths that describe the genesis of native digital platform ecosystems and the transformation of incumbents that transform toward a digital platform ecosystem. The path of native digital platform ecosystem emergence shows how exogenous dynamics in the form of technological trajectories (Dosi 1982) co-evolved with the adoption of newly emerging native platforms. In particular, platform owners made sense and assembled different technologies to support their value proposition of facilitating products or services between a supply and demand side ***(P4)***. While routinizing the assembly of new technologies, native digital platforms co-evolved their infrastructure to support the increasing amount of services provided. In turn, this routinization led to increasing demand for those services, which was recognized by incumbents. Besides informing the theory of platform evolution (Staykova 2019, 21), we also illustrate that newly emerging platform owners acted as bricoleurs (Lévi-Strauss 1962) by assembling existing technologies toward a digital infrastructure that supports a trajectory of mass servitization. Hence, we provide an exogenous view of how digital platform ecosystems co-evolve with and also shape the environment (Tiwana et al. 2010).

The second path of platform emergence is the transformation of incumbents to digital platform ecosystems. As illustrated by the first path, incumbents became aware of the new demand triggered by native digital platforms, which prompted a process of rethinking and transformation ***(P5)***. From a theoretical perspective, we draw on the literature stream that covers the transition of firms from a G-D to S-D logic (Ng et al. 2012; Skålén/Edvardsson 2016). In particular, prior literature revealed that value propositions of G-D and S-D logic differ (Ng et al. 2012) and on how value creation practices need to be enticed and transformed (Skålén/Edvardsson 2016). We complement this literature stream by offering a contextualization in the field of digital platform ecosystems. In addition, we point toward liminality as a fruitful theory to describe how roles in a newly emerging ecosystem can change ***(P5)***. For the contextualization, we illustrate how the incumbent introduced a digital platform as a technical mean to transition from a G-D logic with a business network (Anderson et al. 1994) toward also becoming a service provider with a more autonomous ecosystem that follows an S-D logic (Vargo/Lusch 2008, 2004; Vargo et al. 2008). During this co-evolution, the incumbent, as well as partners in the business network transition through a period of liminality (Henfridsson/Yoo 2014; Turner 1969), where they are exposed to heightened reflexivity (Turner 1986, 76). This heightened reflexivity allows them to dissociate themselves from their prior role to explore new roles based on the affordances provided by the digital platform (Nambisan et al. 2019). Hence, we illustrate that the concept of liminality complements the co-evolution perspective by linking the digital affordances of the digital platform with the self-exploration of new roles in the ecosystem. In addition, we offer a contextualization that shows how incumbents transition their and the role of ecosystem actors toward a digital platform ecosystem following an S-D logic (Lusch/Nambisan 2015).

Third, we contribute with the **standardization of value co-creation practices** to the literature on value co-creation in digital platform ecosystems (cf. Eaton et al. 2015; Foerderer et al. 2019; Ghazawneh/Henfridsson 2013). More specifically, we contribute to the socio-technical view of the complex and interdependent relationship between the provision of boundary resources (Eaton et al. 2015; Ghazawneh/Henfridsson 2013) and their actualization by external actors (Karhu et al. 2018). With the findings of ***P6***, we present insights on how digital platforms utilize boundary resources to implement standardized work practices that engage more or less autonomous actors into the scalable value co-creation process. From a social ecosystem perspective, the platform owner uses the practices to shift the design effort of transaction and innovation value-creation mechanisms outside of the digital platform toward the ecosystem of autonomous actors. As a result, we contribute to the literature on different types of digital platform ecosystems (Evans/Gawer 2016). In particular, we reveal that value co-creation practices consist of different configurations of transaction and innovation mechanisms with a different degree of scalability. Those configurations of transaction and innovation mechanisms, in turn, influence the structure of a digital platform and are at the core of different digital platform ecosystem types ***(P7)***. Besides contributing to the structure and types of digital platform ecosystems, standardized practices can also be seen as a distinct mechanism that illustrates how platform owners can shift the integration effort to the ecosystem to invert the firm (Parker et al. 2017).

Furthermore, the technical provision of boundary resources as standardized practices increases our understanding of S-D related issues in the building blocks of service ecosystems and the service platform (Lusch/Nambisan 2015). First, the platform owner provides knowledge boundary resources such as how-to guides and documentation (Foerderer et al. 2019) to help customers to self-integrate their machines and sensors to the digital platform. In this regard, the platform owner tackles the problem of interpretative flexibility or how easy actors can collaborate in the ecosystem (Tilson et al. 2010). For the supply side, the platform owner also provides SDKs and APIs that secure the compliance of platform standards (Ghazawneh/Henfridsson 2013), increase resource density (Lusch/Nambisan 2015) in that all other ecosystem actors are able to use the product or service provided, and effectively shift the integration effort to ecosystem partners. In addition, we provide a more nuanced understanding of value co-creation practices by illustrating that not all ecosystem actors are able to use the boundary resources as expected. Ecosystem actors that are unable to adopt standardized value co-creation practices require residual practices that also engage the platform owner or boundary spanning entities. This lack of interpretative flexibility, in turn, limits the scalability of value co-creation practices and calls the platform owner to keep standardizing value co-creation practices in a dynamic process ***(P6)***.

In sum, we adopted a socio-technical perspective that guided the inquiry of developing a unified understanding of digital platform ecosystems ***(P1, P2)***, increasing our understanding of how digital platform ecosystems came into existence ***(P3, P4, P5)***, and how they engage ecosystem partners in the co-creation process ***(P6, P7, P8)***.

3.2 Implications for Practice

Besides the implications for theory, the dissertation also provides practitioners with actionable insights on the emerging phenomenon of digital platform ecosystems. In the remainder, we will discuss the practical implications based on the unified definition, on the two paths of platform emergence, and on the process of standardizing value co-creation practices. In the last step, we will elaborate on how practitioners can design digital platform ecosystems based on the DSR framework of ***P8***.

First, practitioners can use the unified definition of digital platform ecosystems to get a more nuanced understanding of the centralization of platform owners, value-creating mechanisms, and varying degrees of complementor autonomy ***(P2)***. Actionable insights comprise the design and governance of digital platforms that are subject to centralized ownership, to a consortium of owners, to a decentralized peer-to-peer community. In addition, the unified understanding helps practitioners to disentangle innovation and transaction value-creating mechanisms based on the perspectives of the platform owner and complementors. Taking innovation mechanisms as an example, the platform owners need to continually evaluate if and what new affordances they provide in coordination with the skills and capabilities of complementors who need to act upon the affordances. Last, the perspective of complementor autonomy can help practitioners to account for differences when integrating low autonomous strategic partners and high autonomous complementors strategically.

Second, we provide two paths of platform emergence that help practitioners to understand how native digital platforms could come into existence and how they, as an incumbent, can transform toward a digital platform ecosystem ***(P3, P4, P5)***. In analogy to a famous quote: *"[t]hose who cannot remember the past are condemned to repeat it"* (Santayana 1905, 284), it is vital to understand how digital platforms emerged and disrupted whole industries. In this regard, we provide practitioners with an example of how technological trajectories led to a new paradigm of mass servitization. In particular, we illustrate that native digital platforms assembled new technologies with a different purpose of providing services instead of improving production efficiency. Hence, we show that practitioners need to deviate from the adoption of technology according to their institutional logic to take novel directions for applying technology ***(P4)***. In addition, we complement the literature on the transformation toward digital platform ecosystems (Sebastian et al. 2017) with a process model that helps to guide practitioners on how they can change form a G-D logic business network toward an S-D logic ecosystem. In particular, we show how incumbents can shift established roles of partners toward new roles. Actionable results comprise different ways on how incumbents can use a digital platform to foster the self-exploration and internalization of new roles by ecosystem actors ***(P5)***.

Third, we provide practical implications on standardized and residual value co-creation practices that illustrate how platform owners can integrate ecosystem partners to facilitate scalable value co-creation activities ***(P6)***. As an actionable insight, we reveal that boundary resources such as APIs and SDKs play a vital role when standardizing value co-creation practices that shift the effort of integration and innovation to ecosystem actors. However, platform owners also need to provide residual value co-creation practices that account for customers and complementors that are not able or willing to use the boundary resources to integrate or innovate. In this regard, the platform owner is always trying to incorporate nonconformity behavior by updating boundary resources to make them applicable to a broad range of consumers and complementors. Hence, the model of standardizing value co-creation practices helps practitioners to continually enhance boundary resources in alignment with the behavior of ecosystem actors to ensure the scalability of transaction and innovation value-creating practices.

Last, we developed a DSR framework that helps practitioners to design digital platform ecosystems ***(P8)***. With this framework, we respond to calls that requested a framework to deal with the multi-actor setting in which digital platform ecosystems are being developed (de Reuver et al. 2018). The design artifact takes account of the multi-actor setting by incorporating characteristics of ecosystem actors, value co-creation, and capture activities, as well as technical resources and governance mechanisms of the service platform (Lusch/Nambisan 2015). As an actionable result, practitioners can design and implement new ecosystem actors with different characteristics, connect those actors with value co-creation, and capture activities that are, in turn, mediated by platform functionalities and resources. During this process, practitioners can discover new solution spaces as new actors with different capabilities can be added or removed from the ecosystem.

4 Limitations

The findings of this dissertation are subject to several limitations. Foremost, we reflect on limitations that are subject to our ontological and epistemological assumptions, as well as the qualitative research strategy with associated research methods. Subsequently, we will discuss and evaluate the limitations in the light of the construct validity, internal validity, external validity, and generalizability of the findings (Yin 2014, 45-49).

First, there are limitations of ontological critical realism that comprise the transitive domain of knowledge about the fallibility of reality and the intransitive domain of the structures, mechanisms, events, and processes of the world, which are independent of the researcher (Bhaskar 1998, 17; Chis 2016). For reality to be fallible, scholars need to account for reality behind its mere appearance with conceptual isomorphism (Cruickshank 2009). Hence, scholars of the realm of critical realism need to assume that their definitions of intransitive knowledge about reality are correct (Cruickshank 2010; Kivinen/Piiroinen 2006). As a consequence, the validity of explanatory concepts stands and falls with the ontological presuppositions of the phenomenon of inquiry (Kemp 2005). In this regard, the results of this dissertation are only valid within its current economic, social, and technical presumptions. As an example, new technologies such as decentralized ledger technology could render some implications of our results obsolete. Hence, the findings of this dissertation are always subject to a fallible and tentative nature of reality. The second ontological limitation of critical realism is that assumptions of the past might convolute the interpretability of our results (Kivinen/Piiroinen 2006). The limitation results from the ontological assumption that structures are causal emergent properties that depend on the past in that they are *"products of past human agency"* (Cruickshank 2010, 589). However, the move of *"ontologizing"* time might be problematic as *"actions of people in the past […] become irreducibly structural once they have receded into history."* (Kivinen/Piiroinen 2006, 226). Whereas we tried to isolate the phenomenon of digital platform ecosystems from other potential convoluting structures of past human agency the findings might nevertheless expose to this epistemic fallacy (Chis 2016). An example is that we treated the concept of technological trajectories (Dosi 1982) in ***P4*** as a fixed pattern that is still valid. However, to consequently avoid convoluting effects, we would need to re-evaluate the concept of technological trajectories in the light of digital platform ecosystem emergence.

Second, there are limitations regarding the epistemological stance of subjectivism and the underlying inductive mode of reasoning. Those limitations concern the uncertainty of drawing wrong conclusions even if the premises are true (Danermark et al. 2002, 86). This argument is subject to the enduring puzzle of philosophy that empirical generalization is always subject to uncertainty. David Hume (1969, 189) summarizes this issue as *"there is nothing in an object, consider[ed] in itself, which can afford us a reason for drawing a conclusion beyond it; and that even after the observation of the frequent or constant conjunction of objects, we have no reason to draw any inference concerning any object beyond those of which we have had experienced."* This internal limitation of the inductive mode of reasoning occurs in all situations where a generalization is made (Ketokivi/Mantere 2010). In this regard, the generalizability of the results in the embedded publications is particularly vulnerable to frequently changing conditions where uncertainty is high. In particular, this means that, for example, the identified value co-creation practices within **P6** might be subject to change as new technologies emerge, whereas the practices of standardization and residualization are more stable as they apply to all value co-creation practices independent of technology. In addition, further limitations of inductive reasoning might be the cause of the availability heuristic (Schwarz et al. 1991), the confirmation bias (Nickerson 1998), and the gambler's fallacy (Rabin/Vayanos 2010). In short, the availability heuristic describes that scholars tend to use only the information that is readily available to them to draw inferences about reality. The confirmation bias builds on the tendency of rather confirming than denying a hypothesis. Last, the gambler's fallacy describes that scholars might draw simplified conclusions for complex problems. The problem was named after gamblers that thought they have had identified simple winning patterns despite the complexity of those games. Whereas we tried to account for all of those biases, for example, through data triangulation and inter-coder reliability (Flick 1992), we still are prone and cannot completely exclude the possibility to become a victim of them.

Third, there are limitations regarding the underlying research methods that comprise literature reviews (Webster/Watson 2002), case studies (Yin 2014), fsQCA (Fiss 2011), and design science research (Hevner 2004). We will discuss and elaborate on the limitations of the embedded publications based on the evaluation criteria of construct validity, internal validity, external validity, and reliability (Yin 2014, 45-49):

- Construct validity comprises the correct operationalization of measures and refers to the question if we measure what we wanted to measure. To make sure that the operationalization of measures reflects the intended purpose, we triangulated the data based on different sources of data (Flick 1992), to establish a chain of evidence (Gioia et al. 2013)[19]. In addition, we made sure that the interview transcripts were sent back to interviewees for revision. In the case of literature reviews or case studies that rely on archival data, we used the concept of inter-coder reliability to ensure construct validity. However, if the validity of the developed construct is valid remains to be tested by further, quantitative research.
- Internal validity describes that inferences about causality are valid and refers to the question of how and why events are causally related. To mitigate this bias, we followed the strategies of pattern matching, explanation building, and addressing rival explanations (Yin 2014, 41). For pattern matching, we only coded axial relationships in the case that open codes show strong causal interference with the dependent variable. When it comes to explanation building, we include detailed case descriptions that illustrate causal links between the variables. We address rival explanations by conducting a detailed literature analysis before we carry out independent studies to determine theories that could fit the empirical results. In the coding process, we tried to apply the rival theories to determine the explanatory power. In addition, all embedded publications went through a double-blind peer-review process, where independent reviewers also inspired us to rule out alternative theories. Whereas we tried to ensure internal validity through all those strategies, we cannot statistically test other causal inferences from neglected variables.

[19] An example of presenting qualitative studies with rigour, that is based on the Gioia Method (Gioia et al. 2013), can be found in Appendix A: Data Representation and Coding.

- External validity determines the generalizability of the results with similar phenomena and refers to the question of whether the findings are valid beyond the immediate case study. To ensure external validity, we grounded single case studies (P4) in well-established theory and introduced a replication logic for multiple case studies (P3, P4, P6). For the former, we employed established theory on role changes (cf. Ashforth 2000) to make sure that the findings can also be applied to other phenomena. For the latter, we conducted cross-case analyses to make sure that the findings are replicable across cases and, potentially, on other phenomena (Yin 2014, 158). However, if the developed theories are valid in other contextual settings remains to be tested.

- Reliability relates to the reproducibility of the results in another context. By following well-established methods such as the eight-step reconstruction of inductive case studies by Eisenhardt (1989) or the seven strategies of process-driven research to reconstruct scientific interference by Langley (1999), we tried to increase reproducibility. However, if the developed theories, for example, on value co-creation practices ***(P6)*** are generalizable, remains to be tested.

In sum, we acknowledge the limitations that result from following ontological critical realism, epistemological subjectivism, and employing qualitative research methods. While we tried to avoid known pitfalls by using established research procedures carefully, our research can still only be a first step toward developing a formal theory (Strauss 1987, 241). In the next chapter, we reveal avenues for future research that illustrate how scholars can use and further develop the findings of this dissertation.

5 Future Research

In this section, we point toward different directions for future research to pursue research on digital platform ecosystems (see Table 18). First, we shed light on how scholars can use the unified definition to identify and elaborate on different types of digital platform ecosystems. Second, we illustrate how the two paths of platform emergence can also be extended to adopt an endogenic perspective that focuses on the capabilities and skills needed to develop a digital platform ecosystem. Third, we call for research on the internal practices within digital platform ecosystems to take the complementor perspective on how to incorporate new affordances and to utilize the generativity of a digital platform ecosystem. Last, we illustrate the need to develop the DSR framework even further to be applicable in a variety of industries helping practitioners to gain transparency over their digital platform ecosystem.

Table 18. Avenues for Future Research building on Embedded Publications

No.	Research Question
P1	**Platform owner perspective of unified definition:** ▪ How do platform consortia govern their ecosystem? ▪ How do peer-to-peer digital platforms govern their ecosystem?
P2	**Complementor perspective of unified definition:** ▪ How do complementors co-create value in digital platform ecosystems? ▪ How can complementors influence strategic decisions in digital platform ecosystems? **Value-creating mechanisms of unified definition:** ▪ What are the antecedents that enable transaction value-creation mechanisms? ▪ What are the antecedents that enable innovation value-creation mechanisms?
P3	**The emergence of native digital platform ecosystems:** ▪ What are the indigenous factors that enabled native digital platforms to come into existence? ▪ How do native platform owners assemble technologies toward a digital platform ecosystem?
P4	**The transition of incumbents toward a digital platform ecosystem:** ▪ What are the organizational antecedents of a successful transition toward a digital platform ecosystem? ▪ What are the technical antecedents of a successful transition toward a digital platform ecosystem?
P5	**New paths of digital platform ecosystem emergence:** ▪ How do platform consortia come into existence? ▪ How do decentralized peer-to-peer platform ecosystems come into existence? ▪ How do mergers and acquisitions influence the emergence of digital platform ecosystems?
P6	**Value-creating mechanisms from the complementor perspective:** ▪ What are standardized value-creating mechanisms from the complementor perspective? ▪ What are residual value-creating mechanisms from the complementor perspective?
P7	**Value-creating mechanisms from the consumer perspective:** ▪ What are standardized value-creating mechanisms from the consumer perspective? ▪ What are residual value-creating mechanisms from the consumer perspective?
P8	**DSR framework to design digital platform ecosystems:** ▪ What configurations of attributes of digital platform ecosystems determine success? ▪ What configurations of attributes of digital platform ecosystems determine failure?

Use the unified definition to identify and elaborate on different types of digital platform ecosystems. First, we developed a unified definition of digital platform ecosystems that comprises platform owners with different degrees of centrality, complementors with different degrees of autonomy, as well as transaction and innovation value-creation mechanisms ***(P2)***. When it comes to the platform owner perspective, there is sparse research on platform consortia and decentralized peer-to-peer platform ecosystems. However, both concepts are going to increase in importance as shown by European initiatives to tackle platform dominance and winner-take-all markets through consortia (Clemons et al. 2019), as well as by the increasing market penetration of distributed ledger technology to democratize digital platform ecosystems (Riasanow et al. 2018). Of particular importance is the question if and how governance mechanisms between central ownership (Schreieck et al. 2018a; Schreieck et al. 2016) and consortia or peer-to-peer platform ecosystems differ. The findings might have valuable implications to provide scholars and practitioners with a more nuanced understanding of how to grow, steer, and sustain different types of digital platform ecosystems.

When it comes to the complementor perspective, we have shown that platform owners need to engage complementors with different degrees of autonomy to thrive ***(P3)***. While we have shed light on value co-creation practices from a platform owner perspective ***(P6),*** it remains to be understood how complementors co-create value with a digital platform ecosystem. Recent examples such as Uber drivers who protest for better working conditions (The Guardian 2019) or Facebook users who want to strengthen data privacy (The Guardian 2018) show that complementors also can influence digital platform ecosystems. Hence, taking the complementor perspective can be a fruitful avenue for future research to contribute to co-evolutionary dynamics in digital platform ecosystems.

Last, when it comes to value-creating mechanisms, we identified that digital platform ecosystems could employ both transaction and innovation mechanisms. While we contributed to this dimension with four configurations that illustrate how digital platform leaders take advantage of internal and external value-creating mechanisms ***(P7)***, there is sparse knowledge on antecedents such as technical and organizational capabilities that enable those two processes (Selander et al. 2013; Teece/Pisano 1994). Examples along those lines are monolithically-designed vs. microservice architectures or linear vs. agile vs. DevOps work practices. In this regard, the identification and influence of antecedents on value-creating mechanisms could be a promising addition to the literature on value co-creation (Lusch/Nambisan 2015; Vargo/Lusch 2008, 2004).

Extension of the paths of digital platform ecosystem emergence. Second, we introduced the path of native digital platform ecosystem emergence and the path of incumbents who transition toward a digital platform ecosystem ***(P3, P4, P5)***. For the former, our research focused on exogenous factors in the form of technological trajectories that led to the emergence of digital platform ecosystems ***(P4)***. However, it remains to be explored how native digital platform owners tinkered and assembled new technologies toward an architecture of servitization. Insights on this process could help incumbents and other companies to understand better how they can explore new solutions spaces without being restricted to their institutional logic.

For the latter, our research revealed preliminary results on how incumbents can transition from a G-D logic toward an S-D digital platform ecosystem. While our research paid particular importance to the transition of roles from being a manufacturer with suppliers as partners to also being a service platform owner that co-creates value with an ecosystem ***(P5)***, more empirical evidence is needed to draw generalizable conclusions. In particular, our preliminary research focused on a single case study in the European heating-manufacturing industry. However, incumbents in other industries might follow different approaches that also lead to success. In addition, non-successful transition cases could provide scholars in the field of digital platform ecosystems and practitioners with valuable insights on antecedents and success factors for those transformations.

Last, there might be yet unexplored ways of how digital platform ecosystems can come into existence. An example of a native digital platform ecosystem emergence can be the emergence of highly decentralized platform ecosystems that build on distributed ledger technology with no central actor. For the transition of incumbents, there is the option of incumbents that form consortia, which, in turn, require more effort to coordinate to the acquisition of platform companies as a way to transition to a digital platform ecosystem.

Incorporate complementor perspective on value co-creation practices in digital platform ecosystems. Third, we derived three core value co-creation practices that illustrate how the platform owner ensures the scalable integration of ecosystem actors ***(P6)***. We determine the scalability of services by linking the degree of complementor autonomy with the interpretative flexibility of boundary resources. In particular, we showed that platform owners strive to standardize practices to increase the interpretative flexibility of boundary resources for autonomous complementors. Furthermore, platform owners residualize practices when ecosystem actors are not able to follow the standardized version. However, despite notable exceptions that focus on the tuning of boundary resources (Eaton et al. 2015), it remains to be understood how complementors and consumers follow and influence those processes. Accordingly, an avenue for future research would be to explore the interdependencies of complementors, consumers, and platform owners to standardize and residualize value co-creation processes. An example of the complementor perspective would be that Airbnb hosts can use sources that are not provided by the platform owner (e.g., renting private bikes) to co-create value. In this regard, complementors can either standardize those services to make them accessible to a broad range of customers or residualize to make them also available to customers that are not able to follow the standardized process. An example of the consumer perspective would be that Uber users could order rides to move furniture or to order food, both services that were originally not intended by Uber. In sum, exploring value co-creating practices from the perspective of different ecosystem actors would help platform owners to determine better which affordances they should integrate next into their digital platform.

Enhance the DSR framework to be more generalizable. Last, we have provided a DSR framework to design digital platform ecosystems ***(R8)***. However, we contextualized the framework for digital platforms in the industry of mobility services ecosystems. To make the framework accessible and applicable to a broad range of industries, we propose to conduct a multiple-case study in a variety of different industries. With a more generalizable framework, scholars in the field of digital platform ecosystems would benefit from generic characteristics that define digital platform ecosystems (de Reuver et al. 2018). Those characteristics, in turn, could help to determine what attributes successful digital platform companies constitute and what failed digital platform ecosystems lack. In addition, a generic framework to design digital platform ecosystems would help practitioners in various industries to gain transparency over the current status of their ecosystem and on potential design decisions to discover new solution spaces.

6 Conclusion

Digital platform ecosystems changed the way how companies create economic value. Instead of relying on dyadic producer-buyer relationships where value is created in linear processes within the confines of a firm, digital platform ecosystems co-create value in polyadic actor-to-actor relationships in complex ecosystems. Due to the rapid emergence, the ongoing evolvement, as well as the high complexity of digital platform ecosystems, there is still conceptual ambiguity of what digital platform ecosystems are. Hence, this dissertation takes a socio-technical perspective of digital platform ecosystems to provide a unified definition, to increase our understanding of how digital platform ecosystems came into existence, and to elaborate on how they co-create value with ecosystem partners.

First, this dissertation provides a unified definition of digital platform ecosystems that comprises the core building blocks of platform owners with different degrees of centrality, complementors with different degrees of autonomy, and value-creating mechanisms that comprise transaction and innovation mechanisms. The unified definition tackles the ambiguity and vagueness of the term digital platform ecosystem and provides scholars with a more nuanced understanding of the phenomenon at hand.

Second, this dissertation reveals two paths of platform emergence. The first path illustrates, based on an exogenous perspective of technological trajectories, how native digital platform ecosystems came into existence. The second path describes how incumbents need to change roles in its existing business network to transform toward a digital platform ecosystem. By revealing insights on the two paths of digital platform ecosystem emergence, scholars and practitioners alike gain a more profound understanding of how digital platform ecosystems can shape the economy and how incumbents can react to this new development.

Third, this dissertation sheds light on three core value co-creation practices that focus on the supply, the demand, as well as on the orchestration between supply and demand. In particular, the practices show the link between complementor autonomy and the scalability of value co-creation practices based on the processes of standardization and residualization. By answering the question of how the platform owners can engage ecosystem partners into value co-creating activities, provides valuable insights into the complex interactions between technical boundary resources and social ecosystem actors. The three value co-creation practices demonstrate how a digital platform can engage the supply and demand side of their ecosystem effectively.

In appreciation of all the work we built on in this dissertation, we want to end with *"nanos gigantum humeris insidentis,"* referring to the phrase that we all stand on the shoulders of giants. We hope that like the work we built on did for us, that also our results can spark interest in the topic and help to generate novel ideas on digital platform ecosystems.

References

Adler, P.A.; Adler, P. (1994): Observational Techniques. In: Handbook of qualitative research. Eds.: Denzin, N.K.; Lincoln, Y.S. Sage Publications, Inc., Thousand Oaks, CA 1994, pp. 105-117.

Adner, R. (2006): Match your innovation strategy to your innovation ecosystem. In: Harvard Business Review, Vol. 84 (2006) No. 4, pp. 98-107.

Adner, R. (2017): Ecosystem as structure: an actionable construct for strategy. In: Journal of Management, Vol. 43 (2017) No. 1, pp. 39-58.

Amini, S.; Beckers, K.; Böhm, M.; Busch, F.; Celikkaya, N.; Cozzolino, V.; Faber, A.; Haus, M.; Huth, D.; Kemper, A.; Kipf, A.; Krcmar, H.; Matthes, F.; Ott, J.; Prehofer, C.; Pretschner, A.; Uludağ, Ö.; Wörndl, W. (2017): Informatikforschung für digitale Mobilitätsplattformen. In: Informatik-Spektrum, Vol. 40 (2017) No. 2, pp. 180-191.

Anderson, J.C.; Håkansson, H.; Johanson, J. (1994): Dyadic business relationships within a business network context. In: Journal of Marketing, Vol. 58 (1994) No. 4, pp. 1-15.

Appfigures; VentureBeat (2020): Number of apps available in leading app stores as of 4th quarter 2019. https://www-statista-com.eaccess.ub.tum.de/statistics/276623/number-of-apps-available-in-leading-app-stores/, accessed at 17.03.2020.

Ashforth, B. (2000): Role transitions in organizational life: An identity-based perspective, Routledge, New York, NY 2000.

Backhouse, J.; Hsu, C.W.; Silva, L. (2006): Circuits of power in creating de jure standards: shaping an international information systems security standard. In: MIS Quarterly, Vol. 30 (2006) No. SI, pp. 413-438.

Baker, T.; Nelson, R.E. (2005): Creating something from nothing: Resource construction through entrepreneurial bricolage. In: Administrative Science Quarterly, Vol. 50 (2005) No. 3, pp. 329-366.

Baldwin, C.Y.; Clark, K.B. (2000): Design rules: The power of modularity (Vol. 1), MIT press, Cambridge, MA 2000.

Baldwin, C.Y.; Woodard, C.J. (2009): The architecture of platforms: A unified view. In: Platforms, markets and innovation. Eds.: Gawer, A. Edward Elgar Publishing, Cheltenham, UK 2009, pp. 19-44.

Basole, R.C.; Karla, J. (2012): Value transformation in the mobile service ecosystem: A study of app store emergence and growth. In: Service Science, Vol. 4 (2012) No. 1, pp. 24-41.

Basurto, X.; Speer, J. (2012): Structuring the calibration of qualitative data as sets for qualitative comparative analysis (QCA). In: Field Methods, Vol. 24 (2012) No. 2, pp. 155-174.

Bateson, G. (1979): Mind and nature: A necessary unity, Dutton, New York, NY 1979.

Bem, D.J. (1987): Writing the empirical journal. In: The compleat academic: A practical guide for the beginning social scientist. Eds.: Zanna, M.P.; Darley, J.M. Lawrence Erlbaum Associates, Inc., Mahwah, NJ 1987, pp. 171-201.

Benbasat, I.; Goldstein, D.K.; Mead, M. (1987): The case research strategy in studies of information systems. In: MIS quarterly, (1987), pp. 369-386.

Bhaskar, R. (1998): Philosophy and scientific realism. In: Critical realism: Essential readings. Eds.: Archer, M.; Bharadwaj, A.; Collier, A.; Lawson, T.; Norrie, A. Routledge, Abingdon, UK 1998.

Böhm, M.; Hein, A.; Hermes, S.; Lurz, M.; Poszler, F.; Ritter, A.-C.; Setzke, D.S.; Weking, J.; Welpe, I.M.; Krcmar, H. (2019): Die Rolle von Startups im Innovationssystem: Eine qualitativ-empirische Untersuchung. Expertenkommission Forschung und Innovation (EFI), 2019.

Bondel, G.; Rehm, S.-V.; Matthes, F. (2020): Just Linking the Dots? Barriers and Drivers to Creating Value From Application Programming Interfaces. In: Proceedings of the 28th European Conference on Information Systems, Marrakech, Morocco.

Boudreau, K.J. (2010): Open platform strategies and innovation: Granting access vs. devolving control. In: Management Science, Vol. 56 (2010) No. 10, pp. 1849-1872.

Boudreau, K.J. (2012): Let a thousand flowers bloom? An early look at large numbers of software app developers and patterns of innovation. In: Organization Science, Vol. 23 (2012) No. 5, pp. 1409-1427.

Bowen, D.E.; Jones, G.R. (1986): Transaction cost analysis of service organization-customer exchange. In: Academy of Management Review, Vol. 11 (1986) No. 2, pp. 428-441.

Brandenburger, A.M.; Nalebuff, B.J. (1996): Co-opetition: A Revolution Mindset that Combines Competition and Cooperation, Currency/DoubleDay Business, New York, NY 1996.

Breidbach, C.F.; Maglio, P.P. (2016): Technology-enabled value co-creation: An empirical analysis of actors, resources, and practices. In: Industrial Marketing Management, Vol. 56 (2016), pp. 73-85.

Bromley, D.B. (1986): The case-study method in psychology and related disciplines, Wiley, Chichester, UK 1986.

Caillaud, B.; Jullien, B. (2003): Chicken & egg: Competition among intermediation service providers. In: RAND journal of Economics, Vol. 34 (2003) No. 2, pp. 309-328.

Casey, T.R.; Töyli, J. (2012): Dynamics of two-sided platform success and failure: An analysis of public wireless local area access. In: Technovation, Vol. 32 (2012) No. 12, pp. 703-716.

Ceccagnoli, M.; Forman, C.; Huang, P.; Wu, D. (2012): Cocreation of Value in a Platform Ecosystem: The Case of Enterprise Software. In: MIS Quarterly, Vol. 36 (2012) No. 1, pp. 263-290.

Cennamo, C.; Santalo, J. (2013): Platform competition: Strategic trade-offs in platform markets. In: Strategic Management Journal, Vol. 34 (2013) No. 11, pp. 1331-1350.

Chis, I.C. (2016): Problematising the Critical Realist Positional Approach to Intersectionality. In: Inquiries Journal, Vol. 8 (2016) No. 2, pp. 1-3.

Christensen, C.M. (2016): The innovator's dilemma: when new technologies cause great firms to fail, Harvard Business Review Press, Boston, MA 2016.

Clemons, E.; Krcmar, H.; Hermes, S.; Choi, J. (2019): American Domination of the Net: A Preliminary Ethnographic Exploration of Causes, Economic Implications for Europe, and Future Prospects. In: Proceedings of the 52nd Hawaii International Conference on System Sciences, Maui, Hawaii.

Conroy, S.A.; O'Leary-Kelly, A.M. (2014): Letting go and moving on: Work-related identity loss and recovery. In: Academy of Management Review, Vol. 39 (2014) No. 1, pp. 67-87.

Constantinides, P.; Henfridsson, O.; Parker, G.G. (2018): Introduction—Platforms and Infrastructures in the Digital Age. In: Information Systems Research, Vol. 29 (2018) No. 2, pp. 381-400.

Cooper, H.M. (1988): Organizing knowledge syntheses: A taxonomy of literature reviews. In: Knowledge, Technology & Policy, Vol. 1 (1988) No. 1, pp. 104-126.

Crotty, M. (1998): The foundations of social research: Meaning and perspective in the research process, Sage Publications Ltd, London, UK 1998.

Cruickshank, J. (2009): The Importance Of Nominal Problems. *Working Papers of the European University Institute*. Fiosele, Italy: European University Institute.

Cruickshank, J. (2010): Knowing social reality: a critique of Bhaskar and Archer's attempt to derive a social ontology from lay knowledge. In: Philosophy of the social sciences, Vol. 40 (2010) No. 4, pp. 579-602.

Danermark, B.; Ekström, M.; Jakobsen, L.; Karlsson, J.C. (2002): Explaining Society: Critical realism in the social sciences, Routledge, London, UK 2002.

de Reuver, M.; Sørensen, C.; Basole, R.C. (2018): The digital platform: a research agenda. In: Journal of Information Technology, Vol. 33 (2018) No. 2, pp. 124-135.

Denzin, N.K.; Lincoln, Y.S. (1994): Introduction: Entering the field of qualitative research. In: Handbook of qualitative research. Eds.: Denzin, N.K.; Lincoln, Y.S. Sage Publications, Inc., Thousand Oaks, CA 1994, pp. 1-17.

Denzin, N.K.; Lincoln, Y.S. (2005): The Discipline of Practice of Qualitative Research. In: Handbook of Qualitative Research (Vol. 3). Eds.: Denzin, N.K.; Lincoln, Y.S. Sage Publications, Inc., Thousand Oaks, CA 2005, pp. 1-19.

Dokko, G.; Kane, A.A.; Tortoriello, M. (2014): One of us or one of my friends: How social identity and tie strength shape the creative generativity of boundary-spanning ties. In: Organization Studies, Vol. 35 (2014) No. 5, pp. 703-726.

Dosi, G. (1982): Technological paradigms and technological trajectories. In: Research Policy, Vol. 2 (1982) No. 3, pp. I47-162.

Eaton, B.; Elaluf-Calderwood, S.; Sorensen, C.; Yoo, Y. (2015): Distributed tuning of boundary resources: the case of Apple's iOS service system. In: MIS Quarterly, Vol. 39 (2015) No. 1, pp. 217-243.

Eisenhardt, K.M. (1989): Building theories from case study research. In: Academy of Management Review, Vol. 14 (1989) No. 4, pp. 532-550.

Eisenhardt, K.M.; Graebner, M.E. (2007): Theory building from cases: Opportunities and challenges. In: Academy of Management Journal, Vol. 50 (2007) No. 1, pp. 25-32.

Eisenmann, T.; Parker, G.; Alstyne, M.V. (2006): Strategies for two-sided markets. In: Harvard Business Review, Vol. 84 (2006) No. 10, pp. 92-101.

Eisenmann, T.; Parker, G.; Van Alstyne, M. (2011): Platform envelopment. In: Strategic Management Journal, Vol. 32 (2011) No. 12, pp. 1270-1285.

Evans, D.S. (2009): How catalysts ignite: The economics of platform-based start-ups. In: Platforms, markets and innovation. Eds.: Gawer, A. Edward Elgar, Cheltenham, UK 2009.

Evans, D.S. (2012): Governing bad behavior by users of multi-sided platforms. In: Berkeley Technology Law Journal, Vol. 2 (2012) No. 27, pp. 1201-1250.

Evans, D.S.; Schmalensee, R. (2010): Failure to launch: Critical mass in platform businesses. In: Review of Network Economics, Vol. 9 (2010) No. 4, pp. 1-26.

Evans, P.C.; Gawer, A. (2016): The rise of the platform enterprise: a global survey. The Emerging Platform Economy Series, 2016.

Faber, A.; Hernandez-Mendez, A.; Rehm, S.-V.; Matthes, F. (2020): Collaborative Modelling and Visualization of Business Ecosystems. In: Australasian Journal of Information Systems, Vol. 24 (2020), pp. 1-20.

Faber, A.; Rehm, S.-V.; Hernandez-Mendez, A.; Matthes, F. (2018): Modeling and Visualizing Smart City Mobility Business Ecosystems: Insights from a Case Study. In: Information, Vol. 9 (2018) No. 11, pp. 1-20.

Faber, A.; Rehm, S.-V.; Hernandez-Mendez, A.; Matthes, F. (2019): Collectively Constructing the Business Ecosystem: Towards Crowd-Based Modeling for Platforms and Infrastructures. In: Proceedings of the 20th International Conference on Enterprise Information Systems, Madeira, Portugal.

Farrell, J.; Saloner, G. (1985): Standardization, compatibility, and innovation. In: The RAND Journal of Economics, Vol. 16 (1985) No. 1, pp. 70-83.

Fiss, P.C. (2007): A set-theoretic approach to organizational configurations. In: Academy of Management Review, Vol. 32 (2007) No. 4, pp. 1180-1198.

Fiss, P.C. (2011): Building better causal theories: A fuzzy set approach to typologies in organization research. In: Academy of Management Journal, Vol. 54 (2011) No. 2, pp. 393-420.

Flick, U. (1992): Triangulation revisited: strategy of validation or alternative? In: Journal for the Theory of Social Behaviour, Vol. 22 (1992) No. 2, pp. 175-197.

Flick, U. (2009): An introduction to qualitative research, Sage Publications Ltd., London, UK 2009.

Foerderer, J.; Kude, T.; Mithas, S.; Heinzl, A. (2018): Does platform owner's entry crowd out innovation? Evidence from Google photos. In: Information Systems Research, Vol. 29 (2018) No. 2, pp. 444-460.

Foerderer, J.; Kude, T.; Schuetz, S.W.; Heinzl, A. (2019): Knowledge boundaries in enterprise software platform development: Antecedents and consequences for platform governance. In: Information Systems Journal, Vol. 29 (2019) No. 1, pp. 119-144.

Fontana, A.; Frey, J.H. (1994): Interviewing: The Art of Science. In: Handbook of qualitative research. Eds.: Denzin, N.K.; Lincoln, Y.S. Sage Publications, Inc., Thousand Oaks, CA 1994.

Frow, P.; McColl-Kennedy, J.R.; Payne, A. (2016): Co-creation practices: Their role in shaping a health care ecosystem. In: Industrial Marketing Management, Vol. 56 (2016), pp. 24-39.

Garud, R.; Kumaraswamy, A. (1995): Technological and organizational designs for realizing economies of substitution. In: Strategic Management Journal, Vol. 16 (1995) No. S1, pp. 93-109.

Gawer, A. (2014): Bridging differing perspectives on technological platforms: Toward an integrative framework. In: Research Policy, Vol. 43 (2014) No. 7, pp. 1239-1249.

Gawer, A.; Cusumano, M. (2007): A strategy toolkit for platform leader wannabes. In: Proceedings of the DRUID Summer Conference on Appropriability, Proximity, Routines and Innovation, Copenhagen, Denmark.

Gawer, A.; Cusumano, M.A. (2002): Platform leadership: How Intel, Microsoft, and Cisco drive industry innovation (Vol. 5), Harvard Business School Press, Boston, MA 2002.

Gawer, A.; Cusumano, M.A. (2008): How companies become platform leaders. In: MIT Sloan Management Review, Vol. 49 (2008) No. 2, pp. 28-35.

Gawer, A.; Cusumano, M.A. (2014): Industry platforms and ecosystem innovation. In: Journal of Product Innovation Management, Vol. 31 (2014) No. 3, pp. 417-433.

Gawer, A.; Henderson, R. (2007): Platform owner entry and innovation in complementary markets: Evidence from Intel. In: Journal of Economics and Management Strategy, Vol. 16 (2007) No. 1, pp. 1-34.

Gephart Jr, R.P. (2004): Qualitative research and the Academy of Management Journal. In: Academy of Management Journal, Vol. 47 (2004) No. 4, pp. 454-462.

Gerwe, O.; Silva, R. (2018): Clarifying the sharing economy: Conceptualization, typology, antecedents, and effects. In: Academy of Management Perspectives, (2018) No. ja.

Ghazawneh, A.; Henfridsson, O. (2013): Balancing platform control and external contribution in third-party development: The boundary resources model. In: Information Systems Journal, Vol. 23 (2013) No. 2, pp. 173-192.

Gioia, D.A.; Corley, K.G.; Hamilton, A.L. (2013): Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. In: Organizational Research Methods, Vol. 16 (2013) No. 1, pp. 15-31.

Glaser, B.G.; Strauss, A.L. (2017): Discovery of grounded theory: Strategies for qualitative research, Routledge, London, UK 2017.

Gnyawali, D.R.; Park, B.-J.R. (2011): Co-opetition between giants: Collaboration with competitors for technological innovation. In: Research Policy, Vol. 40 (2011) No. 5, pp. 650-663.

Gould, S.J. (2002): The structure of evolutionary theory, Harvard University Press, Cambridge, MA 2002.

Gregor, S. (2006): The nature of theory in information systems. In: MIS Quarterly, Vol. 30 (2006) No. 3, pp. 611-642.

Gregor, S.; Hevner, A.R. (2013): Positioning and presenting design science research for maximum impact. In: MIS quarterly, (2013), pp. 337-355.

Guba, E.G. (1990): The Alternative Paradigm Dialog. In: The Paradigm Dialog. Eds.: Guba, E.G. Sage Publications Inc., Thousand Oaks, CA 1990.

Guba, E.G.; Lincoln, Y.S. (1994): Competing paradigms in qualitative research. In: Handbook of qualitative research. Eds.: Denzin, N.K.; Lincoln, Y.S. Sage Publications, Inc., Thousand Oaks, CA 1994, pp. 105.

Hagiu, A. (2009): Multi-sided platforms: From microfoundations to design and expansion strategies. In: Harvard Business School Strategy Unit Working Paper, (2009) No. 09-115.

Han, J.; Cho, O. (2015): Platform business Eco-model evolution: case study on KakaoTalk in Korea. In: Journal of Open Innovation: Technology, Market, and Complexity, Vol. 1 (2015) No. 1, pp. 6.

Hein, A. (2020): Navigating Role Changes During the Transition Toward Service Platform Ecosystems. In: Proceedings of the 28th European Conference on Information Systems, Marrakech, Morocco.

Hein, A.; Böhm, M.; Krcmar, H. (2018a): Digitale Plattformen. In: Strategie und Transformation im digitalen Zeitalter. Eds.: Dahm, M.; Thode, S. Springer, Wiesbaden, Germany 2018a, pp. 181-199.

Hein, A.; Böhm, M.; Krcmar, H. (2018b): Platform configurations within information systems research: A literature review on the example of IoT platforms. In: Proceedings of the Multikonferenz Wirtschaftsinformatik, Lüneburg, Germany, pp. 465-476.

Hein, A.; Böhm, M.; Krcmar, H. (2018c): Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber. In: Proceedings of the 21st International Conference on Business Information Systems, Berlin, Germany, pp. 295-306.

Hein, A.; Scheiber, M.; Böhm, M.; Weking, J.; Rocznik, D.; Krcmar, H. (2018d): Toward a Design Framework for Service-Platform Ecosystems. In: Proceedings of the 26th European Conference on Information Systems, Porthsmouth, UK.

Hein, A.; Schreieck, M.; Riasanow, T.; Setzke, D.S.; Wiesche, M.; Böhm, M.; Krcmar, H. (2019a): Digital platform ecosystems. In: Electronic Markets, Vol. in press (2019a), pp. 87-98.

Hein, A.; Schreieck, M.; Wiesche, M.; Böhm, M.; Krcmar, H. (2019b): The emergence of native multi-sided platforms and their influence on incumbents. In: Electronic Markets, Vol. 29 (2019b) No. 4, pp. 631-647.

Hein, A.; Schreieck, M.; Wiesche, M.; Krcmar, H. (2016): Multiple-case analysis on governance mechanisms of multi-sided platforms. In: Proceedings of the Multikonferenz Wirtschaftsinformatik, Ilmenau, Germany.

Hein, A.; Soto Setzke, D.; Hermes, S.; Weking, J. (2019c): The Influence of Digital Affordances and Generativity on Digital Platform Leadership. In: Proceedings of the 40th International Conference on Information Systems, Munich, Germany.

Hein, A.; Weking, J.; Schreieck, M.; Wiesche, M.; Böhm, M.; Krcmar, H. (2019d): Value co-creation practices in business-to-business platform ecosystems. In: Electronic Markets, Vol. 29 (2019d) No. 3, pp. 503-518.

Hendriks-Jansen, H. (1996): Catching ourselves in the act: Situated activity, interactive emergence, evolution, and human thought, MIT Press, Boston, MA 1996.

Henfridsson, O.; Bygstad, B. (2013): The generative mechanisms of digital infrastructure evolution. In: MIS Quarterly, Vol. 37 (2013) No. 3, pp. 907-931.

Henfridsson, O.; Nandhakumar, J.; Scarbrough, H.; Panourgias, N. (2018): Recombination in the open-ended value landscape of digital innovation. In: Information and Organization, Vol. 28 (2018) No. 2, pp. 89-100.

Henfridsson, O.; Yoo, Y. (2014): The liminality of trajectory shifts in institutional entrepreneurship. In: Organization Science, Vol. 25 (2014) No. 3, pp. 932-950.

Hermes, S.; Maier, M.; Hein, A.; Böhm, M.; Krcmar, H. (2020a): User Roles on Peer-to-Peer Sharing Platforms: A Critical Review of the Literature and Recommended Remedies. In: Proceedings of the 53rd Hawaii International Conference on System Sciences, Manoa, HI.

Hermes, S.; Pfab, S.; Hein, A.; Weking, J.; Böhm, M.; Krcmar, H. (2020b): Digital Platforms and Market Dominance: Insights from a Systematic Literature Review and Avenues for Future Research. In: Proceedings of the 24th Pacific Asia Conference on Information Systems, Dubai, United Arab Emirates.

Hermes, S.; Töller, N.; Hein, A.; Weking, J. (2020c): Gaining Control over Critical Platforms: A Comparative Case Study of European Consortia. In: Proceedings of the 28th European Conference on Information Systems, Marrakech, Morocco.

Hevner, A.R. (2004): Design science in information systems research. In: MIS Quarterly, Vol. 28 (2004) No. 1, pp. 75-105.

Hevner, A.R. (2007): A three cycle view of design science research. In: Scandinavian journal of information systems, Vol. 19 (2007) No. 2, pp. 4.

Hevner, A.R.; Chatterjee, S. (2010): Design science research in information systems, Springer, New York, NY 2010.

Hippel, V.E.; Katz, R. (2002): Shifting innovation to users via toolkits. In: Management Science, Vol. 48 (2002) No. 7, pp. 821-833.

Hodder, I. (1994): The Interpretation of Documents and Material Culture. In: Handbook of qualitative research. Eds.: Denzin, N.K.; Lincoln, Y.S. Sage Publications, Inc., Thousand Oaks, CA 1994, pp. 105.

Huang, L.; Hu, G.; Lu, X. (2009): E-business ecosystem and its evolutionary path: the case of the Alibaba group in china. In: Pacific Asia Journal of the Association for Information Systems, Vol. 1 (2009) No. 4.

Hume, D. (1758): An enquiry concerning human understanding, Open Court Publishing Co., Chicago, IL 1758.

Hume, D. (1969): A treatise of human nature, Penguin Classics, London, UK 1969.

Iansiti, M.; Levien, R. (2004): The keystone advantage: what the new dynamics of business ecosystems mean for strategy, innovation, and sustainability, Harvard Business Press, Boston, MA 2004.

Iivari, J. (2007): A Paradigmatic Analysis of Information Systems As a Design Science. In: Scandinavian Journal of Information Systems, Vol. 19 (2007) No. 2.

Iivari, J.; Hirschheim, R.; Klein, H.K. (2004): Towards a distinctive body of knowledge for Information Systems experts: coding ISD process knowledge in two IS journals. In: Information Systems Journal, Vol. 14 (2004) No. 4, pp. 313-342.

Jacobides, M.G.; Cennamo, C.; Gawer, A. (2018): Towards a theory of ecosystems. In: Strategic Management Journal, Vol. 39 (2018) No. 8, pp. 2255-2276.

Jansen, S.; Cusumano, M.A. (2013): Defining software ecosystems: a survey of software platforms and business network governance. In: Proceedings of the 3rd International Conference on Software Business, Boston, MA.

Kapoor, R. (2018): Ecosystems: broadening the locus of value creation. In: Journal of Organization Design, Vol. 7 (2018) No. 1, pp. 12.

Karhu, K.; Gustafsson, R.; Lyytinen, K. (2018): Exploiting and defending open digital platforms with boundary resources: Android's five platform forks. In: Information Systems Research, Vol. 29 (2018) No. 2, pp. 479-497.

Katz, M.L.; Shapiro, C. (1986): Technology adoption in the presence of network externalities. In: Journal of Political Economy, Vol. 94 (1986) No. 4, pp. 822-841.

Katz, M.L.; Shapiro, C. (1994): Systems competition and network effects. In: Journal of Economic Perspectives, Vol. 8 (1994) No. 2, pp. 93-115.

Kemp, S. (2005): Critical realism and the limits of philosophy. In: European Journal of Social Theory, Vol. 8 (2005) No. 2, pp. 171-191.

Ketokivi, M.; Mantere, S. (2010): Two strategies for inductive reasoning in organizational research. In: Academy of management review, Vol. 35 (2010) No. 2, pp. 315-333.

Khan, C.; Lewis, A.; Rutland, E.; Wan, C.; Rutter, K.; Thompson, C. (2017): A distributed-ledger consortium model for collaborative innovation. In: Computer, Vol. 50 (2017) No. 9, pp. 29-37.

Kivinen, O.; Piiroinen, T. (2006): On the limits of a realist conception of knowledge: A pragmatist critique of Archerian realism. In: The sociological review, Vol. 54 (2006) No. 2, pp. 224-241.

Koh, T.K.; Fichman, M. (2014): Multihoming users' preferences for two-sided exchange networks. In: MIS Quarterly, Vol. 38 (2014) No. 4, pp. 977-996.

Langley, A. (1999): Strategies for theorizing from process data. In: Academy of Management review, Vol. 24 (1999) No. 4, pp. 691-710.

Leidner, D.E. (2018): Review and theory symbiosis: An introspective retrospective. In: Journal of the Association for Information Systems, Vol. 19 (2018) No. 6, pp. 1.

Leigh Star, S. (2010): This is not a boundary object: Reflections on the origin of a concept. In: Science, Technology, & Human Values, Vol. 35 (2010) No. 5, pp. 601-617.

Letourneau, N.; Allen, M. (1999): Post-positivistic critical multiplism: a beginning dialogue. In: Journal of Advanced Nursing, Vol. 30 (1999) No. 3, pp. 623-630.

Levers, M.-J.D. (2013): Philosophical paradigms, grounded theory, and perspectives on emergence. In: Sage Open, Vol. 3 (2013) No. 4.

Lévi-Strauss, C. (1962): The savage mind, Librairie Plon, Paris, France 1962.

Levina, N.; Vaast, E. (2005): The emergence of boundary spanning competence in practice: implications for implementation and use of information systems. In: MIS Quarterly, Vol. 29 (2005) No. 2, pp. 335-363.

Lewicki, R.J.; Brinsfield, C.T. (2009): Trust, distrust and building social capital. In: Social capital: Reaching out, reaching in (Vol. 1). Eds.: Bartkus, V.O.; Davis, J.H. Edward Elgar Publishing 2009, pp. 275-303.

Linnaeus, C. (1753): Species plantarum, Impensis Laurentii Salvii, Stockholm, Sweden 1753.

Lusch, R.F.; Nambisan, S. (2015): Service innovation: A service-dominant logic perspective. In: MIS Quarterly, Vol. 39 (2015) No. 1, pp. 155-176.

Lusch, R.F.; Vargo, S.L.; Tanniru, M. (2010): Service, value networks and learning. In: Journal of the academy of marketing science, Vol. 38 (2010) No. 1, pp. 19-31.

Majchrzak, A.; Faraj, S.; Kane, G.C.; Azad, B. (2013): The contradictory influence of social media affordances on online communal knowledge sharing. In: Journal of Computer-Mediated Communication, Vol. 19 (2013) No. 1, pp. 38-55.

Manner, J.; Nienaber, D.; Schermann, M.; Krcmar, H. (2012): Governance for Mobile Service Platforms: a literature Review and Research Agenda. In: Proceedings of the 11th International Conference on Mobile Business, Delft, Netherlands, pp. 14.

Manner, J.; Nienaber, D.; Schermann, M.; Krcmar, H. (2013): Six Principles for Governing Mobile Platforms. In: Proceedings of the 11th International Conference on Wirtschaftsinformatik, Leipzig, Germany, pp. 86.

Matt, C.; Hess, T.; Benlian, A. (2015): Digital transformation strategies. In: Business & Information Systems Engineering, Vol. 57 (2015) No. 5, pp. 339-343.

McIntyre, D.P.; Srinivasan, A. (2017): Networks, Platforms, and Strategy: Emerging Views and Next Steps. In: Strategic Management Journal, Vol. 38 (2017) No. 1, pp. 141-160.

Merton, R.K.; Kendall, P.L. (1946): The focused interview. In: American journal of Sociology, Vol. 51 (1946) No. 6, pp. 541-557.

Mill, J.S. (1967 [1843]): A system of logic, ratiocinative and inductive (Vol. 1), University of Toronto Press., Toronto, Canada 1967 [1843].

Moazed, A. (2019): Platform Businesses Account for 20% of S&P 500 Returns. accessed at 17.01.2020.

Moore, J.F. (1993): Predators and prey: a new ecology of competition. In: Harvard Business Review, Vol. 71 (1993) No. 3, pp. 75-86.

Moore, J.F. (1997): The death of competition : leadership and strategy in the age of business ecosystems. (First edition. ed.), Harper Business, New York, NY 1997.

Muzellec, L.; Ronteau, S.; Lambkin, M. (2015): Two-sided Internet platforms: A business model lifecycle perspective. In: Industrial Marketing Management, Vol. 45 (2015), pp. 139-150.

Nambisan, S.; Wright, M.; Feldman, M. (2019): The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. In: Research Policy, Vol. 48 (2019) No. 8, pp. 1-9.

Ng, I.; Parry, G.; Smith, L.; Maull, R.; Briscoe, G. (2012): Transitioning from a goods-dominant to a service-dominant logic: Visualising the value proposition of Rolls-Royce. In: Journal of Service Management, Vol. 23 (2012) No. 3, pp. 416-439.

Nickerson, R.S. (1998): Confirmation bias: A ubiquitous phenomenon in many guises. In: Review of General Psychology, Vol. 2 (1998) No. 2, pp. 175-220.

Noe, T.; Parker, G. (2005): Winner take all: Competition, strategy, and the structure of returns in the internet economy. In: Journal of Economics & Management Strategy, Vol. 14 (2005) No. 1, pp. 141-164.

Normann, R. (2001): Reframing business: When the map changes the landscape, Wiley, Chichester, UK 2001.

Ojala, A.; Lyytinen, K. (2018): Competition logics during digital platform evolution. In: Proceedings of the 51st Hawaii International Conference on System Sciences, Waikoloa Village, HI.

Orton, J.D.; Weick, K.E. (1990): Loosely coupled systems: A reconceptualization. In: Academy of Management Review, Vol. 15 (1990) No. 2, pp. 203-223.

Paré, G.; Trudel, M.-C.; Jaana, M.; Kitsiou, S. (2015): Synthesizing information systems knowledge: A typology of literature reviews. In: Information & Management, Vol. 52 (2015) No. 2, pp. 183-199.

Parker, G.; Alstyne, M.V.; Jiang, X. (2017): Platform Ecosystems: How Developers Invert the Firm. In: MIS Quarterly, Vol. 41 (2017) No. 1, pp. 255-266.

Parker, G.; Van Alstyne, M. (2005): Two-sided network effects: A theory of information product design. In: Management Science, Vol. 51 (2005) No. 10, pp. 1494-1504.

Parker, G.; Van Alstyne, M. (2017): Innovation, openness, and platform control. In: Management Science, Vol. 64 (2017) No. 7, pp. 3015-3032.

Parker, G.; Van Alstyne, M.; Choudary, S.P.; Foster, J. (2016): Platform revolution: How networked markets are transforming the economy and how to make them work for you, W. W. Norton & Company, Inc., New York, NY 2016.

Peppard, J.; Rylander, A. (2006): From Value Chain to Value Network: Insights for Mobile Operators. In: European Management Journal, Vol. 24 (2006) No. 2-3, pp. 128–141.

Prahalad, C.K.; Ramaswamy, V. (2004): Co-creation experiences: The next practice in value creation. In: Journal of Interactive Marketing, Vol. 18 (2004) No. 3, pp. 5-14.

Rabin, M.; Vayanos, D. (2010): The gambler's and hot-hand fallacies: Theory and applications. In: The Review of Economic Studies, Vol. 77 (2010) No. 2, pp. 730-778.

Ragin, C.C. (2006): Set relations in social research: Evaluating their consistency and coverage. In: Political Analysis, Vol. 14 (2006) No. 3, pp. 291-310.

Ragin, C.C. (2009): Qualitative comparative analysis using fuzzy sets (fsQCA). In: Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques, Vol. 51 (2009), pp. 87-121.

Riasanow, T.; Burckhardt, F.; Soto Setzke, D.; Böhm, M.; Krcmar, H. (2018): The Generic Blockchain Ecosystem and its Strategic Implications. In: Proceedings of the 24th Americas Conference on Information Systems, New Orleans, LA.

Riasanow, T.; Floetgen, R.J.; Greineder, M.; Moeslein, D.; Böhm, M.; Krcmar, H. (2019a): Co-evolution in Business Ecosystems: Findings from Literature. In: Proceedings of the 40th GI EMISA Conference, Tutzing, Germany.

Riasanow, T.; Jäntgen, L.; Hermes, S.; Böhm, M.; Krcmar, H. (2020): Core, intertwined, and ecosystem-specific clusters in platform ecosystems: analyzing similarities in the digital transformation of the automotive, blockchain, financial, insurance and IIoT industry. In: Electronic Markets, Vol. online (2020) No. forthcoming, pp. 1-16.

Riasanow, T.; Setzke, D.S.; Böhm, M.; Krcmar, H. (2019b): Clarifying the Notion of Digital Transformation: A Transdisciplinary Review of Literature. In: Journal of Competences, Strategy & Management, Vol. 10 (2019b), pp. 5-31.

Rittel, H.W.; Webber, M.M. (1973): Dilemmas in a general theory of planning. In: Policy Sciences, Vol. 4 (1973) No. 2, pp. 155-169.

Rochet, J.C.; Tirole, J. (2003): Platform competition in two-sided markets. In: Journal of the European Economic Association, Vol. 1 (2003) No. 4, pp. 990-1029.

Rogers, E.M. (2003): Diffusion of innovations (Vol. 5), The Free Press, New York, NY 2003.

Santayana, G. (1905): The Life of Reason: Reason in Common Sense (Vol. 1), Charles Scribner's Sons, New York, NY 1905.

Schermuly, L.; Schreieck, M.; Wiesche, M.; Krcmar, H. (2019): Developing an industrial IoT platform–Trade-off between horizontal and vertical approaches. In: Proccedings of the International Conference on Wirtschaftsinformatik, Siegen, Germany.

Schilling, M.A. (2002): Technology success and failure in winner-take-all markets: The impact of learning orientation, timing, and network externalities. In: Academy of Management Journal, Vol. 45 (2002) No. 2, pp. 387-398.

Schreieck, M.; Hein, A.; Wiesche, M.; Krcmar, H. (2018a): The Challenge of Governing Digital Platform Ecosystems. In: Digital Marketplaces Unleashed. Eds.: Linnhoff-Popien, C.; Schneider, R.; Zaddach, M. Springer Berlin Heidelberg, Berlin, Heidelberg 2018a, pp. 527-538.

Schreieck, M.; Hein, A.; Wiesche, M.; Krcmar, H. (2018b): Governance der Akteure einer digitalen Plattform. In: Management digitaler Plattformen: Konzeption und Realisierung eines offenen Ökosystems für intelligente Mobilitätsdienste in der Smart City. Eds.: Wiesche, M.; Sauer, P.; Krimmling, J.; Krcmar, H. Springer Fachmedien Wiesbaden, Wiesbaden 2018b, pp. 53-66.

Schreieck, M.; Wiesche, M. (2017): How established companies leverage IT platforms for value co-creation–insights from banking. In: Proceedings of the 25th European Conference on Information Systems, Guimaraes, Portugal.

Schreieck, M.; Wiesche, M.; Krcmar, H. (2016): Design and governance of platform ecosystems–key concepts and issues for future research. In: Proceedings of the 24th European Conference on Information Systems, Istanbul, Turkey.

Schreieck, M.; Wiesche, M.; Krcmar, H. (2017): The Platform Owner's Challenge to Capture Value-Insights from a Business-to-Business IT Platform. In: Proceedings of the 38th International Conference on Information Systems, Seoul, South Korea.

Schwarz, N.; Bless, H.; Strack, F.; Klumpp, G.; Rittenauer-Schatka, H.; Simons, A. (1991): Ease of retrieval as information: another look at the availability heuristic. In: Journal of Personality and Social Psychology, Vol. 61 (1991) No. 2, pp. 195-202.

Sebastian, I.M.; Ross, J.W.; Beath, C.; Mocker, M.; Moloney, K.G.; Fonstad, N.O. (2017): How Big Old Companies Navigate Digital Transformation. In: MIS Quarterly Executive, Vol. 16 (2017) No. 3, pp. 197-213.

Selander, L.; Henfridsson, O.; Svahn, F. (2013): Capability search and redeem across digital ecosystems. In: Journal of Information Technology, Vol. 28 (2013) No. 3, pp. 183-197.

Shipilov, A.; Gawer, A. (2020): Integrating Research on Interorganizational Networks and Ecosystems. In: Academy of Management Annals, Vol. 14 (2020) No. 1, pp. 92-121.

Siggelkow, N. (2007): Persuasion with case studies. In: Academy of Management Journal, Vol. 50 (2007) No. 1, pp. 20-24.

Simon, H.A. (1996): The Sciences of the Artificial (Vol. 3), MIT Press, Cambridge, MA 1996.

Simon, H.A. (2002): Near decomposability and the speed of evolution. In: Industrial and Corporate Change, Vol. 11 (2002) No. 3, pp. 587-599.

Skålén, P.; Aal, K.A.; Edvardsson, B. (2015): Cocreating the Arab Spring: Understanding transformation of service systems in contention. In: Journal of Service Research, Vol. 18 (2015) No. 3, pp. 250-264.

Skålén, P.; Edvardsson, B. (2016): Transforming from the goods to the service-dominant logic. In: Marketing Theory, Vol. 16 (2016) No. 1, pp. 101-121.

Song, P.; Xue, L.; Rai, A.; Zhang, C. (2018): The ecosystem of software platform: A study of asymmetric cross-side network effects and platform governance. In: MIS Quarterly, Vol. 42 (2018) No. 1, pp. 121-142.

Spagnoletti, P.; Resca, A.; Lee, G. (2015): A design theory for digital platforms supporting online communities: A multiple case study. In: Journal of Information Technology, Vol. 30 (2015) No. 4, pp. 364-380.

Stake, R.E. (1994): Case Studies. In: Handbook of qualitative research. Eds.: Denzin, N.K.; Lincoln, Y.S. Sage Publications, Inc., Thousand Oaks, CA 1994.

Staykova, K.S. (2019): Generative Mechanisms for Digital Platform Ecosystem Evolution, Copenhagen Business School (CBS), Frederiksberg, Denmark 2019.

Steensma, H.K.; Corley, K.G. (2000): On the performance of technology-sourcing partnerships: The interaction between partner interdependence and technology attributes. In: Academy of Management Journal, Vol. 43 (2000) No. 6, pp. 1045-1067.

Steers, R.M.; Porter, L.W. (1974): The role of task-goal attributes in employee performance. In: Psychological Bulletin, Vol. 81 (1974) No. 7, pp. 434-452.

Stouffer, S.A. (1941): Notes on the case-study and the unique case. In: Sociometry, Vol. 4 (1941), pp. 349-357.

Strauss, A.L. (1987): Qualitative analysis for social scientists, Cambridge University Press, Cambridge, UK 1987.

Tan, B.; Pan, S.L.; Lu, X.; Huang, L. (2015): The role of IS capabilities in the development of multi-sided platforms: the digital ecosystem strategy of Alibaba. com. In: Journal of the Association for Information Systems, Vol. 16 (2015) No. 4, pp. 248-280.

Teece, D.; Pisano, G. (1994): The Dynamic Capabilities of Firms: An Introduction. In: Industrial and Corporate Change, Vol. 3 (1994) No. 3, pp. 537-556.

Teece, D.J. (1986): Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. In: Research Policy, Vol. 15 (1986) No. 6, pp. 285-305.

Teece, D.J. (2007): Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. In: Strategic Management Journal, Vol. 28 (2007) No. 13, pp. 1319-1350.

Teece, D.J. (2018): Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. In: Research Policy, Vol. 47 (2018) No. 8.

The Guardian (2018): Faceblock campaign urges users to boycott Facebook for a day. https://www.theguardian.com/technology/2018/apr/07/faceblock-campaign-urges-users-boycott-facebook-for-one-day-protest-cambridge-analytica-scandal, accessed at 01.04.2020.

The Guardian (2019): Uber drivers strike over pay and conditions. Uber drivers strike over pay and conditions, accessed at 01.04.2020.

Tilson, D.; Lyytinen, K.; Sørensen, C. (2010): Research commentary—Digital infrastructures: The missing IS research agenda. In: Information Systems Research, Vol. 21 (2010) No. 4, pp. 748-759.

Tilson, D.; Sørensen, C.; Lyytinen, K. (2012): Change and control paradoxes in mobile infrastructure innovation: the Android and iOS mobile operating systems cases. In: Proceedings of t he 45th Hawaii International Conference on System Sciences, Maui, Hawaii, pp. 1324-1333.

Tiwana, A. (2014): Platform Ecosystems: Aligning Architecture, Governance, and Strategy, Morgan Kaufmann, Burlington, MA 2014.

Tiwana, A. (2015): Evolutionary competition in platform ecosystems. In: Information Systems Research, Vol. 26 (2015) No. 2, pp. 266-281.

Tiwana, A.; Konsynski, B.; Bush, A.A. (2010): Research commentary—Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. In: Information Systems Research, Vol. 21 (2010) No. 4, pp. 675-687.

Tung, L. (2019): Bigger than Windows, bigger than iOS: Google now has 2.5 billion active Android devices. accessed at 17.01.2020.

Turner, V.W. (1969): Liminality and communitas. In: The ritual process: Structure and anti-structure, Vol. 94 (1969), pp. 130.

Turner, V.W. (1986): The anthropology of performance, Performance Arts Journal Publication, New York, NY 1986.

Um, S.; Yoo, Y. (2016): The co-evolution of digital ecosystems. In: Proceedings of the 37th International Conference on Information Systems, Dublin, Ireland.

Vargo, S.L.; Lusch, R.F. (2004): The four service marketing myths: remnants of a goods-based, manufacturing model. In: Journal of Service Research, Vol. 6 (2004) No. 4, pp. 324-335.

Vargo, S.L.; Lusch, R.F. (2008): Service-dominant logic: continuing the evolution. In: Journal of the Academy of Marketing Science, Vol. 36 (2008) No. 1, pp. 1-10.

Vargo, S.L.; Lusch, R.F. (2011): It's all B2B… and beyond: Toward a systems perspective of the market. In: Industrial Marketing Management, Vol. 40 (2011) No. 2, pp. 181-187.

Vargo, S.L.; Maglio, P.P.; Akaka, M.A. (2008): On value and value co-creation: A service systems and service logic perspective. In: European Management Journal, Vol. 26 (2008) No. 3, pp. 145-152.

Venkatraman, N.; El Sawy, O.; Pavlou, P.; Bharadwaj, A. (2014): Theorizing digital business innovation: platforms and capabilities in ecosystems. In: Fox School of Business Research Paper, Vol. 15-080 (2014), pp. 1-36.

Venkatraman, N.; Lee, C.H. (2004): Preferential linkage and network evolution: A conceptual model and empirical test in the U.S. video game sector. In: Academy of Management Journal, Vol. 47 (2004) No. 6, pp. 876-892.

VentureBeat (2020): Number of apps available in leading app stores as of 4th quarter 2019. accessed at 17.01.2020.

Vogelsang, M. (2010): Dynamics of two-sided internet markets. In: International Economics and Economic Policy, Vol. 7 (2010) No. 1, pp. 129-145.

Vom Brocke, J.; Simons, A.; Niehaves, B.; Riemer, K.; Plattfaut, R.; Cleven, A. (2009): Reconstructing the giant: on the importance of rigour in documenting the literature search process. In: Proceedings of the 17th European Conference on Information Systems, Verona, Italy, pp. 2206-2217.

Webster, J.; Watson, R.T. (2002): Analyzing the past to prepare for the future: Writing a literature review. In: MIS Quarterly, Vol. 26 (2002) No. 2, pp. xiii-xxiii.

Weick, K.E. (1976): Educational organizations as loosely coupled systems. In: Administrative Science Quarterly, (1976), pp. 1-19.

Weick, K.E. (1995): Sensemaking in organizations (Vol. 3), Sage, Thousand Oaks, CA 1995.

Weking, J.; Brosig, C.; Böhm, M.; Hein, A.; Krcmar, H. (2018a): Business Model Innovation Strategies for Product Service Systems–An Explorative Study in the Manufacturing Industry. In: Proceedings of the 26th European Conference on Information Systems, Portsmouth, UK.

Weking, J.; Hein, A.; Böhm, M.; Krcmar, H. (2018b): A hierarchical taxonomy of business model patterns. In: Electronic Markets, Vol. In print (2018b), pp. 1-22.

Weking, J.; Lupberger, J.; Hermes, S.; Hein, A.; Böhm, M.; Krcmar, H. (2020): Practices for Open Business Model Innovation–An Innomediaries Perspective. In: Proceedings of the 15th International Conference on Wirtschaftsinformatik, Potsdam, Germany.

Weking, J.; Mandalenakis, M.; Hein, A.; Hermes, S.; Böhm, M.; Krcmar, H. (2019): The impact of blockchain technology on business models–a taxonomy and archetypal patterns. In: Electronic Markets, Vol. In print (2019), pp. 1-21.

Wittgenstein, L. (1922): Tractatus Logico-Philosophicus, Routledge & Kegan Paul, London, UK 1922.

Ye, H.; Kankanhalli, A. (2018): User Service Innovation on Mobile Phone Platforms: Investigating Impacts of Lead Userness, Toolkit Support, and Design Autonomy. In: MIS quarterly, Vol. 42 (2018) No. 1.

Yin, R.K. (2014): Case Study Research Design and Methods (Vol. 5), Sage, Thousand Oaks, CA 2014.

Yoo, Y.; Henfridsson, O.; Lyytinen, K. (2010): Research commentary—the new organizing logic of digital innovation: an agenda for information systems research. In: Information Systems Research, Vol. 21 (2010) No. 4, pp. 724-735.

Zhu, F.; Liu, Q. (2018): Competing with complementors: An empirical look at Amazon. com. In: Strategic Management Journal, Vol. 39 (2018) No. 10, pp. 2618-2642.

Zhu, K.; Kraemer, K.L.; Xu, S. (2006): The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. In: Management Science, Vol. 52 (2006) No. 10, pp. 1557-1576.

Zittrain, J.L. (2005): The generative internet. In: Harvard Law Review, Vol. 119 (2005), pp. 1975-2039.

Appendix A: Supplementary Material

Interviews and Data Material

Table 19. Data of the Embedded Publication 3

Archival Data	Case Description
Supplementary data: 24 sources of archival data, 12 empirical studies.	Native digital platforms in the accommodation industry: ▪ Airbnb: Airbnb was founded in 2008 and is the leading platform for short term lodging and tourism experiences. ▪ HomeAway: HomeAway is a leading platform for vocational rental and one of the biggest competitors of Airbnb.
Supplementary data: 28 sources of archival data, 16 empirical studies.	Native digital platforms in the ride-hailing industry: ▪ Uber: Founded in 2009, Uber triggered the trend of on-demand ridesharing companies. Instead of competing directly with the taxi ecosystem but rather with the concept of owning a car. ▪ Lyft: Lyft emerged as the first direct competitor of Airbnb. Lyft dates back to Zimride, which was a long-distance ridesharing company. Lyft has the same focus as Airbnb with on-demand ridesharing in a peer-to-peer manner.
Coding results: Overall, we used 80 data sources to derive 132 open codes, 21 axial codes, and 4 selective codes that we used as phases of ecosystem evolution.	

Table 20. Data of the Embedded Publication 4

Interview	Role	Duration	Case Description
I1	Principal Smart Embedded System Key Expert	46:51 min	IncumbentCorp is one of the market leaders regarding infrastructure and mobility services around the world. The company has long-standing IT know-how and transportation expertise. Their core business is offering mobile solutions in the field of logistics, smart cities and infrastructure. The company is currently moving toward a smart mobility platform and trying to engage an ecosystem of actors to co-create value.
I2	Product Manager	61:13 min	
I3	Program Manager	40:00 min	
I4	Principal Cyber-Physical System Key Expert	38:08 min	
I5	Digital Solution Manager	52:31 min	
I6	Chief Expert Software	36:54 min	
I7	Head of IT	62:13 min	
I8	Head of Sales	35:14 min	
I9	General Manager (Head of Mobility Services)	26:45 min	
Supplementary data: 35 market reports and technology forecasts, 18 sources of archival data, 35 empirical studies. **Coding results:** Overall, we used 102 data sources to derive 184 open codes, 18 axial codes, and 5 selective codes.			

Table 21. Data of the Embedded Publication 5

Interview	Role	Duration	Case Description
I10	Customer Support I	45:02 min	HeatingCorp is specialized in manufacturing heating and air-handling systems. In the past years, it laid particular emphasis on creating a digital ecosystem for its heating sector. In general, the company, as well as the whole industry, joined the trend, and the developments around digitalization very delayed.
I11	Customer Support II	41:31 min	
I12	Head of Sales	40:10 min	
I13	Head of Strategy and Marketing	39:49 min	
I14	Managing Director	32:12 min	
I15	Project Manager Digitalization	39:43 min	
I16	Senior Project Manager IT	38:38 min	
I17	Managing Director	09:17 min	The most crucial complementor in the ecosystem of HeatingCorp are the installers. HeatingCorp, for the most part, does not sell products to the installer, but the wholesaler instead. The distribution continues from the wholesaler to the installer, and from the installer to customers.
I18	Managing Director	08:12 min	
I19	Managing Director	20:22 min	
I20	Managing Director	19:15 min	
I21	Managing Director	21:20 min	
I22	Managing Director	25:30 min	

Supplementary data: 21 sources such as technical and marketing reports, websites, and on-site observations. In addition, we visited a heating-engineering trade show to observe the reactions of installers to the HeatingCorp exhibition booth.

Coding results: Overall, we explored relationships among 147 open codes to categorize them into 18 axial codes, and four practices of role transitions as selective themes.

Table 22. Data of the Embedded Publication 6

Interview	Role	Duration	Case Description
I23	Innovation Manager	53:20 min	IoTCorpAlpha is a leading IoT platform. They provide industry solutions through strategic partnerships and the combination of open services on their platform. The platform targets enterprise and SME clients.
I24	Business Development	66:25 min	
I25	Head of Sales	54:02 min	
I26	Director Machine-to-Machine Communication	40:40 min	
I27	Knowledge Manager	32:12 min	IoTCorpBeta is a leading Cloud-Platform provider. Through acquisitions and contribution in Open Source software, Beta has established a scalable cloud architecture. This architecture is a prerequisite and the basis of the IoT platform. The IoT platform provides several industry-specific solutions and building blocks in the area of IoT.
I28	Consultant Sales	39:43 min	
I29	Platform Architect	38:38 min	
I30	Technical Consultant	45:15 min	
I31	Platform Architect	41:21 min	
I32	Application Developer	09:17 min	
I33	Chief Executive Officer	86:22 min	IoTCorpGamma is an IoT platform start-up. The firm focuses on OEMs in the automotive industry. Due to the company size, the number of interviewees was limited to the CEO.

Supplementary data: 18 sources such as technical and marketing reports, websites, and on-site observations.

Coding results: Overall, we explored relationships among 160 open codes to categorize them into 12 axial codes, and three value co-creation practices as selective themes.

Table 23. Data of the Embedded Publication 7

Interview	Firm	Phase	Role	Duration	Case Description
I36	01	.4	Chief Executive Officer (Founder)	60:00 min	We conducted the fsQCA in the context of 47 digital platforms.
I34	02	.4	Chief Executive Officer (Founder)	55:25 min	

I35	03	0	Chief Executive Officer (Founder)	54:02 min	The platforms were in different stages of a venture life cycle such as failure (0), conceptualization (.2), monetization (.4), growth (.6), ignition (.8), and leadership (1) stages. On the basis of these stages, we use the concepts of affordances and generativity to derive patterns of successful digital platforms that increase our understanding of how leading platforms use the provision of affordances and the generativity of autonomous complementors to strive.
I36	04	.6	Founder	63:02 min	
I37	05	.6	Chief Executive Officer (Founder)	30:32 min	
I38	06	.8	Product Manager	17:21 min	
I39			Technical Sales	15:00 min	
I40	07	.4	Founder	40:00 min	
I41	08	.8	Chief Executive Officer (Founder)	26:46 min	
I42	09	.4	Chief Executive Officer (Founder)	71:55 min	
I43	10	.6	Chief Executive Officer (Founder)	61:01 min	
I44	11	.4	Chief Executive Officer (Founder)	47:20 min	
I45	12	1	Product Manager	16:20 min	
I46			Operation Manager	21:12 min	
I47	13	0	Chief Executive Officer (Founder)	56:43 min	
I48	14	.8	Product Manager	12:31 min	
I49			Marketing Director	16:40 min	
I50	15	1	Product Manager	09:02 min	
I51			Product Manager	18:52 min	
I52	16	.6	Chief Marketing Officer	49:00 min	
I53	17	.8	Chief Information Officer	33:01 min	
I54	18	.6	Chief Operations Officer (Founder)	43:52 min	
I55	19	.6	Developer	24:08 min	
I56			Lead of Backend Engineering	25:51 min	
I57			Product Owner	27:15 min	
I58	20	.4	Founder	37:00 min	
I59	21	1	Product Manager	17:01 min	
I60			Product Manager	11:11 min	
I61	22	.4	Chief Executive Officer (Founder)	33:00 min	
I62	23	.6	Founder	69:01 min	
I63	24	.2	Co-Founder	46:10 min	
I64	25	.4	Founder	31:00 min	
I65	26	.6	Product Manager	12:00 min	
I66			Public Relations Manager	21:15 min	
I67	27	.6	Head of International Markets	44:42 min	
I68	28	0	Co-Founder	60:00 min	
I69	29	.2	Co-Founder / Public Relations	46:04 min	
I70	30	.2	Founder	40:00 min	
I71	31	0	Co-Founder	31:06 min	
I72	32	.6	Founder	45:00 min	
I73	33	.4	Chief Executive Officer (Founder)	34:00 min	
I74	34	.2	Chief Executive Officer (Founder)	62:13 min	
I75	35	1	Product Manager	10:01 min	
I76			Business Developer	17:43 min	
I77	36	.6	Product Manager	35:21 min	
I78			VP Business Development	18:13 min	
I79			Product Owner	22:04 min	
I80	37	.8	Product Manager	08:14 min	
I81			Product Manager	10:01 min	
I26*	38	1	Director Machine-to-Machine	40:40 min	
I29*			Platform Architect	38:38 min	
I31*			Platform Architect	41:21 min	

Supplementary data: 45 sources such as technical and marketing reports, and websites.

Coding results: Overall, we identified four configurations as shown in P7.

Besides, there are 9 firms where we were unable to get in contact with interviewees. We based those cases on archival data that we triangulated. *We re-used two interviews of P6, as the context and answers given matched the research question.

Table 24. Data of the Embedded Publication 8

Interview	Role	Duration	Case Description

I82	Manager Autonomous Carsharing	52:00 min	The private transportation operator TransCorp is a market leader in providing mobility services as free-floating carsharing and value-added services for its customers in cities worldwide. TransCorp's main role is integrating parts of its existing mobility services and offering them to customers on the mobility-service platform. Customers use an application to allocate, reserve, book and pay the free-floating car service.
I83	Manager Rollout Mobility Services	59:00 min	
I84	Manager Mobile Technologies	63:00 min	
I85	Chief Executive Officer	61:00 min	
I86	Project Lead: Software Platform Carsharing	57:00 min	
I87	Project Lead: Backend System Carsharing	58:00 min	
I88	Project Lead: Platform Conception	38:00 min	The PubInst runs the public transportation system in the city. It offers different mobility services and a wide range of transportation modes such as subway, bus, or bicycle to its customers. Moreover, in the specific case of the mobility-service platform, PubInst's role is a platform provider. PubInst offers access to the mobility-service platform for its end-customers via mobile applications and integrates private transportation operators.
I89	Project Lead: Mobility Management	53:00 min	
I90	Manager Urban Planning and Traffic	38:00 min	
I91	Manager in Traffic Economics	48:00 min	
I92	Manager Business Development and Strategy	30:00 min	
I93	Project Lead: Mobility Platforms	18:00 min	
Supplementary data: 6 market reports and technology forecasts and 3 sources of archival data. **Coding results:** Overall, we explored relationships among 174 open codes to categorize them into 21 axial codes that we classified as attributes, and three core building blocks of service platform ecosystems.			

Data Representation and Coding

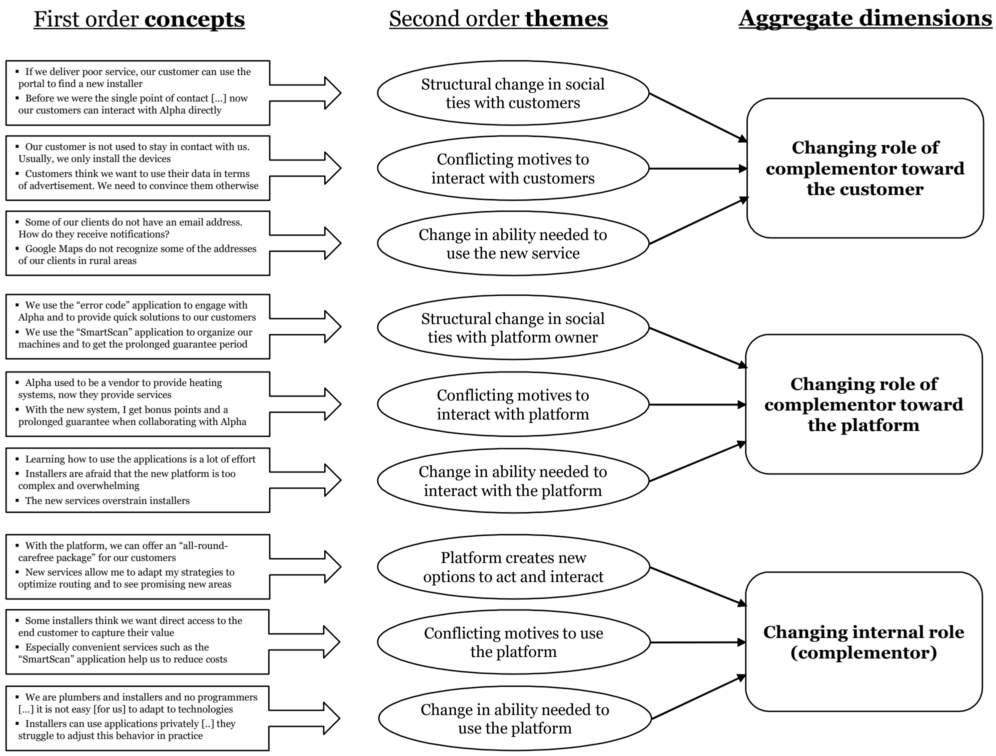

Figure 10. Exemplary Data Representation (P5 Complementor Perspective)

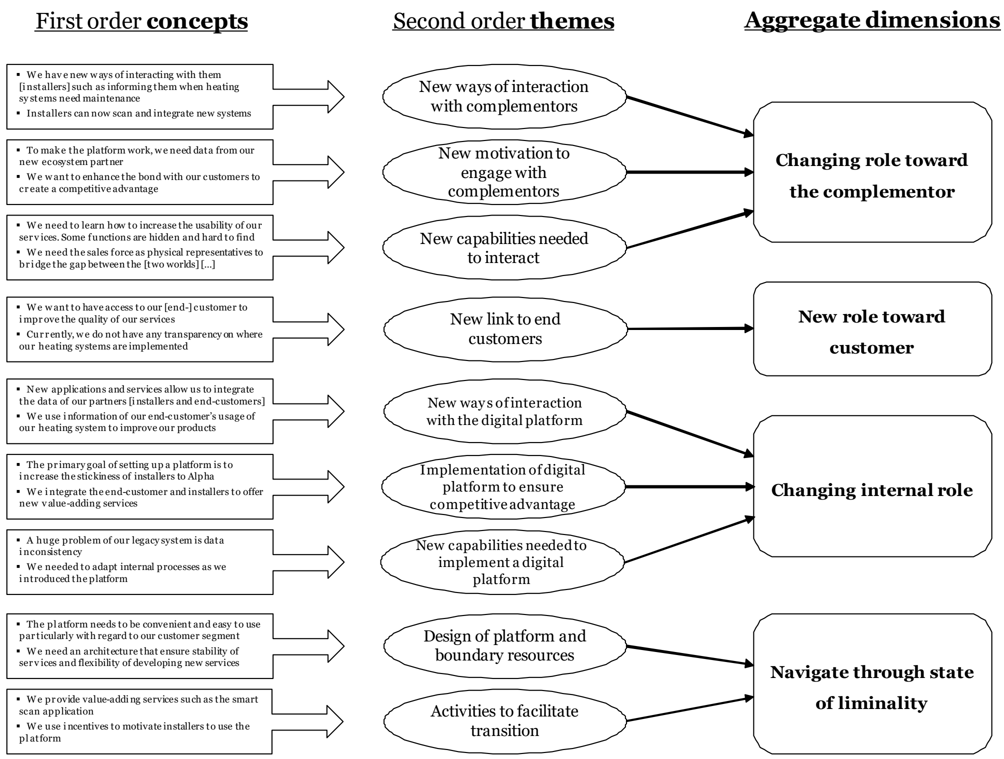

Figure 11. Exemplary Data Representation (P5 Platform Owner Perspective)

Appendix B: Embedded Publications in Original Format

Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms

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Abstract. This contribution aims to shed light on the usage and application of different platform constructs within the context of IoT platforms. The motivation is that Information Systems (IS) scholars and practitioners use the term platform frequently as an unspecific or vague construct. Different research streams shape and influence the understanding of a platform. They range from economic practices like the Two-Sided Market (TSM), Multi-Sided Platform (MSP) or platform business models, to technical platform aspects including standardization and modularization, to the platform ecosystem and the construct of an IS platform fostering value co-creation. Within those constructs, the upcoming phenomenon of IoT platforms represents a specific case to analyze what constructs are used to which extent. Thus, the study helps future IS scholars to use the term platform more precisely and reveals the interrelatedness of the identified constructs. However, the literature review is only a first step towards demystifying the phenomenon of a platform, due to the limited context of IoT platforms.

Keywords: IoT, Platform, Platform Ecosystem, Two-Sided Market, Multi-Sided Platform

1 Introduction

The success in terms of company valuation of recently emerging platform companies indicates their rising importance. A prominent representative is Uber, a transportation service platform that ranks among the top of the Unicorn[1] list with a valuation of over $68 billion [1]. Fueled by this success, more and more companies try to jump on the bandwagon of platforms. To name but a few, Microsoft established the Azure Suite as a platform in the context of the Internet of Things (IoT), Apple created HealthKit as a healthcare platform, and Daimler founded the mobility platform moovel. Inevitably, this raises the question of what a platform is and how companies utilize this construct.

[1] A Unicorn defines a start-up company with an evaluation of over $1 billion.

Unfortunately, there is no clear answer to those questions, as the construct of a platform is context dependent. This becomes clear when considering that researchers use the term platform in various disciplines and meanings. They range from describing vehicles or carriers in the field of biology or medicine [2], to economic research streams on the example of Two-Sided Markets (TSMs) [3], to technical and architectural considerations [4], to production platforms [5]. Also, even within disciplines, scholars do not define the term platform accurately. They use the term platform depending on the context, where the level of analysis varies from a platform's technical architecture to economic and market effects [6, 7]. Thus, it is not clear if the construct platform only describes a technical architecture, or on the contrary a whole market. Using the constructs indifferently blurs the actual meaning of the construct platform in a specific context. To illustrate this point, this contribution draws on the emerging phenomenon of IoT platforms to shed light on what constructs are how used. IoT platforms act as intermediaries to connect different parties like companies, sensor manufacturers, and third-party developers within an ecosystem [8]. One reason for the selection of IoT platforms is that they provide a specific context to elaborate on what platform constructs Information Systems (IS) scholars use. Secondly, the IoT platform literature relates to the interdisciplinary IS research community and, thus, covers a broad range of platform constructs. Further, the community combines several constructs of the term platform, which helps to illustrate the need for a differentiation of platform constructs.

The first construct of a platform relates to TSMs or Multi-Sided Platforms (MSPs). The platform economics go back to the research stream influenced by Rochet and Tirole [3], Eisenmann, Parker and Alstyne [9], Armstrong [10], Evans [11], Hagiu [12], Rysman [13], and Bharadwaj [14]. Economic principles reflect constructs like TSMs or MSPs and deal with network externalities, the chicken & egg problem, pricing mechanisms, and platform envelopment. On the contrary, the idea of an IS platform originates from Gawer and Cusumano [15], Baldwin and Woodard [4], and Tiwana et al. [16]. Key aspects are technical considerations by taking advantage of standardization and modularization through Application Programming Interfaces (APIs) and Software Development Kits (SDKs), as well as the influence of the innovation capabilities within the platform. Besides the different constructs, there are also different levels of analysis. The (platform) ecosystem originates from Moore [17] and is subject to the fact that companies do not evolve in a vacuum but rely on their environment and resources. Here, the platform forms the core of the ecosystem by taking advantage of third-party innovations, also called value co-creation through turning competitors into complementors and suppliers into partners [15, 18]. Hence, the ecosystem takes the organizational level of analysis through value co-creation [19], as well as the market level through network externalities and pricing strategies into consideration [3]. Another level is the design of the technical platform architecture to foster standardization and modularization with the help of APIs and SDKs.

The presented constructs indicate that a platform can, dependent on the use of the construct, affect one or a combination of several levels of analysis. Platform constructs range from TSMs or MSPs including network effects or to more technical constructs in the form of an IS platform including standardization and modularization. Also, each of those constructs can be used to analyze different levels of analysis. Thus, this contribution aims to provide a first step in the direction of differentiating and delineating different platform constructs on the example of IoT platforms. For this purpose, the authors conduct a systematic literature review to reveal how IS scholars use the platform constructs of TSMs and MSPs, as well as IS platforms. The results show how the platform constructs differ, delineate, as well as the level of analysis ranging from technical, over to ecosystems.

2 Design of Literature Review

The literature research follows the proposed approach of Webster and Watson [20]. The structured process ensures reproducibility, transferability, transparency and to work towards a clearly defined goal.

The scope aims to identify how the platform constructs of TSMs [3, 9, 13, 21] or MSPs [11, 14, 22, 23] and IS platforms [4, 15, 16] are applied and differentiated within the IoT literature. The primary audience are IS scholars. The findings show a representative cross-section of the IoT platform literature [24, 25].

The central concept of the literature review is to identify how IS scholars use platform constructs in the context of IoT platforms to reveal differentiations, delineations, and the respective level of analysis. Accordingly, the authors spread the search terms across IoT platforms and the key IS scholars who influenced the constructs of TSMs/MSPs and IS platforms. For the literature search, the terms *"IoT Platform" and "[Alstyne | Armstrong | Baldwin | Bharadwaj | Eisenmann | Evans | Gawer | Hagiu | Rochet | Rysman | Tiwana]"* were used. To reduce the number of false negatives, the authors used the specification of the exact phrase to search the whole text (e.g., *"IoT Platform"* AND *"Gawer"*). By including the main contributors of both constructs in the search term, we focus the literature review on IoT platforms that utilize one or both constructs. This approach can be justified as the goal was not to identify new IoT platform constructs, but to show how TSMs/MSPs and IS platforms were used in the context of IoT platforms and on which levels of analysis. Only peer-reviewed papers were considered to meet the quality standards in research. However, we also included grey literature if the citing source was a peer-reviewed paper (e.g., during the backward search). The time period was not specifically set, as the key IS scholars determine the period for the two platform constructs.The selected database source was Google Scholar to incorporate a broad range of databases for the relatively new topic of IoT platforms. Further, we used Scopus to validate the results.

During the *first iteration,* we scanned the title and abstract and sorted out duplicates, no peer-reviewed, and non-English articles, to determine relevant documents. In the *second iteration,* we dismissed papers that were not subject to the phenomenon of platforms or did not fit the IoT context by reading through the whole text. Thirdly, we conducted a forward and backward search according to the remaining literature to identify additional articles [20]. In the *last step*, the final set of literature was used to conceptualize the findings according to the two constructs of TSMs / MSPs or IS platforms, as well as the units of analysis ranging from an ecosystem or technical perspective in a matrix.

3 Findings for IoT Platforms

In the initial search, we identified 210 articles. In the first iteration, we sorted out three duplicates, five non-English, one patent, ten not peer-reviewed articles, as well as 104 documents due to scanning the title and abstract. In the second iteration, we dismissed 73 articles due to a lack of context. In the third iteration, we completed the resulting 14 papers though adding three in regards to forward and 14 due to backward scanning. In total, the literature review revealed 31 relevant articles (see Table 1). Regarding the meta-data, over two-third (22) papers originate from the IS literature and are marked with parenthesis "[A | B | C | D | 0]". Further, the ranking from "A" (best) to "0" is shown, where "0" means that the conference or journal is not ranked at all[2]. Also, the table marks other research streams like books and book chapters. Additionally, the literature review revealed that other research areas like Marketing and Management work on the subject of IoT platforms.

Table 1 summarizes the results in a concept matrix. Here, the columns show the two major platform constructs of an *IS Platform* and a *TSM / MSP*. We divided them into sub-columns to show on which configuration they were applied (*Tech.* = technical, *Ecos.* = ecosystem).

Table 1. Results of the Literature Review to Identify Platform Constructs in the context of IoT Platforms

Literature	*IS Platform*		*TSM / MSP*	
	Tech.	*Ecos.*	*Tech.*	*Ecos.*
Berkers et al. 2013 [6] [0]				x
Fleisch et al. 2015 [26] [Whitepaper]				x
Giessmann et al. 2014 [27] [C]	x	x		x
Giessmann & Legner 2013 [28] [A]	x	x		x
Hahn et al. 2016 [29] [B]	x	x		x
Hahn et al. 2015 [30] [D]	x	x		
Huntgeburth et al. 2015 [31] [B]		x		
Iivari et al. 2016 [32] [Management]				x
Karapantelakis & Markendahl 2015[33] [0]				x
Keskin & Kennedy 2015 [34] [C]				x
Kortuem & Kawsar 2010 [35] [0]	x	x		
Kübel & Zarnekow 2014 [36] [C]	x	x		x
Kübel et al. 2014 [37] [D]	x	x		x
Leminen et al. 2012 [38] [Book]	x	x		x
Mack & Veil 2017 [39] [Book]	x	x		x
Mazhelis et al. 2012 [40] [Book]	x			
Mazhelis & Tyrvainen 2014 [41] [0]	x			
Menon et al. 2015 [42] [0]	x	x		x
Mineraud et al. 2015 [43] [0]	x			
Mohapatra & Bhuyan 2016 [44] [0]	x			
Ng & Wakenshaw 2017 [45] [Marketing]	x	x		x

[2] The rankings derive from the VHB expert assessment, which can be found at http://vhbonline.org/vhb4you/jourqual/vhb-jourqual-3/hinweise/ (Accessed: 2017-3-14).

Literature	IS Platform		TSM / MSP	
	Tech.	*Ecos.*	*Tech.*	*Ecos.*
Rong et al. 2015 [46] [Marketing]		x		
Saariko et al. 2016 [47] [C]	x	x		
Tesch 2016 [48] [B]				x
Toivanen et al. 2015 [49] [0]	x	x		
Turber & Smiela 2014 [50] [B]	x	x		
Turber et al. 2014 [51] [C]	x	x		
Westerlund & Leminen 2014 [52] [Management]	x	x		
Yablonsky 2017 [45] [Management]				x
Yu et al. 2016 [53] [0]	x			
Zdravkovic & Trajanovic 2016 [7] [0]	x			

The IoT platform literature reveals three different configurations for the two constructs and their application on different levels (see Figure 1 and Table 2).

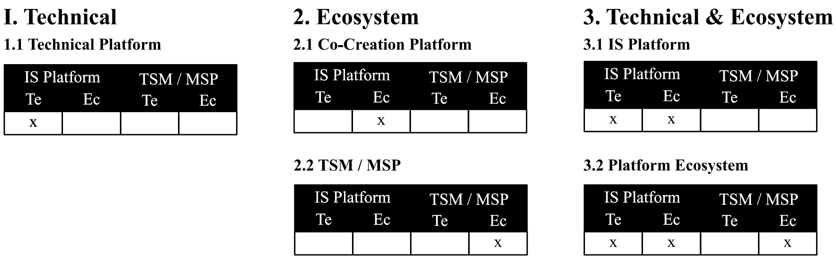

Figure 1. Different IoT Platform Configurations based on the Constructs: IS Platform and TSM or MSP, as well as the Level of Analysis

The *technical* configuration describes the case of a *technical platform* utilizing the construct of an IS platform. Going hand in hand with the definitions of Baldwin and Woodard [4], this configuration illustrates the technical nature of IoT platform regarding standardization and modularization aspects. In the defined context of IoT platforms, the technical usage of the term platform describes an isolated view on the *technical platform* as the core of a *technical* ecosystem, which specifies a corresponding set of modules. The modules serve as sub-systems that connect and add functionality to the core platform [40]. Another interpretation shows the IoT platform as the infrastructure that enables the end-user to interact with smart objects [43]. Lastly, IS scholars utilize the case of technical platforms to introduce technical encapsulated modules offering services like device management, connectivity, and testing on an IoT platform [44]. In total, the technical platform applies concepts like standardization or modularization to provide essential IoT specific services on a technical level.
Both, the case of a co-creation platform and TSM / MSP apply separately in the context of IoT platforms to the second ecosystem configuration. In the first case, the construct of an IS platform solely focus on the ecosystem perspective. A theoretical foundation can be found in the term value co-creation, where independent ecosystem participants

influence the overall value captured of a platform [19]. In the context of IoT platforms, this configuration focuses on the organizational ecosystem and helps, for example, understanding the influence of platform openness on value co-creation or innovation [46]. The second case within this configuration is the utilization of the TSM or MSP construct on the ecosystem level. Regarding theory, this case is grounded in the principles of network effects, overcoming the chicken & egg problem, and platform envelopment [3]. Within IoT platforms, scholars apply this case on the organizational level to describe network externalities between products or services [32] and between devices and consumers [33]. Thus, depending on which case of configuration is applied, a co-creation platform describes the effect of value co-creation within the organization, while TSMs or MSPs help to describe network externalities on the organizational or market level.

Table 2: Summary of the Key Concepts of Platform Constructs in the Context of IoT Platforms.

#	Configuration	Level of Analysis	Key Concepts	IoT Example
1	Technical	Architecture	Standardization / Modularization	Technical architecture describing which standards (e.g. technical protocols) or modules (e.g. device management) are used [41].
2.1	Ecosystem	Organization	Value Co-Creation	Connection and co-evolution of stakeholders with the help of IoT devices [46].
2.2		Market	Network Externalities	The role of network externalities in machine-to-machine partnerships [33].
3.1	Technical & Ecosystem	Combination 1 + 2.1		Show the role of industry standards (e.g. technical protocols) for industry partners on the willingness to participate in an IoT platform [47].
3.2		Combination 3.1 + 2.2		Development of IoT business models based on modularized applications and the technical architecture, value creation through customer data, and the incorporation of network externalities [39].

Thirdly, the technical & ecosystem configuration covers the construct of an IS platform solely or in combination with a TSM / MSP and represents the cases of an IS platform or a platform ecosystem. Case one combines the technical and organizational level and, thus, follows the definition of an IS platform according to Gawer and Cusumano [15]. Within the IoT literature, IS scholars use this configuration to describe the technological platform including standardization and modularization as the technical core of an ecosystem [49, 52]. In this ecosystem, modular services or applications like

APIs, mobility or user management are combined with organizational considerations like fostering value co-creation through governance structures are of interest [30, 54]. In addition, IS scholars describe the roles of platform participants in the process of value co-creation [47, 50]. The second case combines the construct of an IS platform with a TSM or MSP, which leads to the case of a platform ecosystem. Besides value co-creation, the analyzed papers take network externalities, pricing, and competition into consideration. In the literature, IS scholars apply this concept, for example, by declaring technical platform modules or devices as a participant in the organizational ecosystem [28]. Those modules can then be extended (e.g., through complementaries) to foster network effects, which lead to a reinforcing effect [29, 37]. In total, the technical & ecosystem configuration applies on multiple layers and ranges from architectural and organizational aspects within the case of an IS platform, to the addition of market considerations in the case of a platform ecosystem.

4 Discussion

In total, the contribution reveals that IS scholars use the term platform with different meanings and on diverse levels. The literature review shows that the constructs of an IS platform, and a TSM / MSP appear in three different configurations in the context of IoT platforms. Each of the configurations results in one or two particular cases. Thus, the boundaries between the various configurations, as well as different manifestations within a configuration are an obvious choice to illustrate differences and commonalities (see Figure 2).

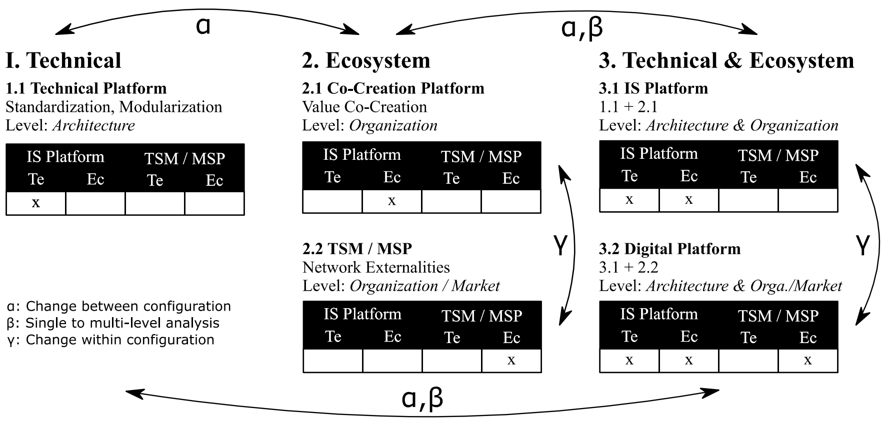

Figure 2. Illustration of changes between and within configurations and the underlying level of analysis.

Differences between configurations, as illustrated in Figure 2 α, lead to a shift in the level of analysis. The first scenario (α) explains a change from the technical to the ecosystem configuration. Here, IS scholars focus on an isolated configuration like the technical architecture or the ecosystem. A typical example is analyzing the influence of standardization and modularization on the development process of IoT applications [41] or taking organizational aspects like value co-creation through roles and complementaries into consideration [31]. The second scenario (α, β) illustrates a shift from a single to a multi-level analysis, where the level is dictated by the configuration. While the first and second configuration describes the phenomenon of platforms in isolation, the third configuration utilizes multiple constructs. In contrast to the example of the technical configuration, a multi-level analysis describes, for instance, the influence of technical modularized layers, like the integration of various IoT devices, on the capability of value co-creation with devices of partners [50]. Also, each of the different platform configurations incorporates distinct attributes like network externalities or value co-creation that help to describe the phenomenon on the respective level. Thus, it is of importance to apply the best-fitting platform construct to suit the underlying context and research design's needs.

For the second and third configuration, the results indicate differences within each of them (γ). The *ecosystem* perspective comprises two lenses. On the one hand, the case of a *co-creation platform* focuses on the organizational viewpoint, while the *TSM or MSP* help to explain organizational and market-based effects according to network externalities. So even in the ecosystem perspective, one must be aware of the different usage of the cases of a *co-creation platform* and a *TSM / MSP* and the underlying context varying from an organizational or market perspective. The *technical & ecosystem* point of view follows a multi-level analysis by combining technical and organizational or market-based aspects. In this case, the effect of technical aspects can influence either organizational roles on value co-creation activities or the whole market through economies of scale resulting from standardization, which leads to a more favorable pricing structure. Hence, even if the level of analysis is correct, IS scholars still need to determine if the particular case fits the research's needs regarding the constructs specific effects.

Lastly, the results share common threads to the Service-Dominant (S-D) logic of Lusch and Nambisan [18]. Their conceptualization differentiates between innovation as an actor-to-actor (A2A) network represented by a service ecosystem, a technical platform that incorporates resources for the facilitation of resources, as well as the value co-creation processes fostering resource integration. Our configuration of a technical platform maps to the concept of a service platform. The TSM/MSP platform illustrates an A2A network incorporating network externalities. Third, the value co-creation concept maps to the case of a co-creation platform. The third configuration with the cases of an IS platform and a digital platform is a combination of the service platform and value co-creation or all three constructs [18]. By combining our research with the results of Lusch and Nambisan [18], we contribute towards a better understanding in terms of the single- and multi-level characteristics of S-D logic in the light of different platform constructs.

Finally, all platform configurations share common features. Each of them aims to increase the value captured for the owner through, technology, organizational or market-based mechanisms ranging from modularization, value co-creation, and complementaries, to pricing and network effects.

This contribution provides theoretical and practical implications. On the theoretical side, the literature review increases the awareness and transparency of the two most common platform constructs in IS research. Here, the results indicate that the respective platform construct and configuration needs to suit the level of analysis. Further, the platform constructs differ also within the configurations by applying different mechanisms like value co-creation and network externalities. Thus, a clear definition of the underlying term platform is of importance and should always go along with the research design. Further, the results indicate that a majority of articles does not stick to one configuration, but utilizes also a second one to explain systemic effects between the technical and market/ecosystem level. Those findings highlight the interrelatedness to the S-D logic, where central S-D concepts can be mapped to concrete platform cases. For the practitioners, this contribution reveals the systemic character of the term platform. The technical introduction of APIs and SDKs, for example, also influences the capability of value co-creation of external partners or complementors through an increased ease of use and economies of scale. Also, the optimized value co-creation process might foster positive network effects that lead to positive reinforcement within an ecosystem. Those insights might help practitioners to take into account that technical changes on the infrastructure level might lead to consequences within the market or ecosystem level.

As a further result, the perspective on the different levels of analysis reveals fruitful avenues of future research. On the one hand, the results show the need of platform governance mechanisms in a new light. The different platform configurations could help to explain how different governance mechanisms [54, 55] mediate or moderate between the layers of analysis. Here, the introduction of boundary resources like APIs may influence the technical architecture, but also indirectly affect the organizational or market perspective. Thus, especially platform governance literature could benefit from future research from the angle of a multi-level characteristic and the systemic implications of the different platform constructs. Lastly, the literature review faces limitations. At first, this contribution can only be a first step towards demystifying the term platform, as the scope is limited to IoT platforms only. By expanding the view through a more established platform context, the study could benefit from an increased generalizability, which leads to a more accurate model of configurations. Also, the study focuses on the two most common platform constructs, ignoring similar constructs like electronic markets, which leads to a limitation regarding the completeness.

5 Conclusion

Overall, this contribution is a first step towards disentangling the buzzword of platforms into logical and understandable configurations. The literature review shows that IS scholars apply different platform constructs on different levels of analysis. On the example of IoT platforms, the results indicate that the technical and ecosystem layer are most frequently used. The usage varies depending on the underlying level of analysis. While the technical constructs focus on standardization and modularization, the ecosystem perspective differentiates between value co-creation and network externalities. Consequently, the exclusive sole bearing of either technical or ecosystem considerations follows a single-level analysis. In addition to that, the literature search revealed that those layers can be combined in a multi-level analysis elaborating on both, the technical and ecosystem perspective. Concluding, this contribution stresses the importance of defining the term platform according to the research subject and the underlying constructs.

6 Acknowledgements

This work is part of the TUM Living Lab Connected Mobility (TUM LLCM) project and has been funded by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology (StMWi) through the Center Digitisation.Bavaria (ZD.B), an initiative of the Bavarian State Government

References

1. CB Insights,, https://www.cbinsights.com/research-unicorn-companies#annotations:8621819, (Accessed: 12.07.2017)
2. Peer, D., Karp, J.M., Hong, S., Farokhzad, O.C., Margalit, R., Langer, R.: Nanocarriers as an emerging platform for cancer therapy. Nature nanotechnology 2, 751-760 (2007)
3. Rochet, J.C., Tirole, J.: Platform competition in two-sided markets. Journal of the European Economic Association 1, 990-1029 (2003)
4. Baldwin, C.Y., Woodard, C.J.: The architecture of platforms: A unified view. In: Gawer, A. (ed.) Platforms, Markets and Innovation. Edward Elgar., Cheltenham, UK and Northampton, US (2009)
5. Muffatto, M.: Introducing a platform strategy in product development. International Journal of Production Economics 60, 145-153 (1999)
6. Berkers, F., Roelands, M., Bomhof, F., Bachet, T., van Rijn, M., Koers, W.: Constructing a multi-sided business model for a smart horizontal IoT service platform. In: 17th International Conference on Intelligence in Next Generation Networks (ICIN), pp. 126-132. IEEE, (2013)
7. Zdravković, M., Trajanović, M.: Survey of Internet-of-Things platforms. In: 6th International Conference on Information Society and Techology, pp. 216-220. 2016 (2016)
8. Dijkman, R.M., Sprenkels, B., Peeters, T., Janssen, A.: Business models for the Internet of Things. International Journal of Information Management 35, 672-678 (2015)
9. Eisenmann, T., Parker, G., Alstyne, V.M.W.: Strategies for two-sided markets. Harvard Business Review 84, 92 (2006)
10. Armstrong, M.: Competition in two-sided markets. The RAND Journal of Economics 37, 668-691 (2006)
11. Evans, D.S.: The antitrust economics of multi-sided platform markets. Yale Journal on Regulation 20, 325-382 (2003)
12. Hagiu, A.: Pricing and commitment by two-sided platforms. The RAND Journal of Economics 37, 720-737 (2006)
13. Rysman, M.: The economics of two-sided markets. The Journal of Economic Perspectives 23, 125-143 (2009)
14. Bharadwaj, A., Sawy, E.O.A., Pavlou, P.A.: Digital business strategy: toward a next generation of insights. MIS Quarterly 37, 471-482 (2013)
15. Gawer, A., Cusumano, M.A.: Platform leadership: How Intel, Microsoft, and Cisco drive industry innovation. Harvard Business School Press Boston, Boston, USA (2002)
16. Tiwana, A., Konsynski, B., Bush, A.A.: Research Commentary—Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics. Information Systems Research 21, 675-687 (2010)

17. Moore, J.F.: Predators and prey: a new ecology of competition. Harvard Business Review 71, 75-83 (1993)
18. Lusch, R.F., Nambisan, S.: Service innovation: A service-dominant logic perspective. Mis Quarterly 39, (2015)
19. Ceccagnoli, M., Forman, C., Huang, P., Wu, D.J.: Co-creation of value in a platform ecosystem: The case of enterprise software. MIS Quarterly 36, 263-290 (2011)
20. Webster, J., Watson, R.T.: Analyzing the past to prepare for the future: Writing a literature review. MIS quarterly (2002)
21. Rochet, J.C., Tirole, J.: Two-sided markets: a progress report. The RAND Journal of Economics 37, 645-667 (2006)
22. Hagiu, A., Wright, J.: Multi-sided platforms. International Journal of Industrial Organization 43, 162-174 (2015)
23. Parker, G., Alstyne, V.M.: A digital postal platform: Definitions and a roadmap. MIT Center for Digital Business, Working Paper (2012)
24. Cooper, H.M.: Organizing knowledge syntheses: A taxonomy of literature reviews. Knowledge in Society 1, 104-126 (1988)
25. Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R., Cleven, A.: Reconstructing the giant: On the importance of rigour in documenting the literature search process. In: 17th European Conference on Information Systems, pp. 2206-2217. (2009)
26. Fleisch, E., Weinberger, M., Wortmann, F.: Business models and the internet of things. In: Ivana, Z., Kresimir, P., Martin, S. (eds.) Interoperability and Open-Source Solutions for the Internet of Things, pp. 6-10. Springer, Split, Croatia (2015)
27. Giessmann, A., Kyas, P., Tyrvainen, P., Stanoevska, K.: Towards a Better Understanding of the Dynamics of Platform as a Service Business Models. In: 47th Hawaii International Conference on Information Systems, pp. 965-974. IEEE, (2014)
28. Giessmann, A., Legner, C.: Designing business models for platform as a service: towards a design theory. In: 24th International Conference on Information Systems. (2013)
29. Hahn, C., Huntgeburth, J., Zarnekow, R.: Leverage once, earn repeatedly-capabilities for creating and appropriating value in cloud platform ecosystems. In: 24th European Conference on Information Systems. (2016)
30. Hahn, C., Röher, D., Zarnekow, R.: A value proposition oriented typology of electronic marketplaces for B2B SaaS applications. In: 20th Americas Conference on Information Systems. (2015)
31. Huntgeburth, J.C., Blaschke, M., Hauff, S.: Exploring Value Co-Creation in Cloud Ecosystems-A Revelatory Case Study. In: 23rd European Conference on Information Systems. (2015)
32. Iivari, M.M., Ahokangas, P., Komi, M., Tihinen, M.: Toward ecosystemic business models in the context of industrial internet. In: 23rd Nordic Academy of Management Conference (2016)
33. Karapantelakis, A., Markendahl, J.: Investigating the role of mobile network operators as platform providers in the internet of things. In: 2015 Regional Conference of the International Telecommunications Society (ITS). Los Angeles: International Telecommunications Society, (2015)
34. Keskin, T., Kennedy, D.: Strategies in Smart Service Systems Enabled Multi-sided Markets: Business Models for the Internet of Things. In: 48th Hawaii International Conference on System Sciences, pp. 1443-1452. IEEE, (2015)
35. Kortuem, G., Kawsar, F.: User innovation for the internet of things. In: Proceedings of the Workshop What can the Internet of Things do for the Citizen (CIoT) at The Eighth International Conference on Pervasive Computing (Pervasive 2010). (2010)
36. Kübel, H., Zarnekow, R.: Evaluating platform business models in the telecommunications industry via framework-based case studies of cloud and smart home service platforms. In: 20th Americas Conference on Information Systems. (2014)

37. Kübel, H., Hanner, N., Zarnekow, R.: An Expert View on the Role of Complementary Assets for the Adoption of Smart Home Platforms. In: 19th Pacific Asia Conference on Information Systems. (2015)
38. Leminen, S., Westerlund, M., Rajahonka, M.: Towards iot ecosystems and business models. In: Andreev, S., Balandin, S., Koucheryavy, Y. (eds.) Internet of Things, Smart Spaces, and Next Generation Networking, pp. 15-26. Springer, St. Petersburg, Russia (2012)
39. Mack, O., Veil, P.: Platform Business Models and Internet of Things as Complementary Concepts for Digital Disruption. In: Khare, A., Stewart, B., Schatz, R. (eds.) Phantom Ex Machina, pp. 71-85. Springer (2017)
40. Mazhelis, O., Luoma, E., Warma, H.: Defining an internet-of-things ecosystem. In: Internet of Things, Smart Spaces, and Next Generation Networking, pp. 1-14. Springer, (2012)
41. Mazhelis, O., Tyrvainen, P.: A framework for evaluating Internet-of-Things platforms: Application provider viewpoint. In: 2014 IEEE World Forum on Internet of Things (WF-IoT), pp. 147-152. (2014)
42. Menon, K., Kärkkäinen, H., Gupta, J.P.: Role of Industrial Internet platforms in the management of product lifecycle related information and knowledge. In: Harik, R., Rivest, L., Bernard, A., Eynard, B., Bouras, A. (eds.) Product Lifecycle Management for Digital Transformation of Industries: 13th IFIP WG 5.1 International Conference, PLM 2016, Columbia, SC, USA, July 11-13, 2016, Revised Selected Papers, pp. 549-558. Springer, Cham (2015)
43. Mineraud, J., Mazhelis, O., Su, X., Tarkoma, S.: A gap analysis of Internet-of-Things platforms. Computer Communications, Special issue on the Internet of Things: Research challenges and Solutions (2015)
44. Mohapatra, S.K., Bhuyan, J.N.: A Solution Framework for Managing Internet of Things (IOT). International Journal of Computer Networks & Communications 8, 73-87 (2016)
45. Yablonsky, S.: Business Models and ICT Technologies for the Fashion Supply Chain. In: Rinaldi, R., Bandinelli, R. (eds.) Business Models and ICT Technologies for the Fashion Supply Chain: Proceedings of IT4Fashion 2016, vol. 413, pp. 135-150. Springer, Cham (2017)
46. Rong, K., Hu, G., Lin, Y., Shi, Y., Guo, L.: Understanding business ecosystem using a 6C framework in Internet-of-Things-based sectors. International Journal of Production Economics 159, 41-55 (2015)
47. Saarikko, T., Westergren, U.H., Blomquist, T.: The Inter-Organizational Dynamics of a Platform Ecosystem: Exploring Stakeholder Boundaries. In: 49th Hawaii International Conference on System Sciences, pp. 5167-5176. (2016)
48. Tesch, J.F.: Discovering the role of scenario planning as an evaluation methodology for business models in the era of the internet of things (IoT). In: 24th European Conference on Information Systems (2016)
49. Toivanen, T., Mazhelis, O., Luoma, E.: Network Analysis of Platform Ecosystems: The Case of Internet of Things Ecosystem. In: 2015 International Conference of Software Business, pp. 30-44. Springer, (2015)
50. Turber, S., Smiela, C.: A business model type for the internet of things. In: 22nd European Conference on Information Systems. (2014)
51. Turber, S., vom Brocke, J., Gassmann, O.: Designing business models in the era of internet of things. In: 2014 International Conference on Design Science Research in Information Systems, pp. 17-31. Springer, (2014)
52. Westerlund, M., Leminen, S.: Designing business models for the internet of things. Technology Innovation Management Review 4, 5 (2014)
53. Yu, J., Bang, H.-C., Lee, H., Lee, Y.: Adaptive Internet of Things and Web of Things convergence platform for Internet of reality services. The Journal of Supercomputing 72, 84-102 (2016)
54. Hein, A., Schreieck, M., Wiesche, M., Krcmar, H.: Multiple-case analysis on governance mechanisms of multi-sided platforms. In: Multikonferenz Wirtschaftsinformatik, pp. 9-11. (2016)

55. Schreieck, M., Wiesche, M., Krcmar, H.: Design and Governance of Platform Ecosystems-Key Concepts and Issues for Future Research. In: ECIS, pp. ResearchPaper76. (2016)

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Electronic Markets
The International Journal on Networked Business

ISSN 1019-6781

Electron Markets
DOI 10.1007/s12525-019-00377-4

Electronic Markets
https://doi.org/10.1007/s12525-019-00377-4

FUNDAMENTALS

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Abstract
Digital platforms are an omnipresent phenomenon that challenges incumbents by changing how we consume and provide digital products and services. Whereas traditional firms create value within the boundaries of a company or a supply chain, digital platforms utilize an ecosystem of autonomous agents to co-create value. Scholars from various disciplines, such as economics, technology management, and information systems have taken different perspectives on digital platform ecosystems. In this Fundamentals article, we first synthesize research on digital platforms and digital platform ecosystems to provide a definition that integrates both concepts. Second, we use this definition to explain how different digital platform ecosystems vary according to three core building blocks: (1) platform ownership, (2) value-creating mechanisms, and (3) complementor autonomy. We conclude by giving an outlook on four overarching research areas that connect the building blocks: (1) technical properties and value creation; (2) complementor interaction with the ecosystem; (3) value capture; and (4) the make-or-join decision in digital platform ecosystems.

Keywords Digital platform · Platform ecosystems · Governance · Openness · Ownership

JEL classification D4 · D15 · O3

Introduction

Regarding its digital platform ecosystems with more than 13,000 partners, the software company SAP stated, "reaching our full potential depends on how well we enable our partners, providing them with [the] tools they need to accelerate growth and exceed customer expectations in an increasingly complex world." (SAP Partner Edge 2017). Digital platforms as technical infrastructures and their ecosystems of social actors continue to change entire industries. Airbnb lists over 4 million accommodations, more than the top five hotel brands combined (Hartmans 2017). Uber has a network of 7 million drivers, overshadowing local taxi companies (Dogtiev 2017). Facebook coordinates 2 billion active users each month (Constine 2017), vastly outnumbering newspaper subscriptions. All of those digital platforms build on the widespread availability of constantly evolving information technology, such as cloud computing, in-memory databases, and analytical solutions for big data.

Responsible Editor: Hans-Dieter Zimmermann

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Digital platforms combine and deploy these technologies in new ways to incubate and coordinate an ecosystem of supply and demand (Hein et al. 2019a). In the ecosystem, actors on the demand side take the role of complementors by co-creating complementary products or services (e.g., Lucas and Goh 2009; Alt et al. 2010). Complementors use boundary resources, such as software development kits (SDK) provided by the platform owner (Ghazawneh and Henfridsson 2013), to co-create specialized products or services (Boudreau 2012). Customers are the beneficiaries and remunerate these services through payments or by providing data and feedback. The platform owner can incorporate this feedback to increase the quality of existing services and tap into new markets (Eisenmann et al. 2011).

Although digital platforms are an omnipresent phenomenon, scholars from various disciplines have adopted different perspectives. This Fundamentals article synthesizes the literature of digital platforms and ecosystems in combination with contemporary examples of digital platform ecosystems to develop a novel research model. The research model helps to characterize and analyze different digital platform ecosystems. Based on this synthesis, we suggest that three attributes are essential when discussing the different variants of digital platform ecosystems: (1) platform ownership, (2) value-creating mechanisms, and (3) the autonomy of complementors. We conclude this article by providing an outlook on four overarching research areas.

Background and definitions

The scholarly field of digital platform ecosystems is broad and diverse. Scholars from various disciplines take different perspectives on how digital platforms orchestrate an ecosystem of actors to co-create value (Lusch and Nambisan 2015). These disciplines include economics with a market-based perspective (Parker et al. 2017; McIntyre and Srinivasan 2017), technology management with a technical perspective (Tiwana et al. 2010; Baldwin and Woodard 2009; Tilson et al. 2010), and information systems with a socio-technical perspective (de Reuver et al. 2018; Constantinides et al. 2018). Additionally, more recent articles have emphasized the dedicated perspective of ecosystems as a fruitful basis for new theories on sustaining competitive advantage (Adner 2017; Jacobides et al. 2018; Kapoor 2018).

Digital platforms

The market-based perspective goes back to the work of Rochet and Tirole (2003), who studied market power in the presence of network externalities (Schilling 2002; Katz and Shapiro 1986). Network externalities describe how the value for one side of the market increases as the number of actors on the other side increases (Schilling 2002). However, placing a higher value on products or services with a vast installed-base of actors presents challenges and offers new opportunities for companies to leverage network effects (McIntyre and Srinivasan 2017). One particular challenge for emerging digital platforms is the chicken-and-egg problem: the platform needs both the complementor and the consumer side to ensure a valid value proposition, but neither side is willing to join as long as the other side is not populated (Caillaud and Jullien 2003). Another factor that influences the performance of digital platforms is the multi-homing behavior of users by reducing the exclusivity and dominant-firm equilibria (Koh and Fichman 2014; Caillaud and Jullien 2003). Digital platforms with a sufficient installed base—so-called platform leaders—can use their dominant position in the market to increase their market share even further (Gawer and Cusumano 2014). Strategies include platform envelopment, adopted for example by Amazon, that used its profits to tap into new markets by subsidizing cloud-computing services or by using its information superiority to out-compete internal complementors (Zhu and Liu 2018). Other examples are antitrust cases, such as those against Microsoft and Google (Iacobucci and Ducci 2019; Schmalensee 2000) that show the relevance and importance of the so-called "winner-take-all" effect of two-sided markets (Cennamo and Santalo 2013).

The technical perspective sees digital platforms as software-based platforms, that is, extensible codebases that provide core functionality, supplemented by modular services (Tiwana et al. 2010; Tilson et al. 2010). Each modular service is a software subsystem that can extend the functionality of the platform (Baldwin and Woodard 2009). Examples for modular services can be SDKs that the platform owner provides or value-adding complements from complementors. Those complementors can use standardized interfaces such as application programming interfaces (API) to integrate new modules (Ghazawneh and Henfridsson 2013; Hein et al. 2019b). The standardized integration process and modular architecture of software-based platforms minimize interdependencies among modules and foster network externalities by reducing translation costs between different modules (Farrell and Saloner 1985; Katz and Shapiro 1994). Thus, the software-based platform is not only a source of economies of scale and scope (Thomas et al. 2014); it also fosters economies of substitution (Garud and Kumaraswamy 1995). Economies of substitution result from reusing modular and upgradable components in a platform instead of designing a system from scratch (Garud and Kumaraswamy 1993). The modularity of a software-based platform makes it easier for both external complementors and the platform owner to substitute system components while retaining a stable core. In turn, upgradability enables both parties to work on already-established modules that preserve the platform's knowledge base (Wheelwright and Clark 1992; Foerderer et al. 2019). In summary, the stability of the software-based platform and boundary resources ensures that complementors can develop and integrate modules without extensive knowledge of platform architectures, whereas the modular architecture allows for versatility and scalability of new modules (Tiwana et al. 2010).

Apart from the modular and architectural views on digital platforms, scholars draw on the innovation capabilities of digital infrastructures (Tilson et al. 2010; Yoo et al. 2012; Constantinides et al. 2018), wherein a crucial characteristic is the provision of digital affordances (Tan et al. 2016; Nambisan et al. 2019). Digital affordances refer to "what an individual or organization with a particular purpose can do with a technology" (Majchrzak and Markus 2013). To provide new affordances, the digital infrastructure builds upon a modular software-based platform that is inherently malleable, meaning it can be reconfigured to adapt user needs and prompt new technological advances (Yoo et al. 2010; Hein et al. 2019a). The platform owner provides affordances via boundary resources, such as SDKs, that assist complementors in cultivating products or services on top of a software-based platform (Constantinides et al. 2018; Hein et al. 2019b). An example is Apple's introduction of the augmented reality kit (ARKit) that extends the iOS platform and provides new affordances to all third-party developers.

The socio-technical perspective focuses on how platform owners integrate and govern an ecosystem of actors (de Reuver et al. 2018). A particular governance mechanism is the provision of boundary resources that takes the form of interfaces, such as APIs, or toolkits, such as SDKs, to integrate and enable an ecosystem of actors to co-create complementary products or services (Ghazawneh and Henfridsson 2013). Interfaces represent standardized processes, whereas toolkits provide a shared worldview by strengthening the interpretative flexibility between actors of the ecosystem and the digital platform (Lusch and Nambisan 2015; Hein et al. 2019b). Depending on the openness of interfaces, the platform owner can restrict the ecosystem to internal use within the company, for example, to enterprise resource planning systems or can open the ecosystem to take advantage of the innovation capabilities of external complementors that provide value-adding services. The degree of openness also influences competition within and across ecosystems (Gawer 2014; Thomas et al. 2014). Depending on the archetype of ownership, either a central platform owner, a consortium of partners or a decentralized peer-to-peer network need to balance control rights against the autonomy of ecosystem actors (de Reuver et al. 2018; Ghazawneh and Henfridsson 2013). The ownership status influences the evolutionary dynamics of an ecosystem by changing how governance mechanisms such as input and output control, and decision rights are implemented (Tiwana et al. 2010; Tiwana 2014; Hein et al. 2016). Consequently, research on digital platforms has emphasized the need to focus on boundaries between digital platforms and their ecosystem (Foerderer et al. 2019; Karhu et al. 2018).

Digital platform ecosystems

The latest conceptual work on ecosystems[1] (Kapoor 2018; Adner 2017; Jacobides et al. 2018) shows the rise of a new research paradigm. Up to now, digital platforms have been mainly analyzed from single paradigms such as economics (Jiang et al. 2018), technical (Tiwana 2015), business (Parker and Van Alstyne 2017), and social (Thies et al. 2016). Whereas the literature on boundary resources only combines the social and technical paradigms (Eaton et al. 2015), we suggest a paradigm shift by integrating the intra-organizational technical perspectives on digital platforms and the inter-organizational economic, business, and social perspectives on ecosystems. In this new paradigm, digital platforms rely heavily on autonomous agents that contribute to the digital platform's value proposition (Teece 2018). This core tenet highlights the need for digital platforms to enable and coordinate an ecosystem of actors while being exposed to interdependencies. The interdependencies between platform and agents in an ecosystem can have both economic and structural components (Kapoor 2018; Adner 2017).

Economic components describe the type of complementarities of products or services provided by complementors. Jacobides et al. (2018) focused on unique and supermodular complementarities to characterize the relationship between a platform and actors in an ecosystem. In a unique complementarity, Product A does not function without Product B. More generally, the value of Product A is maximized with Product B. Additionally, the complementarity can be one-way. Thus, Product A requires a particular Product or Service B. It can also be two-way. Thus, Products A and B both require each other (Teece 1986). In a supermodular complementarity, an increased amount of Product A makes Product B more valuable, where A and B are different products or services. The ecosystem of application stores illustrates the effect of unique and supermodular complementarities. The applications and the application store have unique complementarity in the sense that the applications cannot function without the store and its underlying platform. Furthermore, a supermodular complementarity exists because the presence of applications increases the value of the store (Jacobides et al. 2018).

Another fundamental characteristic of an ecosystem is its generativity (Henfridsson and Bygstad 2013; Yoo et al. 2010), where generativity is defined as the "overall capacity to produce unprompted changes driven by large, varied, and uncoordinated audiences" (Zittrain 2005). Building on the digital affordances provided by the platform owner, ecosystem actors fuel generativity with individual innovation capabilities

[1] The term, "ecosystems," originated from biological systems of interacting organisms that are placed in a habitat. Moore (1993) established this concept in the business literature. The idea was taken up by Iansiti and Levien (2004) to describe mutual dependencies of actors in business ecosystems.

(Nambisan et al. 2019). For example, complementors can share their knowledge to come up with new ideas of value-adding complements, in turn, fueling the generativity of the ecosystem (Dokko et al. 2014). Another example stems from the application development industry, where more external complementors on a digital platform lead to more variety and more applications (Boudreau 2012).

The structural components in an ecosystem describe how actors interact with value proposition and value creation. Recent studies have focused on three structural elements of ecosystems: activities, actors, and architectures (Kapoor 2018; Adner 2017).

Activities are discrete actions that determine how value is co-created in an ecosystem. Activities in a digital platform ecosystem include the development of new applications or the provision of services, such as offering rides or listing new properties. Objects of inquiry include bottlenecks that result from the interdependencies of actors and products in an ecosystem. Bottlenecks are critical components whose performance, costs, and scarcity constrain the value proposition of an ecosystem (Kapoor 2018). Research on digital platforms has suggested that platforms act as bottlenecks to control and limit interactions in an ecosystem (Boudreau 2010).

Actors are agents that can take the role of complementors and consumers who undertake activities and produce different offers. First, complementors provide complementary products or services to contribute to a platform's value proposition. It is important to note that the role of the complementor differs from that of traditional firm-supplier relationships. Whereas the complementor autonomously decides to join an ecosystem, in a firm-supplier relationship, the firm exerts decision rights regarding the cooperation (Kapoor 2018). Second, consumers refer to service beneficiaries that, in turn, contribute to the platform's value proposition by providing insights about how and which complements are used (Lusch and Nambisan 2015).

The architecture defines technological interactions that orchestrate the exchange between the supply and demand sides of an ecosystem. This architecture can result in either a platform- or product-based ecosystem (Kapoor 2018). Platform-based ecosystems contain autonomous agents, such as complementors, that contribute complementary products or services. Depending on the ownership status of platforms, the platform owners establish governance mechanisms that define the ground rules for orchestrating interactions in the ecosystems (Gawer and Cusumano 2002; Tiwana 2014). For example, Uber facilitates the interactions between drivers and passengers. In contrast, product-based ecosystems entail one-sided market interactions between a firm and consumers (Kapoor 2018). For example, the mobility service provider, DriveNow, owns the complementary products (cars) and merely integrates consumers as service beneficiaries.

Summarizing research on digital platforms and ecosystems, we conclude that digital platforms are built on a modular architecture comprising a stable core and a flexible periphery (Tiwana et al. 2010), taking advantage of economies of scale and substitution (Garud and Kumaraswamy 1995; Thomas et al. 2014). With platform governance mechanisms, the platform owner facilitates transactions between autonomous complementors and consumers in an ecosystem (Lusch and Nambisan 2015; de Reuver et al. 2018). Above the modular infrastructure, the platform owner provides affordances that complementors can actualize based on individual innovation capabilities. Besides, complementors can interact with each other to utilize the generativity of the digital platform ecosystem (Yoo et al. 2012; Nambisan et al. 2019). Based on this synthesis, we propose the following definition:

a *digital platform ecosystem comprises a platform owner that implements governance mechanisms to facilitate value-creating mechanisms on a digital platform between the platform owner and an ecosystem of autonomous complementors and consumers.*

Three building blocks of digital platform ecosystems

Applying the definition on established and emerging digital platform ecosystems, we conclude three different building blocks to characterize digital platform ecosystems: status of platform ownership; value-creating mechanisms in the ecosystem; and autonomy of complementors (Fig. 1). In this section, we outline the three building blocks and their characteristics based on variations from well-known digital platform ecosystems.

Platform ownership

Platform ownership is an essential factor for the design and governance of digital platform ecosystems (Bakos and Katsamakas 2008; Tiwana et al. 2010). Platform ownership is not just about the legal entity that owns the digital platform; it also relates to the distribution of power in the ecosystem, which can be centralized or decentralized. It also describes the relationships among partners in the ecosystem. We found different ownership models that depend on the degree of power centralization and classified them into three main archetypes.

First, there are centralized digital platform ecosystems controlled by a single owner, such as Facebook, the Apple iOS mobile operating system, and the SAP Cloud Platform. In this case, power is centralized, and only the platform owner as a single entity defines, establishes, and maintains governance mechanisms. Thus, the platform owner can implement and adjust governance mechanisms quickly and in a way that is best for ecosystem growth. However, with a growing ecosystem, some digital platforms have come to dominate their markets, such as Google and Apple: the mobile operating system market. In such cases, the centralized power of the platform owner becomes overwhelming. For example, platform owners can exclude

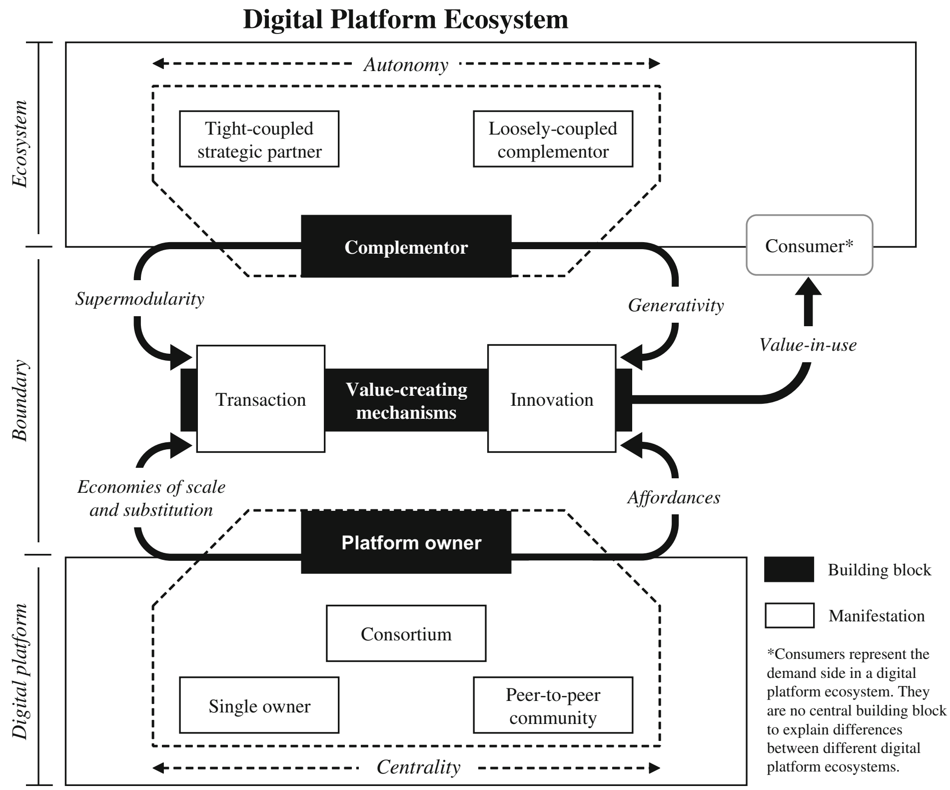

Fig. 1 Building blocks and characteristics of digital platform ecosystems

complementors from their platforms or limit collaboration with hardware partners, such as Google did in 2019 with device manufacturer Huawei (Satariano et al. 2019).

Second, digital platform ecosystems can be formed by consortia, implying that a group of actors owns the digital platform and, thus, establishes the governance mechanisms (Bazarhanova et al. 2019). An example of this ownership archetype is the Cloud Foundry, an open-source, multi-cloud application platform-as-a-service governed by the Cloud Foundry Foundation. In contrast to centralized digital platform ecosystems, consortia typically imply a distribution of power over multiple stakeholders. These stakeholders jointly define, establish, and maintain governance mechanisms for the digital platform ecosystem. In the Cloud Foundry Foundation, actors, such as Cisco, SAP, Dell EMC, IBM, Pivotal, SUSE, and VMware, jointly support the management of the platform ecosystem.

Third, there are decentralized digital platform ecosystems governed by peer-to-peer communities. Blockchain platforms, such as Ethereum or District0x, allow the creation of decentralized ecosystems that can be governed by a community (Riasanow et al. 2018a). This decentralization empowers users to directly influence the future direction of the ecosystem. For instance, District0x offers a digital platform that allows users to design and establish new marketplaces in the form of districts. As users stake tokens to a project, they gain voting rights. These rights can be used to participate in design changes and functionality improvements of a district and to specify how the generated revenue of a marketplace is used or distributed (Lestan et al. 2017).

Platform value-creating mechanisms

Successful digital platforms facilitate value-creating mechanisms in the platform ecosystem. These value-creating mechanisms build on the efficient and convenient facilitation of transactions (Tiwana 2014) and the provision of affordances making the digital platform a breeding ground for innovation (Yoo et al. 2012).

With the first value-creating mechanism of transactions, digital platforms help complementors and consumers locate and interact with each other and exchange value in a mutually beneficial manner (Evans 2012). The digital platform acts as an intermediary by directly matching supply to demand and suggesting possible transactions or by providing easy-to-use search functions through which users can find transaction partners. Via the orchestration of transactions, digital platforms create two-sided markets (Armstrong 2006; Rochet and Tirole 2003) that leverage cross-side network effects. For example, Airbnb is a digital platform that facilitates transactions between property owners and people looking for temporary accommodations. The digital platform helps owners advertise their accommodations and offers a fine-tuned search functionality for users looking for a place to stay. Each new listing utilizes economies of scale and substitution and increases the value of the platform, making it a supermodular complementarity that induces network effects between supply and demand. Thus, individuals across the globe who would never have initiated such a transaction are brought together via the combined value of all listings on the Airbnb platform (Hartmans 2017). The basis for this value-creating mechanism is a modular software-based platform, where the platform owner provides value-creating services, such as payment functionalities or recommender systems to increase the efficiency and convenience of the services for the ecosystem (Hein et al. 2019a).

The second value-creating mechanism refers to the innovation capabilities of digital platforms that enable complementors to create solutions complementary to the platform core (Tiwana 2014). The platform owner provides affordances by offering development tools for complementors, who, in turn, can use those boundary resources to co-create value-adding complements (Ghazawneh and Henfridsson 2013; Nambisan et al. 2019). For example, SAP leverages third-party innovation on its SAP Cloud Platform (Schreieck et al. 2019). The digital platform offers affordances through APIs and other resources for complementors to create applications that complement SAP's enterprise resource planning software. The South-African SAP partner, EPI-USE, developed an application based on the platform's internet-of-things capabilities to monitor endangered species using drones. The nonprofit organization, Elephants, Rhinos & Peoples, uses this application to obtain better information about the number of endangered animals (SAP SE 2018).

Similar to Elephants, Rhinos & People, many other complementors utilize the generativity of SAP's offerings, because third parties often have specialized knowledge and experience, leading to knowledge transfer and better solutions. Customers can choose from these innovative complementary applications when adapting the enterprise resource planning software to their own needs or developing applications for their use.

Additionally, the generativity of the ecosystem can spoil new affordances that can be used by the platform owner. After establishing its ridesharing platform, Uber used its broad ecosystem to build additional services, such as UberEats, effectively enveloping and tapping into new markets.

Complementor autonomy

The autonomy of complementors describes the degree of freedom complementors have when co-creating value with the digital platform (Ye and Kankanhalli 2018). Complementors with a high autonomy are loosely coupled to the digital platform and contribute to the variety and amount of complements (Boudreau 2012). In turn, complementors with a low autonomy are tightly coupled to a digital platform and form strategic partnerships that strengthen the core focal-value proposition (Danneels 2003). Depending on the autonomy of complementors, the platform owner must cope with varying levels of control, scalability, and flexibility (Parker and Van Alstyne 2017).

High autonomy complementors refer to a loosely coupled relationship in which the complementor is independent and separate from the digital platform (Orton and Weick 1990). The complementor can either be an actor that actively contributes to the digital platform or another platform that is compatible but not actively engaged in the digital platform. An example of the former includes complementors of Airbnb, where homeowners have relatively low entrance barriers and can easily multi-home between different platforms. Autonomous platform-to-platform relationships can be illustrated in the case of Facebook, where other platforms can implement features, such as the "like" button. Although platform owners cannot exert direct control over high autonomy complementors, they can use the design of boundary resources to channel the interpretative flexibility of complementors to specify the design process of complements (Lusch and Nambisan 2015). An example includes SDKs, which help complementors develop complements by providing them with guidance and boilerplate code (Hein et al. 2019b; Foerderer et al. 2019).

Low-autonomy complementors refer to tightly coupled strategic partners in which both the platform owner and the complementor are mutually dependent and aligned (Orton and Weick 1990). Again, low-autonomy complementors can be individual actors or other platforms. An example of tightly coupled actors is the Open Handheld Alliance (OHA), used to promote and develop the Android operating system and to jointly compete against other mobile platforms, such as from Apple and Microsoft. Low-autonomy platform-to-platform relationships describe core dependencies and contributions to focal-value propositions such as Netflix that strongly relies on the Amazon Web Services infrastructure, despite having competing video-on-demand services (Butler 2013). Compared to high-autonomy relationships, tightly coupled partnerships are determined by high mutual trust, a commonly defined goal, and contracts (Steensma and Corley 2000) that define whether parties are allowed to provide their services to competing platforms.

It is important to note that digital platforms can build upon both high- and low-autonomy complementors. Taking Android as an example, they incorporate value-adding complements in the form of applications from a large amount of highly autonomous application developers while also sustaining low-autonomy relationships in the OHA to improve the core operating system.

Research outlook

We recommend that future research on digital platform ecosystems considers the intersection between the internal digital platform and the platform owner, the external ecosystem and the autonomous complementors, and the intermediate perspective of value-creating mechanisms in the ecosystem. Combining different perspectives and the three building blocks provides holistic insights and actionable recommendations for theory and practice. In particular, we suggest investigating four novel avenues (see Table 1):

Technical properties and value creation

The first avenue for future research aims to reveal on how the platform owner can influence the value-creating mechanisms in the digital platform ecosystem. Prior information system studies on digital platform ecosystems primarily focused on economic aspects and advanced our understanding of topics, including organizational design (Ondrus et al. 2015) and market mechanisms (Lee 2013). To better understand the success factors of digital platform ecosystems, it is useful to examine their underlying technical properties (Tilson et al. 2010) and how those properties influence the co-creation of value with the ecosystem (de Reuver et al. 2018). Whereas the simple model of a platform as a stable core with a flexible periphery helps us understand the fundamental mechanisms of digital platforms, it does not illustrate the complexity of digital platforms that have emerged in recent years such as in the case of Taobao.com (Xie et al. 2018).

Although we know that the efficient and convenient orchestration of transactions between supply and demand is a core mechanism of digital platforms (Gawer 2014; Thomas et al. 2014), it remains unclear how the IT artifact maintains a stable core and flexible periphery of modular complements. When observing the release history of iOS, significant updates are deployed each year, introducing new features, that can substitute complementary services, and boundary resources, such as ARKit (Costello 2019), that provide affordances to an ecosystem of complementors. This example illustrates how the software-based platform is subject to frequent changes at its stable core. However, it is unclear how, when, or why the stable core is altered to introduce new features, and what external information leads to the enhancement of the digital platform. Fruitful areas of future research range from investigating core IT artifacts, such as microservice architectures (Balalaie et al. 2016) and the relationship between infrastructure and supermodular complements (Tiwana 2018), work practices such as DevOps (Ebert et al. 2016; Wiedemann et al. 2019) that maintain and accelerate economies of substitution, and the utilization of customer data to determine which additional resources the platform owner needs to deploy to fuel the generativity of the ecosystem.

Another avenue of future research is the digital platform's technical innovation capabilities (Tilson et al. 2010; Yoo et al. 2012; Henfridsson and Bygstad 2013). We know that platform owners use boundary resources as standardized forms to enable a wide variety of complementors (Hein et al. 2019b; Ghazawneh and Henfridsson 2013) to develop many various complements (Boudreau 2012) fostering economies of scope.

Table 1 Fruitful avenues for future research in digital platform ecosystems

Avenue	Immediate future research questions
Technical properties and value creation	• When, why, and how is the stable core altered to introduce new affordances? • How does the platform owner balance the standardization and interpretative flexibility of boundary objects?
Value capture in digital platform ecosystems	• What is the ideal degree of value capture in different competitive situations and lifecycle stages of a digital platform? • At what point do additional investments in platform architecture and governance no longer pay off in terms of value capture? • How is value shared in a platform ecosystem owned by a consortium or a peer-to-peer community?
Complementor interaction with the ecosystem	• How do different types of complementors interact with the digital platform to increase generativity? • How can complementors in ecosystems influence the strategic decisions of owners of digital platforms?
Make-or-join decision in digital platform ecosystems	• When and how should firms establish a new digital platform ecosystem? When and how should firms join an existing digital platform ecosystem? • Which technical, economic, and ecosystem capabilities do platform owners need to build a digital platform ecosystem? • How do we motivate complementors to join, grow, stay, and engage in the digital platform ecosystem?

However, standardizing boundary resources too much could reduce the affordances provided by limiting the flexibility of complementors to come up with creative, out-of-the-box solutions (Foerderer et al. 2014). Hence, the platform owner must carefully balance the standardization of boundary resources to enable easy adoption in combination with the flexibility provided to use the innovation capabilities of individual complementors. By understanding this tradeoff, we can elaborate what measures platform owners can take to control the generativity of a digital platform ecosystem by either reducing entrance barriers to a variety of complementors through standardization or by granting flexibility to come up with innovative complements.

Value capture in digital platform ecosystems

The second avenue for future research aims to indicate how the platform owner and the autonomous complementors capture value in digital platform ecosystems. Recent research on digital platforms has predominantly aimed to explain how platform owners and complementors interact in the digital platform ecosystem to create value. We summarized this as value-adding mechanisms for transaction and innovation. The question of how the value is distributed among the platform owner and complementors, that is, who captures what share of the value, remains mostly unanswered (Helfat and Hall 2018).

To better understand the value a platform owner can capture, it is crucial to analyze their position to claim value and their costs associated with governing the ecosystem. For example, a platform owner who dominates a market can claim a higher share of the value than a platform owner new to a market. Simultaneously, creating economies of scale and substitution and providing affordances require investments in the platform's architecture and boundary resources.

Considerations of value capture must go beyond pricing and revenue-sharing mechanisms (Hagiu 2006; Tiwana 2014; Oh et al. 2015). Scholars have already suggested that the absorption of complementary solutions (Parker et al. 2017; Eisenmann et al. 2009) and investments in selected complementary products (Rietveld et al. 2016) are further mechanisms capturing value from a digital platform ecosystem. Building on that knowledge, it would be worthwhile to study the ideal degree of value capture in different competitive situations and lifecycle stages of a digital platform. The ideal degree of value capture might also differ for different levels of autonomy that complementors are granted. Furthermore, we raise the question of at what point additional investments in platform architecture and governance no longer pay off in terms of value capture. For example, maintaining and updating resources, such as an SDK for third-party developers, is costly and needs to be considered when calculating the value captured from third-party innovation in the ecosystem. Lastly, value sharing and thus, value capture, differs across ownership archetypes. Even the definition of what is perceived as value might differ, because participation in a consortium can be based on motives other than monetary, such as gaining insights into technological advances or being visible within an industry.

Complementor interaction with ecosystem

The third avenue for future research aims to shed light on how the autonomous complementors in a digital platform ecosystem can influence value-creating mechanisms. The scientific research on the autonomy of complementors in digital platform ecosystems has focused mainly on the platform-owner perspective and the paradox of balancing control and openness (Boudreau 2012; Tiwana et al. 2010). The platform owner can either use the design of boundary resources (Ghazawneh and Henfridsson 2013; Eaton et al. 2015) or governance mechanisms, including defining decision rights and review processes (Tiwana 2014; Song et al. 2018) to balance control and openness. However, we still know little about how complementors as a level of analysis can influence the creation of value in a digital platform ecosystem (Selander et al. 2013) or even how the generativity of an ecosystem can influence the digital platform (Adner 2017).

Taking the complementor as a level of analysis, we know that different states of complementor motivation can influence the performance of digital platforms (Chen et al. 2018) and that complementors cross-pollinate from a variety of different ecosystems to increase the generativity of the digital platform ecosystem (Selander et al. 2013). Apart from notable exceptions (Ye and Kankanhalli 2018), it remains unclear how different types of high and low autonomy complementors interact with the digital platform to provide new affordances and increase the generativity of the digital platform ecosystem. Shifting the object of inquiry to complementors allows us to shed light on their work processes, their adoption processes, and their development of platform-specific capabilities. We seek to understand how complementors can shape the future direction of the digital platform. An example is the growing discontent of Uber drivers who protest for better working conditions. They are attempting to impose changes in governance mechanisms implemented by the platform owner (Conger et al. 2019).

The ecosystem perspective primarily deals with the impact of network effects (Song et al. 2018; Parker et al. 2017) or how the digital platform can fuel or constrain the focal-value proposition of an ecosystem (Kapoor 2018; Kapoor and Agarwal 2017). However, as shown in the example of striking complementors in the case of Uber (Conger et al. 2019), complementors can also influence the strategic decisions of digital platform ecosystems. The same interdependencies can be observed at the ecosystem level, where not only the platform owner can provide affordances to the ecosystem, but the ecosystem can also generate affordances that the platform owner can actualize. Taking Uber as an example, the company first established an efficient infrastructure that orchestrates interactions between drivers and passengers and then recognized that this ecosystem could also be used to provide additional services, such as UberEats. Those interdependencies give rise to novel questions, such as how the structure of ecosystems can influence strategic decisions of platform owners. Zhu and Iansiti (2019), for example, showed that local clusters of supply and demand in the case of Uber provided less (supermodular) value to the digital platform compared to global clusters in the case of Airbnb. A consequence is that less-dense ecosystem structures are more prone to multi-homing effects.

Make-or-join decision in digital platform ecosystems

Last, the fourth avenue for future research spans across all three building blocks and covers the perspective of incumbent firms that find themselves confronted with the decision of whether to establish a new digital platform ecosystem or join an existing one. Recent examples can be found in various industries, ranging from mobility-service platforms (Frahm 2019) to additive manufacturing (EOS GmbH 2019). In the former case, both Daimler and BMW created product-based platforms and joined forces by merging into a consortium-based mobility platform ecosystem. In the latter case, EOS, an additive manufacturing company, established a new digital production ecosystem.

Despite notable exceptions (Sebastian et al. 2017), we know relatively little about how incumbents transition toward digital platform ecosystems and what challenges arise during their transformations (Hein et al. 2019a; de Reuver et al. 2018). It is unclear why and how firms should establish a digital platform. Organizations can develop a platform on their own, as a consortium of industry partners, or as a peer-to-peer platform ecosystem. Additionally, we suggest future research to uncover the technical, economic, and ecosystem capabilities needed to build a digital platform ecosystem (Tan et al. 2016). First, technical capabilities deal with how firms transform their legacy system toward a digital infrastructure capable of fostering economies of scale and substitution and digital affordances. Second, economic capabilities deal with how the firm can innovate their business model from a one-sided to a two-sided business model where they can still capture sufficient value. Third, from an ecosystem perspective, it is pivotal to understand how firms can integrate their existing network of stakeholders from a goods-dominant perspective of creating value to a services-dominant perspective of co-creating value (Lusch and Nambisan 2015). Thus, incumbents can apply platform governance mechanisms used in digital platform ecosystems, but they must adapt them to the specific situations related to their existing network of stakeholders. Additionally, firms must align those capabilities to define the core functionalities of their digital platform and determine what is left for complementary services building on the modular architecture of the digital platform (Tiwana et al. 2010; Ghazawneh and Henfridsson 2013).

Based on technical or economic reasons, the decision may also be to join an existing digital platform ecosystem. First, a thorough analysis of the ecosystem is helpful to identify the roles of the actors (Riasanow et al. 2018b). Organizations should also understand value creation in the ecosystem (Urmetzer et al. 2018). Based on the assessment and the analysis of their own technical and economic capabilities, organizations can identify suitable roles in the ecosystem. However, this can depend on the ownership structure and the technical architecture of the digital platform. For example, some services may not be feasible to provide, or they are already covered by the digital platform owner and architecture.

Acknowledgments We would like to thank the editor, Hans-Dieter Zimmermann, and anonymous reviewers whose insightful comments helped to advance the development of this paper throughout the review process.

References

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management, 43*(1), 39–58.

Alt, R., Abramowicz, W., & Demirkan, H. (2010). Service-orientation in electronic markets. *Electronic Markets, 20*(3), 177–180.

Armstrong, M. (2006). Competition in two-sided markets. *RAND Journal of Economics, 37*(3), 668–691.

Bakos, Y., & Katsamakas, E. (2008). Design and ownership of two-sided networks: Implications for internet platforms. *Journal of Management Information Systems, 25*(2), 171–202.

Balalaie, A., Heydarnoori, A., & Jamshidi, P. (2016). Microservices architecture enables Devops: Migration to a cloud-native architecture. *IEEE Software, 33*(3), 42–52.

Baldwin, C. Y., & Woodard, C. J. (2009). The architecture of platforms: A unified view. In A. Gawer (Ed.), *Platforms, markets and innovation* (pp. 19–44). Cheltenham: Edward Elgar Publishing.

Bazarhanova, A., Yli-Huumo, J., & Smolander, K. (2019). From Platform Dominance to Weakened Ownership: How External Regulation Changed Finnish E-Identification. *Electronic Markets* (In print).

Boudreau, K. J. (2010). Open platform strategies and innovation: Granting access Vs. devolving control. *Management Science, 56*(10), 1849–1872.

Boudreau, K. J. (2012). Let a thousand flowers bloom? An early look at large numbers of software app developers and patterns of innovation. *Organization Science, 23*(5), 1409–1427.

Butler, B. (2013). Amazon and Netflix: Competitors Who Need Each Other. *NetworkWorld*, https://www.networkworld.com/article/2168433/amazon-andnetflix% 2D%2Dcompetitors-who-need-each-other.html. Accessed 01.04.2019.

Caillaud, B., & Jullien, B. (2003). Chicken & egg: Competition among intermediation service providers. *RAND Journal of Economics, 34*(2), 309–328.

Cennamo, C., & Santalo, J. (2013). Platform competition: Strategic trade-offs in platform markets. *Strategic Management Journal, 34*(11), 1331–1350.

Chen, W., Wei, X., & Zhu, K. X. (2018). Engaging voluntary contributions in online communities: A hidden Markov model. *Management Information Systems Quarterly, 42*(1), 83–100.

Conger, K., Xu, V. X., & Wichter, Z. (2019). Uber Drivers' Day of Strikes Circles the Globe before the Company's I.P.O. *The New York Times*, https://www.nytimes.com/2019/05/08/technology/uber-strike.html . Accessed 01.06.2019. Times, https://www.nytimes.com/2019/05/08/technology/uber-strike.html. Accessed 01.06.2019.

Constantinides, P., Henfridsson, O., & Parker, G. G. (2018). Introduction—Platforms and infrastructures in the digital age. *Information Systems Research, 29*(2), 381–400.

Constine, J. (2017). Facebook Now Has 2 Billion Monthly Users… and Responsibility. https://techcrunch.com/2017/06/27/facebook-2-billion-users/. Accessed 01.12.2017.

Costello, S. (2019). The History of Ios, from Version 1.0 to 12.0. *Lifewire*, https://www.lifewire.com/ios-versions-4147730. Accessed 20.05.2019.

Danneels, E. (2003). Tight–loose coupling with customers: The enactment of customer orientation. *Strategic Management Journal, 24*(6), 559–576.

de Reuver, M., Sørensen, C., & Basole, R. C. (2018). The digital platform: A research agenda. *Journal of Information Technology, 23*(2), 124–135.

Dogtiev, A. (2017). Uber Revenue and Usage Statistics 2017. *Business of Apps*, https://www.businessofapps.com/data/uber-statistics/. Accessed 01.12.2017.

Dokko, G., Kane, A. A., & Tortoriello, M. (2014). One of us or one of my friends: How social identity and tie strength shape the creative Generativity of boundary-spanning ties. *Organization Studies, 35*(5), 703–726.

Eaton, B., Elaluf-Calderwood, S., Sørensen, C., & Yoo, Y. (2015). Distributed tuning of boundary resources: The case of Apple's Ios service system. *MIS Quarterly, 39*(1), 217–243.

Ebert, C., Gallardo, G., Hernantes, J., & Serrano, N. (2016). Devops. *IEEE Software, 33*(3), 94–100.

Eisenmann, T. R., Parker, G., & Van Alstyne, M. (2009). Opening platforms: How, when and why? In A. Gawer (Ed.), *Platforms, markets and innovation* (pp. 131–162). Cheltenham: Edward Elgar.

Eisenmann, T. R., Parker, G., & Van Alstyne, M. (2011). Platform envelopment. *Strategic Management Journal, 32*(12), 1270–1285.

EOS GmbH (2019). 30 Years of Eos. *EOS GmbH*, https://www.eos.info/30-years-of-eos-84f2244fcd6652e5. Accessed 01.05.2019.

Evans, D. S. (2012). Governing bad behavior by users of multi-sided platforms. *Berkeley Technology Law Journal, 2*(27), 1201–1250.

Farrell, J., & Saloner, G. (1985). Standardization, compatibility, and innovation. *The Rand Journal of Economics, 16*(1), 70–83.

Foerderer, J., Kude, T., Schuetz, S., & Heinzl, A. (2014). *Control Versus Generativity: A Complex Adaptive Systems Perspective on Platforms. In Proceedings of the International Conference on Information Systems*. New Zealand: Auckland.

Foerderer, J., Kude, T., Schuetz, S. W., & Heinzl, A. (2019). Knowledge boundaries in Enterprise software platform development: Antecedents and consequences for platform governance. *Information Systems Journal, 29*(1), 119–144.

Frahm, C. (2019). Was Man Zur Carsharing-Fusion Wissen Muss. *Spiegel Online*, https://www.spiegel.de/auto/aktuell/carsharing-daimler-und-bww-legencar2go-und-drive-now-zusammen-a-1200573.html. Accessed 01.50.2019.

Garud, R., & Kumaraswamy, A. (1993). Changing competitive dynamics in network industries: An exploration of sun Microsystems' open systems strategy. *Strategic Management Journal, 14*(5), 351–369.

Garud, R., & Kumaraswamy, A. (1995). Technological and organizational designs for realizing economies of substitution. *Strategic Management Journal, 16*(1), 93–109.

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy, 43*(7), 1239–1249.

Gawer, A., & Cusumano, M. A. (2002). *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation* (Vol. 5): Harvard Business School Press Boston, MA.

Gawer, A., & Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management, 31*(3), 417–433.

Ghazawneh, A., & Henfridsson, O. (2013). Balancing platform control and external contribution in third-party development: The boundary resources model. *Information Systems Journal, 23*(2), 173–192.

Hagiu, A. (2006). Pricing and commitment by two-sided platforms. *The Rand Journal of Economics, 37*(3), 720–737.

Hartmans, A. (2017). Airbnb Now Has More Listings Worldwide Than the Top Five Hotel Brands Combined. *Business Insider*,http://www.businessinsider.de/airbnb-total-worldwide-listings-2017-8?r=US&IR=T. Accessed 01.12.2017.

Hein, A., Schreieck, M., Wiesche, M., Böhm, M., & Krcmar, H. (2019a). The Emergence of Native Multi-Sided Platforms and Their Influence on Incumbents. Electronic Markets, (In print), 1-17.

Hein, A., Schreieck, M., Wiesche, M., & Krcmar, H. (2016) Multiple-Case Analysis on Governance Mechanisms of Multi-Sided Platforms. In *Proceedings of the Multikonferenz Wirtschaftsinformatik, Ilmenau, Germany,* (pp. 9-11).

Hein, A., Weking, J., Schreieck, M., Wiesche, M., Böhm, M., & Krcmar, H. (2019b). Value Co-Creation Practices in Business-to-Business Platform Ecosystems. *Electronic Markets, 29*(3), 503–518.

Helfat, C. E., & Hall, T. (2018). Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research Policy, 47*(8), 1391–1399.

Henfridsson, O., & Bygstad, B. (2013). The generative mechanisms of digital infrastructure evolution. *MIS Quarterly, 37*(3), 907–931.

Iacobucci, E., & Ducci, F. (2019). The Google search case in Europe: Tying and the single monopoly profit theorem in two-sided markets. *European Journal of Law and Economics, 47*(1), 15–42.

Iansiti, M., & Levien, R. (2004). Strategy as ecology. *Harvard Business Review, 82*(3), 68–81.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal, 39*(8), 2255–2276.

Jiang, Y., Ho, Y.-C., Yan, X., & Tan, Y. (2018). Investor platform choice: Herding, platform attributes, and regulations. *Journal of Management Information Systems, 35*(1), 86–116.

Kapoor, R. (2018). Ecosystems: Broadening the locus of value creation. *Journal of Organization Design, 7*(1), 12.

Kapoor, R., & Agarwal, S. (2017). Sustaining superior performance in business ecosystems: Evidence from application software developers in the Ios and android smartphone ecosystems. *Organization Science, 28*(3), 531–551.

Karhu, K., Gustafsson, R., & Lyytinen, K. (2018). Exploiting and defending open digital platforms with boundary resources: Android's five platform forks. *Information Systems Research, 29*(2), 479–497.

Katz, M. L., & Shapiro, C. (1986). Technology adoption in the presence of network externalities. *Journal of Political Economy, 94*(4), 822–841.

Katz, M. L., & Shapiro, C. (1994). Systems competition and network effects. *Journal of Economic Perspectives, 8*(2), 93–115.

Koh, T. K., & Fichman, M. (2014). Multi-homing users' preferences for two-sided exchange networks. *Management Information Systems Quarterly, 38*(4), 977–996.

Lee, R. S. (2013). Vertical integration and exclusivity in platform and two-sided markets. *American Economic Review, 103*(7), 2960–3000.

Lestan, M., Urgo, J., & Khoriaty, A. (2017). District0x Network - a Cooperative of Decentralized Marketplaces and Communities. https://district0x.io/docs/district0x-whitepaper.pdf. Accessed 01.02.2018.

Lucas, H. C., & Goh, J. M. (2009). Disruptive technology: How Kodak missed the digital photography revolution. *The Journal of Strategic Information Systems, 18*(1), 46–55.

Lusch, R. F., & Nambisan, S. (2015). Service innovation: A service-dominant logic perspective. *MIS Quarterly, 39*(1), 155–175.

Majchrzak, A., & Markus, M. L. (2013). Technology affordances and constraints in management information systems (Mis). In E. Kessler (Ed.), *Encyclopedia of management theory* (Vol. 1, p. 832). Thousand Oaks: SAGE Publications.

McIntyre, D. P., & Srinivasan, A. (2017). Networks, platforms, and strategy: Emerging views and next steps. *Strategic Management Journal, 38*(1), 141–160.

Moore, J. F. (1993). Predators and prey: A new ecology of competition. *Harvard Business Review, 71*(3), 75–83.

Nambisan, S., Wright, M., & Feldman, M. (2019). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy, 48*(8), 1–9.

Oh, J., Koh, B., & Raghunathan, S. (2015). Value appropriation between the platform provider and app developers in Mobile platform mediated networks. *Journal of Information Technology, 30*(3), 245–259.

Ondrus, J., Gannamaneni, A., & Lyytinen, K. (2015). The impact of openness on the market potential of multi-sided platforms: A case study of Mobile payment platforms. *Journal of Information Technology, 30*(3), 260–275.

Orton, J. D., & Weick, K. E. (1990). Loosely coupled systems: A reconceptualization. *Academy of Management Review, 15*(2), 203–223.

Parker, G., & Van Alstyne, M. (2017). Innovation, openness, and platform control. *Management Science, 64*(7), 3015–3032.

Parker, G., Van Alstyne, M., & Jiang, X. (2017). Platform ecosystems: How developers invert the firm. *MIS Quarterly, 41*(1), 255–266.

Riasanow, T., Burckhardt, F., Soto Setzke, D., Böhm, M., & Krcmar, H. (2018a) The Generic Blockchain Ecosystem and Its Strategic Implications. In *Proceedings of the Americas Conference of Information Systems, New Orleans, LA, United States.*

Riasanow, T., Flötgen, R. J., Soto Setzke, D., Böhm, M., & Krcmar, H. (2018b) The Generic Ecosystem and Innovation Patterns of the Digital Transformation in the Financial Industry. In *Proceedings of the Pacific Asian Conference on Information Systems, Yokohama, Japan.*

Rietveld, J., Schilling, M. A., & Bellavitis, C. (2016) Reload and Relaunch: Value Creation and Value Capture in Platform-Based Markets. In *Proceedings of the Academy of Management Annual Meeting, Anaheim, California.*

Rochet, J.-C., & Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association, 1*(4), 990–1029.

SAP Partner Edge (2017). Geschäftschancen als Sap Partner. *SAP SE*, https://www.sap.com/germany/partner/become.html. Accessed 26. 03.2017.

SAP SE (2018). Transforming Elephant and Rhino Conservation. https://discover.sap.com/best-run/en-us/customer-erp/index.html. Accessed 10 Mar 2019.

Satariano, A. Zhong, R., & Wakabayashiand D. (2019) U.S. Tech Suppliers, Including Google, Restrict Dealings With Huawei After Trump Order, The New York Times, https://www.nytimes.com/2019/05/20/technology/google-android-huawei.html.

Schilling, M. A. (2002). Technology success and failure in winner-take-all markets: The impact of learning orientation, timing, and network externalities. *Academy of Management Journal, 45*(2), 387–398.

Schmalensee, R. (2000). Antitrust issues in Schumpeterian industries. *American Economic Review, 90*(2), 192–196.

Schreieck, M., Wiesche, M., Kude, T., & Krcmar, H. (2019) Shifting to the Cloud – How Sap's Partners Cope with the Change. In *Proceedings of the Hawaii International Conference on System Sciences, Maui, Hawaii, USA.*

Sebastian, I. M., Ross, J. W., Beath, C., Mocker, M., Moloney, K. G., & Fonstad, N. O. (2017). How Big Old Companies Navigate Digital Transformation. *MIS Quarterly Executive, 16*(3).

Selander, L., Henfridsson, O., & Svahn, F. (2013). Capability search and redeem across digital ecosystems. *Journal of Information Technology, 28*(3), 183–197.

Song, P., Xue, L., Rai, A., & Zhang, C. (2018). The ecosystem of software platform: A study of asymmetric cross-side network effects and platform governance. *MIS Quarterly, 42*(1), 121–142.

Steensma, H. K., & Corley, K. G. (2000). On the performance of technology-sourcing partnerships: The interaction between partner interdependence and technology attributes. *Academy of Management Journal, 43*(6), 1045–1067.

Tan, T. C. F., Tan, B., & Pan, S. L. (2016). Developing a leading digital multi-sided platform: Examining it affordances and competitive actions in Alibaba. *Communication of the AIS, 38*(1), 739–760.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*(6), 285–305.

Teece, D. J. (2018). Profiting from Innovation in the Digital Economy: Enabling Technologies, Standards, and Licensing Models in the Wireless World. *Research Policy, 47*(8).

Thies, F., Wessel, M., & Benlian, A. (2016). Effects of social interaction dynamics on platforms. *Journal of Management Information Systems, 33*(3), 843–873.

Thomas, L. D. W., Autio, E., & Gann, D. M. (2014). Architectural leverage: Putting platforms in context. *Academy of Management Perspectives, 28*(2), 198–219.

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Research commentary—Digital infrastructures: The missing is research agenda. *Information Systems Research, 21*(4), 748–759.

Tiwana, A. (2014). *Platform ecosystems: Aligning architecture, governance, and strategy*. Burlington: Morgan Kaufmann.

Tiwana, A. (2015). Evolutionary competition in platform ecosystems. *Information Systems Research, 18*(1), 7047–7047.

Tiwana, A. (2018). Platform synergy: Architectural origins and competitive consequences. *Information Systems Research, 29*(4), 829–848.

Tiwana, A., Konsynski, B., & Bush, A. A. (2010). Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. *Information Systems Research, 21*(4), 675–687.

U.S. Tech Suppliers, Including Google, Restrict Dealings with Huawei after Trump Order. (2019), *The New York Times*.

Urmetzer, F., Gill, A., & Reed, N. (2018) Using Business Ecosystems Mapping to Generate New Competitive Value Propositions. In *CIE 48, Auckland, NZ.*

Wheelwright, S. C., & Clark, K. B. (1992). *Revolutionizing product development: Quantum leaps in speed, efficiency, and quality*. New York: Simon and Schuster.

Wiedemann, A., Forsgren, N., Wiesche, M., Gewald, H., & Krcmar, H. (2019). The DevOps phenomenon. *Communications of the ACM, 62*(8), 44–49.

Xie, K., Liu, Z., Chen, L., Zhang, W., Liu, S., & Chaudhry, S. S. (2018). Success factors and complex dynamics of Crowdfunding: An empirical research on Taobao platform in China. *Electronic Markets, 29*(2), 187–199.

Ye, H., & Kankanhalli, A. (2018). User service innovation on Mobile phone platforms: Investigating impacts of Lead Userness, toolkit support, and design autonomy. *MIS Quarterly, 42*(1), 165–187.

Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for innovation in the digitized world. *Organization Science, 23*(5), 1398–1408.

Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). Research commentary—The new organizing logic of digital innovation: An

agenda for information systems research. *Information Systems Research, 21*(4), 724–735.
Zhu, F., & Iansiti, M. (2019). Why Some Platforms Thrive and Others Don't. *Harvard Business Review* (1), 118-125.
Zhu, F., & Liu, Q. (2018). Competing with Complementors: An empirical look at Amazon. *Com. Strategic Management Journal, 39*(10), 2618–2642.
Zittrain, J. L. (2005). The generative internet. *Harvard Law Review, 119*, 1975–2039.

Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber

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Abstract. The emergence of digital platforms changes the way how companies interact with their ecosystem. Successful platforms like Apple's App Store utilize an ecosystem of third-party developers to drive innovation. Those platforms are expanding the sphere of influence beyond internal resources and capabilities by taking advantage of a scalable ecosystem of external developers. However, until now it is unclear on how those companies establish a platform ecosystem. This article draws on two case studies in the form of ridesharing and accommodation platforms to illustrate how they transitioned through four evolutionary phases with the help of tight and loose coupling partnerships.

Keywords: Digital Platform, Platform Ecosystem, Ecosystem Evolution

1 Introduction

The success of digital platforms is unheard [1]. Examples range from application platforms like Apple's App or Google's Play Store to the currently emerging IoT platform market. In either case, the surrounding ecosystem of partners, developers, and users strongly determines the success of the platform. In contrast to traditional businesses, where the company produces products or services, a platform orchestrates the interaction in a two-sided market of suppliers (e.g., App developers) and users (e.g., App users) [2-4]. The ecosystem fosters cross-side network effects between both sides, where each side profits from additional exchange [2, 3]. By capturing a margin of the created value, the platform has a self-interest in growing this ecosystem. Current practices in starting an ecosystem that incorporates tight coupling of selected parties through individual partnership to a scalable utilization of boundary resources like Application Programming Interfaces (APIs) and Software Development Kits (SDKs) resulting in a loosely coupled partnerships [5, 6]. Based on those practices, ecosystems go through several phases starting with the birth, expansion, leadership, and self-renewal [7]. Those rapidly emerging digital platform ecosystems pose challenges to traditional companies. They face the question of how to start an ecosystem effectively to remain competitive.

This article sheds light on this question by elaborating on the ecosystem evolution of the recent phenomenon of transactional service platforms like Uber and Airbnb. Both provide a servitization in the form of mobility or accommodation services based on software artifacts. Uber, for example, faced little competition and managed to grow an ecosystem of developers by providing APIs and SDKs resulting in new possibilities to support their core mobility service. The ridesharing company uses the ecosystem to co-create new software services to enhance, for example, the trip experience of passengers. Airbnb, on the other hand, managed to survive in a shark tank of competition. The platform became one of the highest evaluated start-ups by growing an ecosystem that surpassed the competition by fostering tight coupling partnerships. Also, Airbnb established securing mechanisms to maintain authority and control. Airbnb finally opened their ecosystem in late 2017 for external developers. Both cases provide valuable insights on the use of different coupling mechanisms during the ecosystem evolution to shed light how to start and grow a platform ecosystem.

2 Theoretical Background

This article draws on the theoretical groundwork of Moore [7] on business ecosystems and the theory of Weick [8] on tightly and loosely coupled systems. We combine both lenses to elaborate on how platform ecosystems evolved.

2.1 The Platform Ecosystem

The theory of business ecosystem is shaped by influences from the field of Anthropology and co-evolution [9], as well as from Biology and natural ecosystems [10]. Co-evolution emphasizes that interdependent species or actors evolve in nearly endless reciprocal cycles. The evolution of one species, thus, influences the natural selection of another species in the same ecosystem and vice versa. On the other hand, natural ecosystems respond with sensitivity to environmental change [9, 10]. Moore combines both aspects to describe how businesses evolve under ever-changing environmental influences in an ecosystem of partners, suppliers, and customers. The theory proposes four evolutionary stages [7]:

Birth: The first evolutionary phase describes risk-taking entrepreneurs that focus on customer needs and how to satisfy those needs. An example is the rise of the personal computer in the 1970s, which started in 1975 by the sole effort of hobbyists in hard-to-use products. Only in the late 1970s, companies like Apple utilized an ecosystem of business partners in the field of independent software developers, training institutes or computer stores. In this ecosystem, Apple tightly controlled the computer design and the operating software, while encouraging and co-evolving with other partners to contribute complementary software or hardware [7].

The first phase harbors the cooperative challenge of collaborating with the demand and supply side to create new value propositions that are the basis for future innovations. At the same time, the young ecosystem needs to protect its value proposition from imitation by tightly integrating the parties involved in the ecosystem [7].

Expansion: In the second phase, business ecosystems expand to new territories. This phase is characterized by direct battles for market share between competing or overlapping ecosystems. Companies that aim to expand their ecosystem need to have a scalable business concept in place. An example for capturing territory can be found in the personal computer ecosystem when IBM entered and replaced Apple' dominant position. IBM opened its architecture to hardware supplier fostering additional complementary products. Also, they licensed MS-DOS and ensured the compatibility and portability of popular applications like Wordstar [7].

The cooperative challenge is to establish a scalable ecosystem of supply and demand to achieve maximum market coverage. From a competitive perspective, the company needs to establish a de-facto industry standard by dominating key market segments [7].

Leadership: The ecosystem leadership phase expresses stable structures and a high concentration of bargaining power by a dominating company. The leader creates products or services that are of critical value for the whole ecosystem and protects this position through patents or constant innovation. The central ecological position of the ecosystem leader is often instantiated by clearly defined interfaces to partners reflecting the industry standard. Though those interfaces, the ecosystem leaders encourage partners in the ecosystem to take over activities and to accelerate the growth of the whole. In the case of the personal computer ecosystem, missing leadership and a too open architecture opened a window of opportunity for competitors like Lotus, Intel, and Microsoft. Microsoft and Intel proofed to exercise control over critical components in the form of the operating systems and chips needed for the personal computer [7].

The cooperative challenges imply to provide a compelling vision for the future that encourages the ecosystem to work together to strengthen the central position of the leader. On the other hand, the competitive challenge is to maintain central bargaining power in the ecosystem [7].

Self-Renewal: The last phase of business ecosystems covers self-renewal or death. Established or incumbent ecosystems are threatened by risk-taking actors and innovations. A typical example of this stage is Apple's comeback with the iPod and later iPhone software ecosystem. The company managed to overhaul incumbent ecosystems like Nokia's Symbian operating system. Thus, leading and sustaining an ecosystem through continually adapting and absorbing technological advances is crucial to long-term success. Countermeasures of platform leaders are slowing the growth or enveloping competing ecosystems [2, 7].

The cooperative challenges in this phase is that ecosystem leaders need to work closely with innovators to incorporate new ideas into their ecosystem. From a competitive perspective, the ecosystem leader should focus on maintaining high entrance barriers to prevent competitors from invading and switching costs for users to prevent them from leaving the ecosystem [7].

2.2 Tight and Loose Coupling

Tight and loose coupling describes the degree of dependency between actors within and between organizations or systems. Orton and Weick [6] differentiate between tight, loose, and decoupled systems:

Tight Coupling: In a tightly coupled system, elements are strongly dependent on each other, and they do not act independently. Researchers speak of responsiveness without distinctiveness [6, 8]. Typical characteristics of tightly coupled systems are an increased understanding of each other's needs, a close relationship, a low degree of information asymmetry, and the ability to tailor products or services to strategic needs [8, 11]. A practical example for tight coupling is a strategic partnership like seen in the IT outsourcing, where the partnership is determined by precise rules like Service-Level-Agreements and a high degree of mutual dependency [12]. **Loose Coupling:** The concept of loose coupling refers to independent elements that are distinct or separate from one another, yet responsive. Scientists call this order distinctive responsiveness. The advantage of a system is that elements maintain flexibility to react to change from outside but adhere to standards in the system. Thus, the system maintains stability as change from external sources cause no ripple effects. As a result, the system is simultaneously closed and open, flexible and stable, as well as rational and spontaneous [6]. **Decoupling:** In opposition to neither distinctive nor responsive elements, which is per definition no system, decoupled elements are distinct to each other [6].

3 Research Approach

The research design follows a multiple case study with subject to accommodation and ridesharing platforms. The method is particularly suitable as it captures and describes the complexity of real events [13]. The cases show boundaries, features, and limitations, by putting the business ecosystems [7] and tight/loose coupling [6, 8] theories into a specific context including the respective environment and firms [14]. Benbasat, Goldstein and Mead [15] provide an orientation on whether the analyzed topic is a phenomenon and the usage of a case study is appropriate. First, the context is crucial to observe the phenomenon of emerging platform ecosystems opposed to an isolated view on platforms. Secondly, the tremendous success of platform businesses like Airbnb and Uber shows the significance and actuality of the research topic and link to the contemporary event of emerging platform ecosystems [13]. Additionally, neither control nor manipulation of the subject or event took place. This was guaranteed as the case study describes the phenomenon in the view of a neutral observer [16]. After conducting the two case studies, we draw cross-case conclusions on how a platform ecosystem evolves by showing similarities and differences between the cases.

The data for the two cases are based on archival data and empirical studies, ranging from the emergence of the respective platform ecosystem to the present. Archival data includes financial data, independent reports on milestones, partnerships, key events (like introducing an API), and the general development of the platform and its ecosystem. We used additional empirical studies to validate financial figures, events, as well as strategic decisions. Further, we adhered to the principle of data triangulation to make sure that each fact or decision is cross-validated [17]. Another mechanism to take care of business model specifics was including the main competitor as a benchmark in the ecosystem. Overall, we collected 24 archival data sources and 12 empirical studies on the case of accommodation platform ecosystems, as well as 28 archival data sources and 16 empirical studies on the ridesharing platform ecosystem case (see Table 1).

Table 1. Data used for the multiple-case study.

Industry	Case	Archival Data[1]	Empirical Studies
Accommodation	AirBnb	14	12
	Competitors (HomeAway)	10	
Ridesharing	Uber	18	16
	Competitors (Lyft)	10	

4 Results

The results show that both platform ecosystems used tight coupling to evolve from birth to the expansion phase. In a second stage, both adhered to a more open approach through loose coupling resulting in platform leadership and self-renewal.

Birth: Founded in 2009, Uber triggered the trend of on-demand ridesharing companies. Instead of competing directly with the taxi ecosystem but rather with the concept of owning a car, Uber managed to collect $ 1.75 million during their first two rounds of seed investment in 2009 and 2010. The company started in the San Francisco Bay Area and provided “high-end” sedans with reputable drivers that can be easily booked via iPhone taking advantage of the GPS sensors. Uber did not want to compete for the lowest price but charged 1.5x of the regular taxi rate offering a comfortable and convenient way of moving from A to B. Another distinguishing feature is the use of state-of-the-art technology incorporating the iPhone sensors to provide an easy to use experience. Uber managed to establish a position in the mobility ecosystem by matching the demand of convenient mobility services with the supply of professional chauffeurs.

Most people tend to think that Airbnb had always been the number one platform when it comes to short-term lodging. The truth is that Airbnb was surrounded by other vacation rental companies like HomeAway or Flip-key founded in 2005 and 2007 from the very beginning. In 2008, the company called AirBed & Breakfast entered a highly competitive ecosystem offering short-term living quarters in the center of San Francisco. During the initial phase, Airbnb managed to keep up with its competitors by providing additional value-adding services resulting from tight-coupled partnerships. One of them was proposing free and professional photography from the housings on the platform to reduce, on the one hand, the effort for the host to join the platform and

[1] Archival data ranges from financial reports found on: Forbes, Bloomberg, VentureBeat, CB Insights, Crunchbase; and independent reports from: TechCrunch, Programmableweb, Business Insider, Fortune, CNBC, The Guardian, The Verge, Forbes, and company websites.

to increase, on the other hand, the reliability and trustworthiness for the guest. At the end of 2011, Airbnb established its position in the ecosystem and raised over $ 1 billion in funding, which was nearly half the amount of HomeAway with 2.2 billion dollars.

Expansion: After introducing the iOS and Android Apps in 2010, Uber launched a national expansion starting in the San Francisco Bay Area, expanding to New York City in 2011. Until the year 2012, Uber collected over $ 1.9 billion in funding and could develop their business without any direct competition in the ecosystem. In the same year, Lyft emerged as the first direct competitor. Lyft dates back to Zimride, which was a long-distance ridesharing company. Lyft has the same focus as its competitor with on-demand ridesharing in a peer-to-peer manner. Ending in the year 2012, Uber used the three years without competition to establish its position with a valuation of $ 1.9 billion compared to $ 275 million of Lyft. Based on this leading edge, Uber established various tightly coupled partnerships to secure and expand on its current position in the ecosystem. One exemplary partnership that strengthened the supply side (drivers) was providing special interest rates on car loans for GM and Toyota vehicles [18]. Newly bought cars that engage in the Uber platform can be seen as assets to lower the interest rates for potential drivers ensuring scalability on the supply side. Other partnerships involve PayPal and American Express to offer additional payment services reducing the entrance barriers for passengers or the corporation with Concur for business travelers or flight procedures within United Airlines to expand the market reach [19]. With the help of those tightly managed partnerships, Uber could extend its position in the ecosystem and establish itself as a de-facto standard until 2014 with a valuation of $ 41 billion compared to 2.5 $ billions of Lyft.

Airbnb needed to be more careful as they acted in a highly competitive ecosystem. One example is that Airbnb offered an active API endpoint including an affiliation program for developers [20]. However, new competition in the form of Wimdu and 9Flats emerged. Airbnb could not establish enough authority and consequently did not officially introduce the programming interface. Besides closing the API end-point, Airbnb also launched a new flagging feature to defend its content by reporting questionable behavior. The response is somewhat understandable, as both new competitors were known to copy established business models including their content [21]. Airbnb focused on additional tight coupling partnerships to grow the ecosystem and to progress further. Examples are the partnerships with Lloyds of London to offer insurances for hosts included in every platform booking or the affiliation with American Express introducing new payment functionalities [22]. All those partnerships aim to improve the relationship between the host and the guest, in turn, affecting the reputation of Airbnb. At the end of the year 2015, Airbnb harvested the fruits of their expansion with $ 25.5 billion followed by HomeAway with an evaluation of $ 3.9 billion. Besides, also the number of listings (Airbnb: from 50,000 listings in 2011 to 550,000 in 2014) and active drivers (Uber: from near zero in 2012 to 160,000 in 2014) rose sharply [23, 24].

Leadership & Self-Renewal: Starting the next phase, Uber established enough authority in the ecosystem to respond to the demand of third-party developers by opening up the platform through Application Programming Interfaces (APIs) and Software Development Kits (SDKs). Starting in 2014, third-party developers could integrate core mobility services provided by Uber, like ordering a ride with the help of predefined code snippets. Further, Uber opened the micro-service architecture of the platform to help developers using driver, car, and ride data to develop new applications, and to enhance the driving experience during the trip [25]. One example of tweaking the open mobility services is the use of calling an Uber via an SMS over the phone. Those apps emerge out of the loosely coupled relationship between developers in the ecosystem and are especially useful in areas without mobile internet. Uber is not only using the ecosystem to expand the market reach but also takes advantage of the innovation capabilities of external developers. They control the ecosystem through the strategical use of components in the form of APIs like the Trip Experience API or the UberRUSH API strengthening their core service. One example is the integration of contextual information during the ride that Uber provides to third-party developers. They use the information to create value-adding applications that benefit both Uber and the passenger. Consequently, Lyft followed this strategy and introduced an open API in 2016. As of 2017, Uber has established a vibrant ecosystem of developers providing five different APIs, 22 SDKs in several programming languages and three software libraries [26]. They transitioned from a tight coupling approach to target special needs like supporting potential drivers owning a car to a more loosely coupled approach to utilize a whole ecosystem of developers to foster constant innovation.

In the accommodation industry, it was after 2015 and onward, as Airbnb's competitor HomeAway first opened their platform through active API endpoints including documentation, guides, and an affiliate program. The market need for the content data of those accommodation platforms was omnipresent. In this period, several companies tried to scrape the data from the Airbnb platform, like AirDNA analyzing the content of Airbnb and selling it for investment purposes or several attempts to reverse engineer the not yet publicly open Airbnb API endpoints. All those efforts point toward the direction that Airbnb controlled the core components of the platform ecosystem. Finally, the combination of all those market signals and the economic advance and authority regarding market valuation to the leading competitors influenced Airbnb's decision towards a more open and loosely coupled approach. Arrived at the year 2017, Airbnb emerged as a winner of the shark tank of short-term lodging platforms and finally taking control over their ecosystem by introducing an official API program including documentation and partnership programs.

5 Discussion

The two cases show that platform ecosystems follow the evolutionary pattern of business ecosystems. In addition, the theoretical lens of tight and loose coupling helps to explain how platforms exercise scalability through network effects to drive innovation. The results indicate that the platforms use tight coupling partnerships in the birth and expansion phase to become ecosystem leaders, followed by a transition towards openness and loosely coupled partnerships to drive external innovation (see Fig. 1). Instead of dominating each step in the value chain as, for example, Original Equipment Manufacturers do in the automotive industry; platform ecosystems are in their mature states more loosely coupled and open, which fosters open innovation effects.

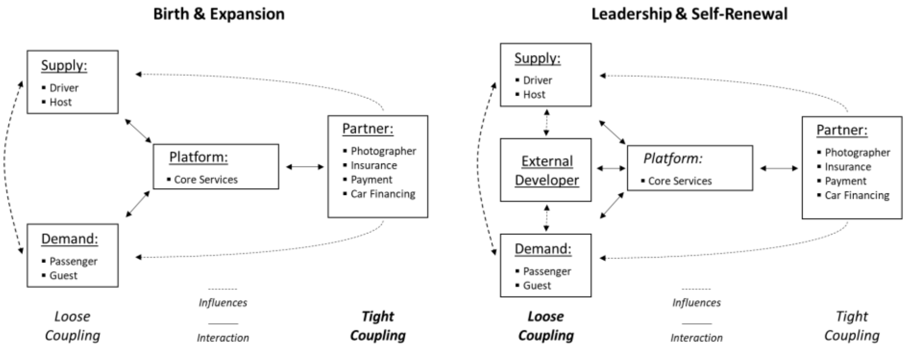

Fig. 1. The use of tight and loose coupling during the evolution of platform ecosystems.

5.1 Tight Coupling: Controlling the Ecosystem

During the birth phase, both platforms exercised a high degree of control over their ecosystem. Airbnb needed to deal with competition and utilized tight coupling partnerships to increase the scope of the platform, thus, maximizing the value for customers. An example is the collaboration with professional photographers to increase the trust between guests and hosts. Uber had no direct competition in the first place but managed to differentiate its value proposition through a more convenient and reliably way of inner-city traveling. The phase of expansion dealt with an emerging competition and encouraged securing and expanding mechanisms. The appearance of additional competition forced Airbnb to retain control over their content by closing all open API endpoints. Also, the platform established tight coupling partnerships like insuring apartments with companies to further increase the trust between hosts and guests. On the other hand, Uber used tight coupling partnerships on the supply side by collaborating with GM to provide special interest rates for potential drivers out-competing other platforms. Both, GM and Uber developed mutual trust, where Uber convinced GM that drivers could use the car as a profit generation resource, while GM convinced Uber to provide safe and reliable vehicles. Another example is the cooperation with Concur to expand to business travelers. The left part of Fig. 1 illustrates how both platforms took advantage of tight coupling partnerships to indirectly influence the value proposition between the demand and supply side. Airbnb offered a professional photo shooting for free, creating value for the host through the polished appearance of the room, as well as value for the guest as all pictures made by Airbnb were verified reducing the risk of being tricked. The same is true for the special car financing loans for Uber drivers. Passengers enjoy brand-new cars and drivers have the opportunity to earn an independent living. The platforms indirectly enhanced cross-side network effects between the supply and demand-side through strategic or tightly coupled partnerships. The aim of those partnerships is either to strengthen the value proposition between the two sides as seen in the photograph or car financing example or to expand the ecosystem as with Concur. Tight coupling partnerships lead to a high degree of control over the strategic intention and output of the collaboration. In return, both parties need to allocate resources to align on a mutual strategy and outcomes.

5.2 Loose Coupling: Opening the Ecosystem

When eventually opening the platform for loose coupling, both platforms achieved leadership in their respective ecosystems surpassing the competition regarding market valuation with a factor of 16 in the case of Uber vs. Lyft and 8 in the case of Airbnb vs. HomeAway. The two platforms managed to obtain authority over core services and strong bargaining power, which provided the opportunity to open the ecosystem through APIs and SDKs to directly induce network effects and open innovation. Airbnb achieved this state just recently in end 2017 when announcing an official API due to the ongoing competition. Uber opened the platform already in 2014 providing until now five different APIs and 22 SDKs to their ecosystem of developers. External developers can use boundary resources to co-create additional value around the core mobility service. Each API, follows a predefined interface structure in the form of data payloads but also provides flexibility for the developer to use the service however they want. Based on this loose coupling partnership, the external developers can use their unique background to satisfy special (long-tail) needs. A similar pattern can be found in the app store ecosystems of Apple and Google. Fig. 1 shows how ecosystem leadership enabled platforms to open their ecosystems to benefit from external innovations. Instead of tightly integrating and optimizing new value-adding services around their core components (e.g., mobility or accommodation matching), platforms engage their ecosystem to constantly innovate on the platform. The arms-length cooperation reduces the intensity of the partnership in exchange for lower coordination efforts and control over the ecosystem. This loose coupling allows the platforms to untap the innovation potential of a rapidly growing ecosystem.

5.3 How to Open the Platform?

According to Uber, the primary intention behind opening the platform was based on the three pillars of utility, revenue, and distribution [27]. Uber sees utility as a continuous improvement process of making the platform profit from new ideas within the ecosystem. They utilize a compelling vision for the future of mobility-as-a-service going hand in hand with Moore's description of ecosystem leadership. The second pillar aims to incentivize the development of new applications in the form of affiliate programs that encourage ecosystem partners to contribute toward core components. Lastly, the distribution pillar provides value during additional distribution (e.g., improving the experience during the ride). Uber provides stability by leading the co-innovation through targeted APIs like the Trip Experience API enabling developers to embed complementary content, games or other functionality that enhance the experience during trips. As

Airbnb just opened their platform, it is at a too early stage to predict what complementary services emerge around the ecosystem. However, the early approaches of setting up an affiliate program point in a somewhat similar direction. As a prerequisite for opening the platform, both platforms established control and authority over their ecosystem to deal with competition. The examples of Uber and Airbnb show the utilization of tight coupling partnerships to build the core ecosystem. Both platforms used value-adding partnerships to enhance the scope and range of the platforms core services, as well as securing mechanisms to stay on the leading edge regarding competition [5]. After expanding to a dominant position, both platforms opened their ecosystem around crucial platform services that evolved toward a market standard. They integrated external developers in loosely coupled partnerships through boundary resources like APIs and SDKs. Other platforms from industries like Social Networks and App Stores follow a similar approach. From the majority of loosely coupled developers' point of view, it makes sense to invest time and resources in an already established market standard, instead of multi-homing between several competing platforms with an increased effort. A technical commonality is that both companies transitioned from a monolithic to a modular micro-service infrastructure that can be adapted to key products or services. With this approach, the platform makes sure that newly created products extend the main product or service. Uber, for example, opened the ecosystem for third party development to add additional value to passengers during the ride fostering complementary innovation. To achieve this goal, both platforms use scalable interfaces between the modular micro-service infrastructure and the ecosystem. SDKs, libraries, and documentation help to simplify the development process by covering the most used programming languages to include pre-defined functions and snippets helping developers to get started. By transitioning from a tightly coupled ecosystem to a more arms-length approach, the platform governance needs to be adapted as well as shown in the example of the incentive programs. Other aspects of the ecosystem range from coping with the on- and off-boarding of developers in a scalable way to the automatic input and output control of applications within the ecosystems [28, 29].

6 Conclusion, Implications, and Future Research

This research provides insights into evolutionary phases and coupling mechanisms in the context of platform ecosystems. We show that platforms follow the evolutionary phases as proposed by Moore [7]. However, there are differences when introducing the mechanisms of tight and loose coupling. The two cases indicate that platforms use tight coupling partnerships in the beginning to enhance the core service or value proposition strengthening cross-side network effects between the supply and demand-side. Thus, tight coupling is one promising mechanism to answer the open question on how platforms strategize to foster cross-side network effects [30]. Another theoretical contribution points towards the increasing role of value co-creation in a platform ecosystem [31]. We highlight that platforms first prepare the ecosystem and then enable third-party developers to actively innovate around core services. For practitioners, we show that timing is crucial when it comes to the question when to open a platform. Airbnb learned that authority and control over their ecosystem were important and that the platform's content can be scraped by competitors if not protected properly. Thus, it was important to first strengthen core services through strategically selected tight coupling partnerships and then opening up to utilize the innovation capability of a loosely coupled ecosystem. In this sense, a fruitful area for future research could be the identification of value co-creation practices with emphasize on the tangible character of tight coupling partnerships and loosely-coupled or intangible ecosystem relationships. Also, new technology like blockchain might influence the future development of platform ecosystems. The research also faces limitations. The data for the two case studies are mainly based on archival data and empirical research taking the role of the neutral observer. We thus limit the explanatory power of this contribution on answering the motives or exact practices of both platforms when using tight and loose coupling mechanisms. One way to mitigate this problem is conducting in-depth case studies to elaborate on the why and how of tight and loose coupling practices. In total, this research helps to explain how platforms accelerate network effects in their ecosystem evolution. They first establish ecosystem leadership with the help of strategical or tight coupling partnerships that strengthen the value proposition of their core service. Then, they unleash the network externalities by opening the platform to the ecosystem and enabling third parties in loosely coupled partnerships through clearly defined interfaces to innovate around those core services.

References

1. Evans, P.C., Gawer, A.: The rise of the platform enterprise: A global survey. (2016)
2. Eisenmann, T., Parker, G., Alstyne, V.M.W.: Strategies for two-sided markets. Harvard Business Review (2006)
3. Rochet, J.C., Tirole, J.: Platform competition in two-sided markets. Journal of the European Economic Association 1, 990-1029 (2003)
4. Hein, A., Böhm, M., Krcmar, H.: Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms. Multikonferenz Wirtschaftsinformatik, Lüneburg, Germany (2018)
5. Ghazawneh, A., Henfridsson, O.: Balancing platform control and external contribution in third-party development: the boundary resources model. Information Systems Journal 23, 173-192 (2013)
6. Orton, J.D., Weick, K.E.: Loosely coupled systems: A reconceptualization. Academy of Management Review 15, 203-223 (1990)
7. Moore, J.F.: The death of competition : leadership and strategy in the age of business ecosystems. Harper Business, New York (1997)
8. Weick, K.E.: Educational organizations as loosely coupled systems. Administrative Science Quarterly 1-19 (1976)
9. Bateson, G.: Mind and nature: A necessary unity. Dutton New York (1979)
10. Gould, S.J.: The structure of evolutionary theory. Harvard University Press (2002)
11. Danneels, E.: Tight–loose coupling with customers: the enactment of customer orientation. Strategic Management Journal 24, 559-576 (2003)

12. Steensma, H.K., Corley, K.G.: On the performance of technology-sourcing partnerships: The interaction between partner interdependence and technology attributes. Academy of Management Journal 43, 1045-1067 (2000)
13. Yin, R.K.: Case study research: Design and methods. Sage Publications, Thousand Oaks, CA (2014)
14. Merriam, S.B.: Case Study Research in Education: A Qualitative Approach. Jossey-Bass, San Francisco (1988)
15. Benbasat, I., Goldstein, D.K., Mead, M.: The case research strategy in studies of information systems. MIS Quarterly 369-386 (1987)
16. Siggelkow, N.: Persuasion with case studies. Academy of Management Journal (2007)
17. Klein, H.K., Myers, M.D.: A set of principles for conducting and evaluating interpretive field studies in information systems. MIS Quarterly (1999)
18. Tam, D.: Uber teams up with GM, Toyota to get more cars on the road, C-net, https://www.cnet.com/news/uber-teams-up-with-gm-toyota-to-get-more-cars-on-the-road/, (Accessed: 01.11.2017)
19. Hempel, J.: Uber and the future of American Express, Fortune, http://fortune.com/2014/06/09/uber-and-the-future-of-american-express/, (Accessed: 1.11.2017)
20. DuVander, A.: AirBNB API Will Pay Developers With Affiliate Program, ProgrammableWeb, https://www.programmableweb.com/news/airbnb-api-will-pay-developers-affiliate-program/2011/10/13, (Accessed: 01.02.2018)
21. Tsotsis, A.: Airbnb Freaks Out Over Samwer Clones, TechCrunch, https://techcrunch.com/2011/06/09/airbnb/, (Accessed: 1.11.2017)
22. Empson, R.: Airbnb Makes Good, Will Now Cover Up To $1M In Property Damages, TechCrunch, https://techcrunch.com/2012/05/22/airbnb-1m-guarantee/, (Accessed: 01.11.2017)
23. Hall, J.V., Krueger, A.B.: An analysis of the labor market for Uber's driver-partners in the United States. ILR Review 0019793917717222 (2015)
24. Ferenstein, G.: Uber and Airbnb's incredible growth in 4 charts, VentureBeat, https://venturebeat.com/2014/06/19/uber-and-airbnbs-incredible-growth-in-4-charts/, (Accessed: 01.02.2018)
25. Haddad, E.: Service-Oriented Architecture: Scaling the Uber Engineering Codebase As We Grow, Uber Engineering, https://eng.uber.com/soa/, (Accessed: 01.11.2017)
26. Programmable Web: Uber API, Programmable Web, https://www.programmableweb.com/api/uber, (Accessed: 1.11.2017)
27. Wintrob, G.: Talking to Uber about the three pillars of its API platform, TechCrunch, https://techcrunch.com/2016/06/16/talking-to-uberhe-three-pillars-of-ubers-api-platform/, (Accessed: 01.02.2018)
28. Hein, A., Schreieck, M., Wiesche, M., Krcmar, H.: Multiple-case analysis on governance mechanisms of multi-sided platforms. Multikonferenz Wirtschaftsinformatik, pp. 1613-1624, Ilmenau, Germany (2016)
29. Schreieck, M., Hein, A., Wiesche, M., Krcmar, H.: The Challenge of Governing Digital Platform Ecosystems. Digital Marketplaces Unleashed, pp. 527-538. Springer (2018)
30. McIntyre, D.P., Srinivasan, A.: Networks, platforms, and strategy: Emerging views and next steps. Strategic Management Journal 38, 141-160 (2017)

Lusch, R.F., Nambisan, S.: Service innovation: A service-dominant logic perspective. MIS Quarterly 39, (2015)

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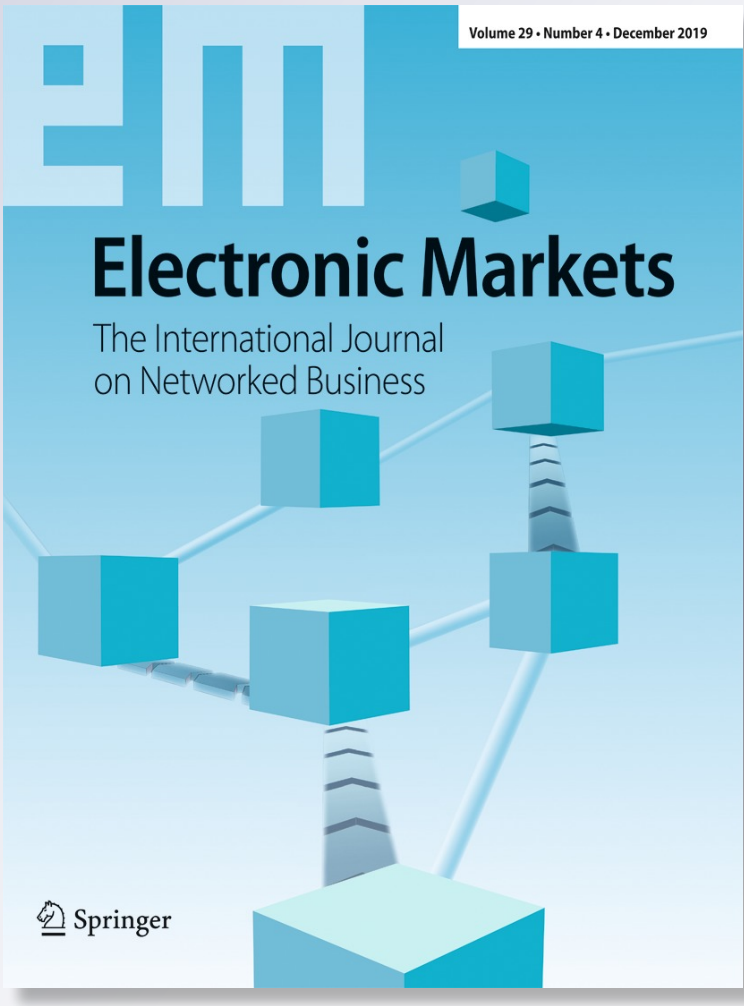
Electronic Markets
The International Journal on Networked Business

ISSN 1019-6781
Volume 29
Number 4

Electron Markets (2019) 29:631-647
DOI 10.1007/s12525-019-00350-1



Springer

Electronic Markets (2019) 29:631–647
https://doi.org/10.1007/s12525-019-00350-1

RESEARCH PAPER

The emergence of native multi-sided platforms and their influence on incumbents

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Received: 30 March 2018 / Accepted: 25 April 2019 / Published online: 10 May 2019

Abstract

Multi-sided platforms (MSPs) are one of the dominant designs of the digital age. However, prior research focuses mainly on established MSPs, leaving little insight into their emergence. We use the literature on technological trajectories and technology diffusion to derive four propositions that increase our understanding on the emergence of MSPs. The propositions include the emergence of native MSPs based on the assimilation of technologies in technological trajectories; how uncertainty influences incumbents to not follow those trajectories; how native MSPs create new demand; and how this demand eventually triggers the transformation process of incumbents to transform toward an MSP provider. We conduct a multiple-case study in the context of mobility services with three native MSP companies along with an incumbent that is transforming toward an MSP provider. The resulting process model shows that MSPs follow a process of sense-making and bricolage to assemble a service-oriented architecture, contrary to the incumbent who adopts technologies according to its institutional logic to improve existing products and processes.

Keywords Multi-sided platforms · Technological trajectories · Servitization · Platform evolution · Mobility services · Mobility platform

JEL classifications O32 · O33 · O39 · O14

Introduction

Advances in information technology are moving at an ever-accelerating pace and push innovations in various fields. New smartphone generations, Internet of things devices and increasingly powerful cloud computing applications are only three examples of technology pushing innovation (Bharadwaj et al. 2013). In contrast, consumers are pulling for new solutions that range from sustainability to contribute toward issues such as decreasing carbon dioxide emissions to new forms of mobility to cope with increasing urbanization (Kasman and Duman 2015). This interplay of technological advances and economic pull factors form technological trajectories or innovation paths (Dosi 1982).

Multi-sided platforms (MSPs) are built on technological advances such as smartphones, cloud computing and data analytics to facilitate the interactions between supply and demand (Hagiu and Wright 2015; Tiwana et al. 2010).[1] Prominent

[1] In the remainder of this paper, we will use the words "MSP" and "platform" synonymously.

This article is part of the Topical Collection on *Research Advances in Multi-Sided Platforms*

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examples are mobility service MSPs, such as Uber, BlaBlaCar and Flixbus, which have disrupted the transportation industry. Those platforms challenge incumbents by utilizing an ecosystem of users and complementors that provide complementary products or services. Instead of owning mobility resources such as cars and buses, the platforms integrate and orchestrate an ecosystem of different actors (Willing et al. 2017). In addition, the success of platforms such as Apple's App Store triggered new demand represented by the emerging app economy (Perez 2017), where users expect convenient and easy to use digital services. The resulting demand has caused the transformation of incumbent firms such as Google and Microsoft who also adopted the concept of an app store. Both examples illustrate that MSPs use technological advances to create new demand and that this demand can cause the transformation of incumbents to adopt an MSP model.

However, platform literature mainly focuses on mature platform ecosystems (de Reuver et al. 2017; McIntyre and Srinivasan 2017) and provides little insight into how MSPs emerge. It remains unclear as to which technological trajectories influenced the emergence of MSPs and how this emergence influences incumbent companies to adopt an MSP (Tiwana et al. 2010). Examining startups that natively adopted an MSP and grew to industry-leading platform companies could help to identify technological trajectories that influenced the emergence and further evolution of MSPs. Furthermore, empirical insights into the process that describes the emergence of MSPs and the influence of successful MSPs on established industries could help scholars and practitioners develop a better understanding of the phenomenon of MSPs. In total, this article answers the following research questions.

(1) *How do technological trajectories foster the development of native MSPs?*
(2) *How do incumbents react to trajectories that fostered the development of native MSPs?*
(3) *How do native MSPs trigger the transformation of incumbents to transform toward an MSP provider?*

To answer the research questions, we first derive four propositions according to the literature of technological trajectories and technology diffusion. The four propositions follow the phases of the emergence of native platform companies through risk-taking actors and the subsequent diffusion and internalization among incumbents in an oligopolistic market (Dosi 1982). We evaluate the four propositions based on an embedded multiple-case study (Yin 2017). The multiple-case study comprises the three native platform companies Uber, BlaBlaCar and Flixbus, and an incumbent that currently transforms toward an MSP provider. We use the context of mobility services as it reflects a contemporary phenomenon in that an increasing number of incumbents in the automotive industry shifted toward a service-oriented business (e.g., DriveNow owned by BMW, car2go owned by Daimler). Besides, there are concepts from automotive companies to establish an MSP that incorporates an ecosystem of mobility actors in the case of Toyota Mobility Services (IEEE Connected Vehicles 2016). By validating technology push and demand pull factors in a cross-case analysis, we derive a process model that explains how native MSPs emerged, how incumbent firms reacted to native MSPs in the first place and how the native platforms triggered the transition of the incumbent toward an MSP provider.

Theoretical background

During the past decades, scholars have relied on two dominant perspectives to explain the direction of technological change: technology push and demand pull (von Hippel 1976; Mowery and Rosenberg 1979; Rosenberg 1969; Schmookler 1966). Over time, researchers such as Dosi (1982) and Kline and Rosenberg (2010) have advocated a shift from a linear to a more interactive model of technological change. They use technological trajectories as a combination of technology push and demand pull to describe the direction of technological advances. In recent years, a combination of several trajectories has led to the genesis of digital convergence, fostering the development of new types of business models such as MSPs (Yoo et al. 2012).

Technological trajectories

Technology push proponents argue that basic science is the foundation for applied research that enables product development and commercial production of innovations (Nemet 2009; Rosenberg 1969; Nelson and Winter 1977). The central thesis is that advances in science determine the rate and direction of innovations (Nelson and Winter 1977). Those advances account for the increased role of scientific inputs in innovative processes and the emergence of disruptive technological advances (Freeman 2000; Dosi 1982). The "TRACES" project, sponsored by the National Science Foundation, revealed that 341 basic research events (e.g., in the field of magnetic ferrites or the video tape recorder) influenced future innovations in a time frame of 30 years (Isenson 1968). The downside of this lens is the risk of a "lab in the woods" approach, which views innovation in isolation of demand or the reinvention of the wheel through a lack of taking the market into account (Burgelman et al. 2008). In addition, the sole technology push perspective ignores pricing mechanisms, changing economic conditions and the process of growth and economic change (Dosi 1982; Costantini et al. 2015; Lee and Shim 2007).

On the contrary, advocates for the **demand pull** perspective argue that the market is the main actor when it comes to creating new business opportunities. Firms invest in innovations to satisfy unmet user needs, thus driving innovation (Schmookler 1966; Kleinknecht and Verspagen 1990). The fundamental argument of this research stream is that demand steers firms to work on unmet needs (Rosenberg 1969). The "Project Hindsight" provides support for this theory, where the U. S. Department of Defense presented that nearly 95% of all military innovations in the 1960s emerged from a particular defense need (Sherwin and Isenson 1967). Important demand-based factors are the price (Hicks 1963), the identification of current or urgent demands (Schmookler 1966) and potential new markets (Vernon 1966). The strength of this theoretical lens is to explain incremental innovation and to consider economic factors. However, the demand pull perspective fails to predict disruptive innovations that do not emerge from a market demand (Mowery and Rosenberg 1979), nor does the theory answer the when and why a technology emerges or develops (Dosi 1982; Nemet 2009; Costantini et al. 2015; Lee and Shim 2007).

Besides technology push and demand pull, there is a third factor of **regulatory push**. Empirical studies show that establishing or abolishing rules or regulations can lead to innovations (Jaffe and Stavins 1995; Porter and Van der Linde 1995). However, scientific research shows that regulatory push factors mainly influences eco-innovations triggered by environmental policies (Porter and Van der Linde 1995; Green et al. 1994; Rennings 2000). Besides technology push and demand pull, we decided to control for regulatory push factors due to the ecological sensitivity of mobility services regarding carbon dioxide reduction.

Out of this discussion, researchers found consensus on the shortcomings of each perspective and moved toward a common explanation for technological change (Dosi 1982; Mowery and Rosenberg 1979; Singh et al. 2015). Dosi (1982) used the notion of technological paradigms following Kuhn's scientific paradigms as a model and pattern of solutions for a selected technological problem (Dosi 1982; Kuhn 1996). Building on this, each technological problem can be solved in different ways through technological paradigms that manifest as a **technological trajectory.** The transition from labor-intensive work to mass production represents a shift in technological paradigms. Mass production uses different skills and heuristics to solve the problem of increasing production throughput. A technological trajectory or way to solve this problem based on the paradigm of mass production is mechanization in the form of the conveyer belt compared with the labor-based made-to-order paradigm. In this way, technological trajectories emphasize the interplay between technology push through the underlying technological paradigm and the demand pull through economic traction (Dosi 1982; Singh et al. 2015).

The innovation diffusion literature provides three steps on how organizations can **assimilate** with innovations or technological trajectories. First, firms initiate and evaluate the potential benefits of the technologies in a trajectory. Based on the evaluation, firms adopt the technologies of trajectories for value-creating activities. Finally, there is routinization, where firms assimilate to the trajectory and the underlying technologies as an integral part of their value-creating activities (Zhu et al. 2006; Rogers 2003). However, organizations have limited resources, which poses a challenge in their ability to assimilate any but the most promising technological trajectories. The assimilation of a new trajectory also includes the risk of not meeting the anticipated benefit. As a consequence, companies follow a selection process (initiation) and consider a variety of economic, institutional and social factors. Examples range from economic factors such as the marketability, potential profitability, cost-saving capabilities, and economies of scale to institutional factors such as the company structure to social factors such as technology acceptance (Dosi 1982; Rosenberg 1976).

Another factor to consider is the maturity of companies regarding the willingness to follow technological trajectories. Dosi (1982) described this aspect as the differentiation of two phases that reflect the emergence and maturity of industries. The **first phase** involves economic trial and error, which characterizes the implementation and commercial exploitation of technological trajectories through risk-taking actors. Those actors try to routinize technological trajectories in the search for new profit and market opportunities. If successful, the risk-taking actors can enjoy temporary monopolies. In this phase, incumbents do not follow new trajectories due to uncertainty regarding the technical approach or "means," uncertainty regarding market focus or "ends," and uncertainty regarding timing or "urgency" (Pearson 1990). Scientific research suggests that technology push factors dominate the first phase (Pavitt 1984). In sum, the first phase describes the emergence of native platforms characterized by risk-taking actors that assimilate technologies in technology push-dominated trajectories (Dosi 1982; Pavitt 1984). Furthermore, uncertainties in the initiation process regarding the technical approach, market focus and timing prevent incumbents from assimilating technologies in the same trajectories (Pearson 1990; Dosi 1982). An example is the rise of Apple's iTunes as an MSP, where traditional vendors of CDs (incumbents) did not follow the new technological trajectory. Risk-taking actors are motivated by commercial success in high reward markets, while incumbents need to evaluate new technologies in the light of economic, institutional and social factors (Dosi 1982; Rosenberg 1976). This behavior is closely linked to the Innovator's Dilemma (Christensen 2016). For the context of MSPs, we therefore posit the following propositions:

Proposition 1
(P1): *Risk-taking actors emerge as native MSP companies through the assimilation of technologies in technology push-dominated trajectories.*

Proposition 2

(P2): *Uncertainties in the initiation process prevent incumbents from assimilating technologies in technology push-dominated trajectories to transform toward an MSP provider.*

The **second phase** corresponds to an oligopolistic maturity where successfully routinized technologies in technological trajectories cause new demand. These new demand pull factors influence the assimilation process of incumbents by reducing the uncertainty toward technologies in the technological trajectory, which in turn leads to diffusion and internalization among incumbents (Dosi 1982; Rogers 2003; Zhu et al. 2006). Hence, the second phase can be split into one phase that characterize the routinization of technologies in technological trajectories to create new demand and a **third phase** that describes the diffusion and internalization among incumbents. Particularly relevant for the second phase are demand pull factors that foster the further diffusion of technological trajectories (Pavitt 1984). Based on the mitigation of uncertainties, incumbents follow the new demand pull-dominated trajectory in the third phase by assimilating technologies (Dosi 1982; Pavitt 1984) with the goal to transform toward a platform. For the context of MSPs, we propose:

Proposition 3

(P3): N*ative MSP companies that routinize technologies in technology push-dominated trajectories create new demand pull-dominated trajectories.*

Proposition 4

(P4): *Incumbents become aware of the new demand pull-dominated trajectories and assimilate technologies used by native MSPs to transform toward an MSP provider.*

Evolutionary dynamics of platforms

The current state of research is that the convergence of technological trajectories in the form of media content, data storage and data distribution has led to the emergence of technology-enabled MSP companies such as Spotify and Hulu (Yoo et al. 2012). Further examinations emphasize that technological platforms have emerged as a new concept, resilient to the fast pace of changing technological trajectories (Tiwana et al. 2010). The platform ensures stability through a modular architecture that can be extended with new technologies, referred to as stable flexibility (Kim and Kogut 1996; Sanchez and Mahoney 1996). The platform achieves this stable flexibility regarding changing market condition in two ways. First, the MSP follows a design of interconnected modules that are connected via standardized interfaces. The standardization fosters network effects between modules as each module communicates with the next without further translation costs (Katz and Shapiro 1994). This effect is also referred to Metcalfe's law (Metcalfe 2013). Second, the platform ensures composability, which refers to the resistance of modules to change (Tiwana et al. 2010). The platform can adopt new market trends by exchanging or enhancing modules without compromising the whole system. As a result, the platform enables malleability, which refers to the adoption of evolving user needs by enabling a flexible reconfiguration or extension of existing modules (Messerschmitt and Szyperski 2005). Through a modular platform, the platform owner can distribute new technologies to an ecosystem of users and complementors through software development kits (Ghazawneh and Henfridsson 2013). Thus, the platform enables knowledge diffusion among complementors, which in turn fosters the development of complementary innovations. One example is the introduction of Apple's ARKit, which enabled complementors to take advantage of the new Augmented Reality functionality to create new applications. Each new complementary innovation increases the value of the platform through network effects (Tiwana et al. 2010; Kim and Kogut 1996).

Research design

The research design follows a multiple-case study (Eisenhardt 1989) of three native platforms and an incumbent in the field of mobility services (Hein et al. 2018b). For the three native platforms, we draw on an embedded multiple-case study (Yin 2017) to describe the influence of technology push and demand pull factors that led to the emergence of MSPs and their impact on an incumbent. In analogy to other research (Karhu et al. 2018; Wright and Zammuto 2013) and to mitigate a hindsight bias (Fischhoff and Beyth 1975), the embedded multiple-case study is built on four different archival data sources in alignment with the two phases stated in the propositions. Second, a single-case study integrates the perspective of an incumbent that was transforming toward an MSP (Yin 2017). Semi-structured interviews reveal what factors prevented the incumbent from following the same technology push and demand pull factors that led to the initial emergence of native MSPs and what new factors eventually triggered the transformation. Finally, a cross-case analysis compares the case of the incumbent with the native platforms to conclude the applicability of the propositions in a process model (Eisenhardt 1989; Yin 2017).

Native multi-sided platforms

The embedded multiple-case study is subject to three native mobility service platforms to elaborate on the view of risk-taking actors that leveraged technology push and demand pull factors. To reduce the influence of contextual factors such as different business models, we selected three well-established platform companies, ranging from the field of peer-to-peer ridesharing to intercity bus traveling to carpooling (see Table 1). All companies started with a platform model (native MSP) and managed to establish a vibrant ecosystem of complementors and users. We rely on archival data to mitigate the hindsight bias of native platforms where the evolution toward an MSP seems to be predetermined. Contrary to interviews, archival data only covers information about the past and present (Fischhoff and Beyth 1975) and does not provide any information on the future use of technological advances or market demand.

For the data gathering process, we collected market reports and technological forecasts in a period two years before the founding of the three native platforms to describe the emergence of native MSPs. Market reports reveal current trends and uncover demand pull factors, whereas technological forecasts, such as the *Gartner Hype Cycle*, help detect technology push factors. In addition, we gathered archival data and empirical research from the founding date to early 2018 to elaborate on the evolution of the three native MSPs and their impact on the incumbent. Each fact was cross-validated through data triangulation within and between the two periods (Klein and Myers 1999). Overall, we collected 35 market reports and technology forecasts, 18 sources of archival data and 35 empirical studies. We used this data to test the validity of propositions one, where risk-taking actors emerge as native MSPs by assimilating technologies in technology push-dominated trajectories and proposition three, where evolving native MSPs create demand pull-dominated trajectories.

Incumbent that is transforming toward an MSP provider

In the single-case study, we analyzed the case of an incumbent in the field of mobility services that was transforming toward an MSP provider. Regarding the sampling strategy, we focused on a non-platform mobility company that acted as an incumbent and was transitioning (early 2018) toward a platform. We used interview data to capture the qualitative aspects of organizational uncertainty (Patton 2014). Another aspect that speaks in favor of interviews is the fact that the incumbent was transitioning toward a platform, which represented a contemporary event (Yin 2017). In addition, observing this phenomenon offered the opportunity to determine which technology push and market pull factors the incumbent adopted and which not. Furthermore, employees and decision-makers could justify their decision of not following the technological trajectories in the first place and instead elaborate on what factors eventually triggered the transformation process. Hence, we first determined factors that prevented the adoption of technology push and demand pull factors that led to the existence of native platforms. Second, we combined the interviews of the incumbent with the data of the native MSPs to reveal what factors eventually triggered the transformation process of the incumbent. We added market reports and technological forecasts over two years before the time when the transformation was triggered to make sure that we can determine if not-yet-identified demand pull or technology push factors influenced the transformation process. In total, we conducted ten face-to-face interviews between December 2017 and February 2018, each lasting 24–65 min (see Table 2). Besides, the interviews were recorded, transcribed, anonymized and sent back to the interviewees to provide additional comments. The final transcripts are the basis for further data analysis.

Data analysis

The data analysis follows the mechanisms of open, axial and selective coding as proposed by Strauss and Corbin (1990). We adhered to word-by-word open coding of the market reports, technological forecasts, archival data, empirical research and interviews to derive information such as technology push, demand pull factors and uncertainties of the incumbent. In total, we coded 102 data sources with 184 different in-vivo codes.

During the process of axial coding, we used a narrative strategy to link each code with the temporal perspective of

Table 1 Case descriptions of native MSPs

Native MSPs	Case Description
Uber	Founded in 2009, Uber is a peer-to-peer ridesharing platform based in San Francisco, California. The platform matches individual Uber drivers (supply) with passengers (demand) by providing value-adding services such as matchmaking, payment and rating mechanisms.
BlaBlaCar	Founded in 2006, BlaBlaCar is a carpooling platform based in Paris. The platform matches regular commuters or casual drivers (supply) with passengers (demand) to travel together. The platform provides value-adding services such as matchmaking, rating mechanisms and integrated payment.
Flixbus	Founded in 2011, Flixbus is an intercity bus service platform based in Munich. The platform integrates a variety of independent bus companies (supply) and matches them with mid-, to long-range drivers (demand). The platform provides value-adding services such as matchmaking, routing, rating mechanisms and integrated payment.

Table 2 Case description and interviewees of the incumbent in the mobility industry that is t transforming toward an MSP

Case Description	Interviews (Role of interviewee)		Duration
Alpha is one of the market leaders regarding infrastructure and mobility services around the world. The company has long-standing IT know-how and transportation expertise. Their core business is offering mobile solutions in the field of logistics, smart cities and infrastructure. The company is currently moving toward a smart mobility platform and trying to engage an ecosystem of actors to co-create value.	1	Principal Smart Embedded System Key Expert	46:51 min
	2	Product Manager	61:13 min
	3	Program Manager	40:00 min
	4	Principal Cyber-Physical System Key Expert	38:08 min
	5	Digital Solution Manager	52:31 min
	6	Chief Expert Software	36:54 min
	7	Head of IT	62:13 min
	8	Head of Sales	35:14 min
	9	General Manager (Head of Mobility Services)	26:45 min
	10	Program Manager Autonomous Driving	23:59 min

the data collection process (see Fig. 1) (Langley 1999). Hence, each code referred to one of the three phases that explains the genesis and diffusion of MSPs on the basis of technological trajectories. To describe why risk-taking actors emerged as native platforms, we compared the factors identified in the period two years before the founding of native MSPs with the initial offering of native platforms derived by archival data and empirical research. This comparison ensured that we only coded factors as relevant for the emergence of native platforms when those factors were also incorporated in the initial offering of native platforms. To further support this relationship, we also triangulated the data with statements from industry experts from the case company. Based on those findings, the interviews were designed to ascertain how the incumbent dealt with those factors in the assimilation phase of initiation and what factors (e.g., uncertainties) might have mitigated the decision to adopt an MSP in the first place. Factors identified within archival data and empirical studies in combination with interviews of the incumbent were used to derive new trajectories triggered by native platforms that were routinizing new technologies. Lastly, interview data were used to elaborate on factors that eventually triggered the incumbent's transformation toward an MSP provider. To make sure that not-yet-identified factors might have influenced the transformation process, we also use contemporary market reports and technological forecasts two years before the transformation for cross-validation. Finally, selective coding was used to test the validity of the four propositions across all cases. The result is a process model based on three temporal phases (Langley 1999) that describes the emergence of MSPs based on the assimilation process to technologies in technological trajectories (Eisenhardt 1989).

Results

The results describe the empirical data of the embedded multiple-case study subject to the three native platform companies and the subsequent single-case study of an incumbent transforming toward a platform. We use the three phases of (*I*) emergence of native mobility service platforms (*P1* and *P2*), (*II*) their influence on incumbents (*P3*) and the eventual (*III*) transformation of incumbents toward a platform (*P4*) to structure the data.

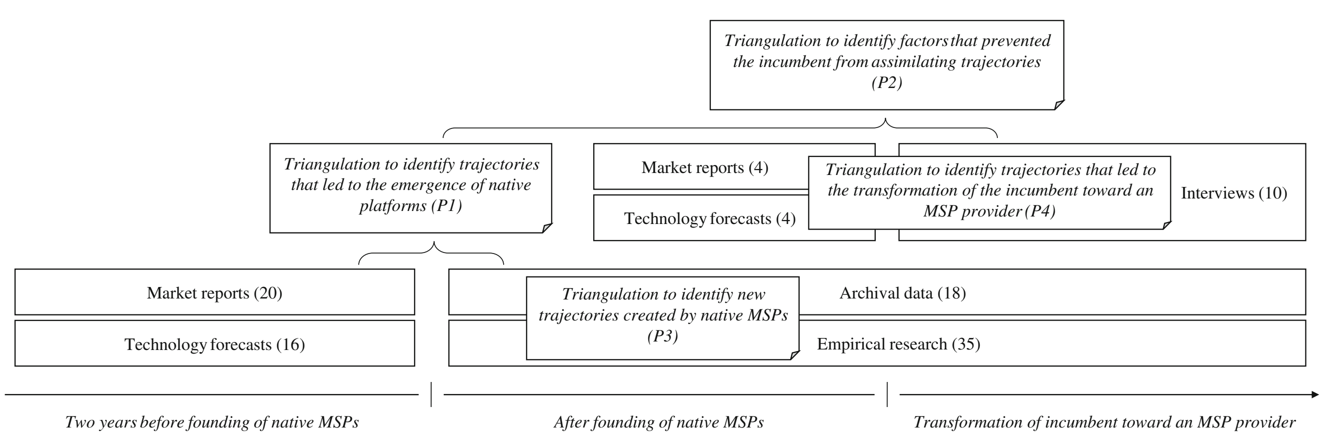

Fig. 1 Research model and theoretical propositions

Phase I: Emergence of native platforms

The data from the market and technology reports and interviews indicate that there were four dominant technology push, three demand pull and one regulatory factor that led to the emergence of native platform companies. A factor is categorized as dominant if the factor was found in the market and technology reports and was also part of the initial native platform model (see Table 3).

Technology push factors

The first technology push factor represents **Web 2.0** technologies such as AJAX or other client-side script languages that allow users to participate in or create own content. Prominent examples that utilize Web 2.0 technology are social networks (Macmanus 2006; Sutter 2009) or blogs (Butcher 2005; Fortt 2004). The *Gartner Hype Cycle* (2006–2009) indicates that Web 2.0 technologies started from the peak of inflated expectations in the year of 2006 and went from the trough of disillusionment to the slope of enlightenment (Gartner Inc. 2009; 2008; 2006). BlaBlaCar used this technology as the basis of their platform to enable users to share open seats on long-distance rides (Casprini et al. 2015). The concept of car-pooling is not new. However, the use of Web 2.0 technology provided travelers with a central platform compared with the decentralized municipal sharing communities. The central platform enabled every user with internet access to offer and look for car-pooling opportunities on their personal computer (Rose and Wheeler 2017).

The second technology that affected the development of mobility service platforms is the **mobile device** or smartphone. The iPhone, which was introduced in 2007 by Apple, represented a quantum leap from regular cellular phones to smart devices. The smartphone provides convenient access to a variety of services in the form of applications (Sutter 2009; Forbes 2013). Technology trends (Fortt 2004) and the Product Manager of the case company "Alpha" confirmed that the smartphone and the underlying foundation, including the edge infrastructure, GPRs/3G technology and navigation software, were necessary for mobility service platforms to evolve. Uber emerged during the influence of this technology and used the smartphone from the very beginning to bundle navigation services with the ability to book limousines on the go (Kooti et al. 2017). Customers could determine their location and send it to the next driver, which in turn allowed them to track the exact location of the car. In addition, drivers were able to use Web 2.0 features to offer rides on the platform. Due to the rapid market penetration of smartphones, increasing numbers of users were able to access and participate (Web 2.0) in the Uber ecosystem (Sutter 2009).

The growth of mobility services precipitated a surge in demand for computational power to ensure reliable services, which brings the third technology push factor, **cloud computing**, into play. The *Gartner Hype Cycle* (2008–2013) indicates that the technology started as a technology trigger, peaked in 2009 to disillusionment, although it promised cost-effectivity and a flexible increase of computational resources when needed (Gartner Inc. 2009; 2008; 2012; 2013). The Program Manager, Product Manager and Principal Cyber-Physical Systems Expert of Alpha confirmed that cloud computing was a necessity for mobility service platforms to handle the continually growing amount of traffic and to lower marginal costs. Uber and BlaBlaCar went from a monolithic IT architecture to a platform that utilizes cloud services. While initially working with on premise hardware, both companies now use the Amazon Web Services (AWS) cloud computing platform to ensure the scalability of their services (Nappez et al. 2015; Kenney and Zysman 2016). Flixbus, on the other hand, adopted a combination of Salesforce and AWS cloud computing (Herrmann 2016).

The last technological factor is **big data analytics**, which offers companies the opportunity to take advantage of the increasing amount of data generated through Web 2.0 technology and mobile devices. Data analytics is the most recent technology and peaked in 2012 as a result of inflated

Table 3 Technology push and market pull factors during the initial founding of the platform (Phase I)

Timespan (two years prior to founding year–founding year)			('04–'06)	('07–'09)	('11–'13)
Phase	Dimension	Factors	BlaBlaCar	Uber	Flixbus
Emergence of Native Platform Companies Phase I	Technology push	Web 2.0	+	+	+
		Mobile devices	o	+	+
		Cloud computing	o	o	+
		Big data analytics	o	o	+
	Demand pull	Social media	o	+	+
		Affordable devices	+	+	o
		Sustainability	+	+	+
	Regulatory	Liberalization	o	o	+

expectations in the *Gartner Hype Cycle* (Gartner Inc. 2012, 2013; Ulanoff 2012). Technological forecasts describe it as the next frontier of innovation (Manyika et al. 2011). Besides, the Principal Cyber-Physical Systems Expert of Alpha confirmed that the adoption of big data analytics technology is a logical consequence of the ever-increasing amount of data generated to increase the quality of the services offered on a continuous basis. Consequently, all three native platform companies use data analytics to take advantage of the generated data to increase the quality of their services (Nappez et al. 2015; Schlesiger 2016; Kenney and Zysman 2016).

Demand pull factors

The emergence of **social media** and digital word-of-mouth corresponds with the development of Web 2.0 functionalities (Macmanus 2006; Sutter 2009). All three native platforms were born into a world where social networks re-shaped the way we communicate, share and recommend products or services (Forbes 2013; Sutter 2009).

The second market demand is that newly developed mobile devices became increasingly **affordable** due to rapid market penetration. Cheap devices reinforce positive effects on reducing entrance barriers for potential service users (Sutter 2009). Thus, this trend has enabled an increasing number of users to benefit from the GPS sensor in their device in combination with the mobile Internet to calculate routes, book rides and consume services.

Lastly, there is the need for **sustainability**, where fuel is seen as the highest cost factor for commuting (Antich 2007) and car-sharing as a way to reduce carbon dioxide emissions (Cannon and Summers 2014).

Regulatory factors

Regulatory factors that triggered the emergence of mobility service platforms are adjustments to **liberalize** the public transportation industry. In the case of Flixbus, the Federal Republic of Germany repealed the monopoly of the Deutsche Bahn (German-based private transportation/railway provider) on long-distance routes (Gremm 2017; Grimaldi et al. 2017). Besides liberalization, users adopt new services due to capacity issues with conventional modes of transportation. BlaBlaCar benefitted in this regard from a general strike of French railway companies, which forced people to seek alternative transport solutions (Rose and Wheeler 2017).

Uncertainty

The interview data gathered from the incumbent Alpha reveal ambiguity regarding the application of each technology on its own and hesitation to adopt a platform solution. Five interviewees indicated that the incumbent implemented each technology separately to support existing processes or to enhance the products. One example is the use of Web 2.0 functionality to gather feedback from clients, which is then used to improve existing products. Furthermore, Alpha used cloud solutions to reduce operating costs and introduced data analytics to improve their production processes.

In addition, the interviews reveal insights into why the incumbent did not follow an approach similar to the emerging native companies. First, the Head of IT of Alpha mentioned that data ownership was one of the most important topics when it comes to offering accurate and useful mobility services. Alpha did not see the opportunity to gather enough data to build a mobility service platform; the reasons for this range from regulatory or data privacy constraints to security standards. Furthermore, the Principal Cyber-Physical Systems Expert of Alpha stated that clients and ecosystem partners were reluctant to share their data. Second, Alpha struggled to find a solution for coopetition in their ecosystem. The Head of Mobility Services explained that Alpha is in direct competition with other mobility service providers; however, if they did plan to provide a platform solution offering value-added services to their customers, then they would need to collaborate with competitors. During that period (*Phase I*), Alpha had no incentive to cooperate with competitors. While each of the possible ecosystem partners had different motives for participating in a platform ecosystem, Alpha was unable to provide a one-size-fits-all solution. Finally, Alpha did not have a compelling platform business case. The Head of Sales said that they had no pressure to be successful as they had a profitable business model and that startups were more eager to work hard to get their idea into reality. Furthermore, Alpha needed to justify the application of new technologies with a business case.

Phase II: Impact of native platforms on incumbents

The empirical results show that native mobile platforms triggered one technological advancement and three market-driven effects during the phase of routinization. As Table 4 indicates, the timespan for the routinization phase lasts from the founding year to the end of data collection (early 2018). Again, a factor was coded as relevant for this timespan if it could be cross-validated across archival data, empirical studies and interviews from industry experts represented by the case company Alpha.

Technology push factor

Native platforms combined technology push and demand pull factors as of *Phase I* to create a more robust infrastructure for handling the vastly increased amount of services (Rajesh 2016). Uber, for example, started with a monolithic

Table 4 Technology push and market pull factors that result from the impact of mobility service platforms in the period after their founding (Phase II)

Timespan (founding year–end of study)			('06–'18)	('09–'18)	('13–'18)
Phase	Dimension	Factors	BlaBlaCar	Uber	Flixbus
Impact of Native Platform Companies Phase II	Technology Push	Microservice architecture	+	+	o
	Demand Pull	Servitization	+	+	+
		Gig/Sharing economy	+	+	+
		Coverage/Availability	+	+	+

architecture designed for single offerings in distinct cities and developed a **microservice architecture** capable of introducing and changing scalable services worldwide more quickly (Haddad 2015; Reinhold 2016). The architecture is based on cloud computing technology and aims to provide stability for the ever-increasing amount of service requests while also being flexible in adopting new services or changing existing services. Hence, the modular microservice architecture can manage the core value service (e.g., booking/offering rides) around supporting services that range from payment, authentication, rating rides and navigation. Besides, new services generated from complementors (Raasch et al. 2008) of the ecosystem can be integrated without disturbing the integrity of the architecture (Reinhold 2016; Fraud 2014). An example is the UberRide API, where developers can create value-adding services while the passengers are driving to their destination (Haddad 2015; Hein et al. 2018a).

Demand pull factors

Evolving mobility service platforms contribute toward **servitization** by distributing ride requests to a widely distributed network of drivers (Chen and Sheldon 2016; Posselt and Roth 2017). The driver can focus on the central mobility service as the platform takes care of secondary services that range from payment to navigation to matchmaking. So, mobility service platforms impact the way how we consume goods or services as no private car is needed to travel from A to B. Rapidly growing mobile services companies such as DriveNow or Car2Go are only two examples (Kooti et al. 2017). The Digital Solutions Manager of Alpha stated that a variety of other companies followed this trend as exemplified by car- and bike-sharing: each focuses on a specific task or service and tries to map the service digitally. The Head of Sales summarized that service bundling is a crucial feature triggered by emerging platform companies. Native platforms led to people's expectation that the platform provides essential services such as ticketing, payment, reservation and peer-rating.

The second demand triggered by native platforms is the **gig or sharing economy**, which led to a shift from fixed contracts to a flexible work system. Uber drivers can decide when and how much they want to drive to earn a living (Chen and Sheldon 2016; Berger et al. 2018). Drivers have full control over their work schedule and can generate extra income when needed (Kooti et al. 2017). However, there are also critical voices pointing out that legislation has lagged behind the trend of gig companies. The case of Uber demonstrates that platforms operate in an underregulated market (e.g., the status of drivers regarding employment/insurance) (Drahokoupil and Fabo 2016).

Lastly, the flexible adoption of new subcontractors allowed native platforms to break new ground. Flixbus, for example, also **covers** less-frequented rural areas by connecting them through hubs in the form of big cities (Schlesiger 2016). Uber and BlaBlaCar follow the same pattern, where more people close to a destination using the service increase the value for all others nearby (Casprini et al. 2015).

Phase III: Transformation of incumbents toward a platform

Table 5 shows two dominant technology push and demand pull factors that influenced the incumbent's decision toward adopting an MSP. The interview results indicate that in addition to the factors of *Phase II*, blockchain technology (six independent mentions), artificial intelligence (nine independent mentions) and electrification (four independent mentions) influenced the incumbent's transitioning toward an MSP.

Technology push factors

The first additional technology push factor not triggered by the evolving platforms is the **blockchain technology**. The Program Manager of Alpha stated that this technology promises to establish trust and transparency in a mobility service ecosystem. Everyone can identify who altered which data or transaction and when. However, he also stated that the technology is at a too early stage to be applicable. Furthermore, the General Manager of Mobility Services pointed out that blockchain technology can help Alpha develop new business models where no intermediary or trusted party is needed to deal with contracts,

Table 5 Technology push and market pull factors at the start of the transformation process of the incumbent (Phase III)

Timespan (start of transformation–end of study)			('17–'18)
Phase	Dimension	Factors	Incumbent (Alpha)
Transformation of Incumbent Phase III	Technology push	Blockchain technology	+
		Artificial intelligence	+
	Demand pull	Electrification	+

payments, or authentication. Blockchain and smart contracts manage all transactions to cope with the coopetition issue. Additionally, the Chief Expert of Software indicated that the blockchain could help mitigate data regulation problems by creating transparency and reducing the ecosystem complexity.

Artificial intelligence is the second technology mentioned to affect the transformation process. The Program Manager for Autonomous Driving indicates that artificial intelligence enables Alpha to provide users with a fully automated mobility service. The car can be sent just-in-time to the user's front door to offer them the best possible experience. Furthermore, Alpha can provide the service as cheaply as possible due to saving on personnel costs, in addition to being as reliable as possible due to the high degree of automation.

Demand pull factor

The additional demand pull factor deals with **electrification**, which Alpha recognizes as a trend toward e-mobility. According to the Principal Smart Embedded Systems, the demand promises a more ecological and less health-endangering technology that includes lower maintenance costs and easier integration in a connected car and with live updates. The demand drives the need for Alpha to come up with an architecture that supports the increasing number of smart/electrified devices.

Discussion

In alignment with the three phases and the four propositions, we discuss the implications, limitations and future research based on the empirical results (see Fig. 2).

The first phase characterizes the emergence of MSPs as an architecture of servitization. We use the notion of bricolage to explain that risk-taking actors adopt and assemble different technologies to support servitization, whereas incumbents adopt the technologies according to their institutional logic. While not being a central part of the adoption process, also regulatory factors can either enable (Flixbus and market liberalization) or amplify (BlablaCar and general strikes) the adoption process. Next, evolving native platforms cause new demand, for example, the gig/sharing economy and thereby establishing a trajectory toward mass servitization. During the initiation process, incumbents become aware of the new path but hesitate to follow it due to uncertainty. Eventually, native platforms routinize the assembled technologies as of *Phase I* as an architecture toward mass servitization. The resulting microservice architecture in combination with new

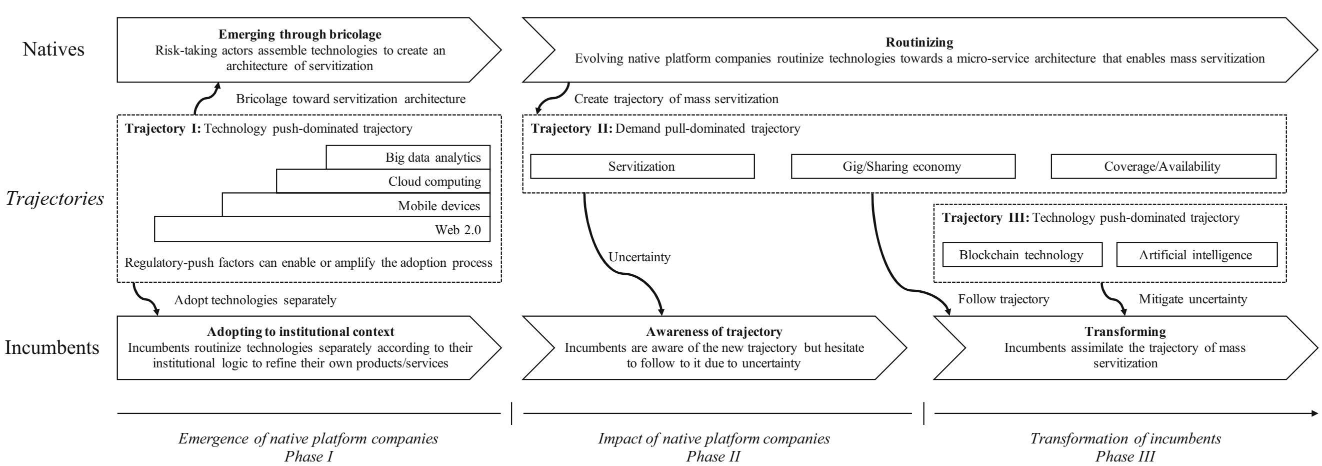

Fig. 2 Process model on the emergence of native platform companies and the transformation of incumbents toward an MSP provider

technologies, such as blockchain or artificial intelligence, mitigates initial uncertainties and triggers the assimilation process of the incumbent.

Bricolage: Assembling the architecture of mass Servitization

Proposition 1 states that risk-taking actors emerge as platforms through the assimilation of technologies in technology push-dominated trajectories. However, the data indicate that those risk-taking actors do not assimilate to technologies in isolation but, instead, assemble them toward an architecture of servitization. We use the notion of bricolage to discuss the process of native platforms that assemble technologies and take advantage of market trends to develop an MSP based on an architecture of servitization (see Fig. 3).

Lévi-Strauss (1966) introduced the bricoleur as someone who has a limited number of tools and resources to perform many diverse tasks. In contrast to the engineer, who selects the tools and resources to achieve a planned goal, the bricoleur uses "whatever is at hand" (Baker and Nelson 2005). BlaBlaCar used the contemporary technology of Web 2.0 functionalities to solve the task of connecting a broad range of drivers with passengers. The original idea of Web 2.0 functionalities was to enable lively conversations and interactions on websites (O'Reilly 2007). Through sense-making, BlaBlaCar interpreted this concept in another way and enabled interactions between passengers and drivers by facilitating the offering of mobility services between the two groups.

Building on this basic level of interaction, mobile devices provided an increasing number of people with the opportunity to access mobility services regardless of their position. Uber took advantage of the GPS sensors in smartphones in combination with Web 2.0 functionalities. The result was a mobile application that provided drivers and passengers with convenient supporting services such as payment, tracking and peer-rating to ensure trust.

Through the increased accessibility of mobility services, companies such as BlaBlaCar and Uber saw the need for improved performance, scalability and reliability of their service architecture. At the start, both companies built a monolithic architecture to support single services in isolated cities. However, as the cloud-computing technology became increasingly popular, the native platforms integrated this new technology to ensure the scalability of their mobile services (Alt et al. 2010).

Finally, the native platforms adopted the technology of big data analytics due to the vast amount of user- and device-generated data. All three mobility service platforms apply data analytics to improve their services continuously. Contemporary demand-based factors such as electronic word-of-mouth through social networks, a decrease in the costs of mobile devices—making them more accessible—and an increased awareness of sustainability further enhanced the composition of technologies.

The native platforms followed a process of sense-making of the different technologies according to their core mobility services and assembled them in the process of bricolage toward a microservice architecture. The microservice architecture is capable of splitting tasks into specific services. Those loosely coupled services act as modular entities connected through standardized protocols (e.g., in the form of an API). This architecture ensures composability due to the extensibility of services without compromising the whole architecture. Besides, the microservice architecture supports malleability due to the rapid adoption of new services and to the altering of existing services by dedicated service owners. Uber extends this concept not only to internal development but also to an ecosystem of external developers. The ride-sharing platform offers APIs such as UberRUSH or TripExperience. For the latter, Uber provides external developers with tools to create own services or applications for the time while the passenger gets to his/her destination (Hein et al. 2018a). According to Uber, the to-be-developed services aim to enhance the trip experience for the passenger (Saad 2016).

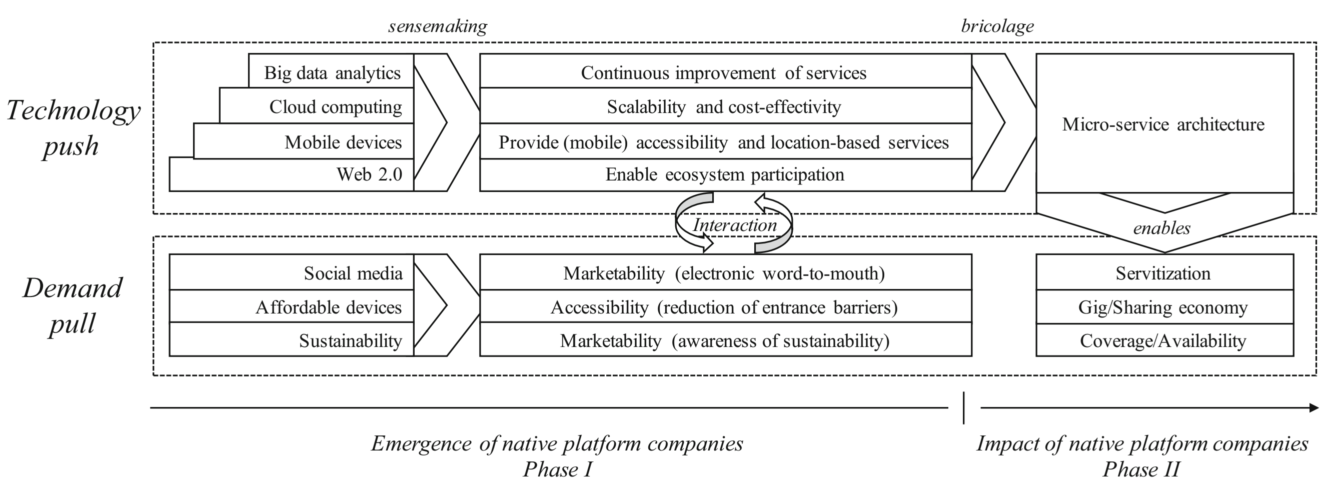

Fig. 3 Process of assembling technology push and demand pull factors toward an architecture of servitization

Concluding, native platforms follow a process of sensemaking (Weick et al. 2005) of technology push and demand pull factors according to the provision of their core mobility services. In this context, the native platforms transitioned from a monolithic to a microservice-oriented architecture by tinkering with technologies to support their core service (Baker and Nelson 2005; Ciborra 2009). Reflecting on the initial proposition, we suggest that the assimilation process of technologies in technology-push dominated trajectories follows the concept of bricolage, where risk-taking actors assemble and tinker technologies to emerge as MSPs as an architecture of servitization.

Proposition 2 describes that incumbents hesitate to assimilate technologies in technology-push dominated trajectories due to uncertainty. As indicated in Fig. 2, our results show an ambivalent approach of incumbents. The interviews suggest that there are uncertainties that prevented the incumbent from adopting technologies such as unsettled data regulations, coopetition with ecosystem partners and a missing platform business model. However, those results are likely to incorporate a hindsight bias where the interviewees already knew about the platform and its role in the process of servitization. This bias becomes clear when observing the adoption of technologies separately. The incumbent indeed adopted each of the four technologies that led to the emergence of native platform companies according to its institutional logic (Thornton and Ocasio 2008; Alt and Klein 2011). They incorporated Web 2.0 functionality technically to gather customer feedback, used mobile devices to enhance the productivity of employees, or utilized cloud computing and big data analytics to improve manufacturing processes. Hence, the incumbent did not assemble the different technologies like native platforms did to support the provision of mobility services. In sum, it seems reasonable to conclude that it was less the uncertainty but more the lack of ambidexterity that could be the cause of an "Innovator's Dilemma" restricting the application of new technologies to the existing institutional logic to assemble an architecture of servitization (O'Reilly III and Tushman 2008; Christensen 2016).

Creating demand: Prompting a trajectory toward mass Servitization

During the impact of native platform companies in *Phase II*, the technology change literature proposes that native platform companies routinized technologies to create demand pull-dominated trajectories (**Proposition 3**). The data support this proposition by illustrating that native platforms incrementally routinize the new technology stack as an architecture of servitization. Those native platforms create demand in the form of increased awareness of servitization, the transition from fixed to flexible employment represented by the gig or sharing economy and the coverage and availability of mobile services in rural areas. The awareness of servitization reflects the claim for convenience through service bundling where users see the platform as a one-stop shop. Users can plan trips, navigate possible routes, order from a pool of drivers and pay/rate the service afterward without any media disruption. This kind of service bundling is an essential condition for user satisfaction (Ranganathan et al. 2006; Bouwman et al. 2007).

Furthermore, mobility service platforms led to the emancipation of service workers through increased flexibility. The term "gig" or "sharing economy" was shaped by Uber and describes that drivers are free to participate in the platform and accept passengers as they want. The driver can focus on the carriage of passengers as Uber takes care of additional services. This provision of services has influenced the emergence of an increasing number of mobility service companies such as bike- or car-sharing (e.g., car2go, DriveNow). However, the increased flexibility of drivers triggered the need for new regulations to mitigate the market power of platforms (Cannon and Summers 2014).

The steadily increasing adoption of mobility service platforms finally led to broad coverage of areas where the service is available. Flixbus started with highly frequented routes and then expanded into more rural regions around those hotspots. The satisfaction of those new demands was enabled by the microservice architecture, serving as a vehicle for the increased demand of servitization.

Eventually, the interplay of technological routinization and demand led to the development of MSPs as an architecture toward mass servitization. One can find a similar evolution when comparing the transition from made-to-order in the manufacturing industry to the technological paradigm of mass production. Architectures such as the assembly line and the conveyer belt helped reduce production costs and foster economies of scale through standardized tasks (Hounshell 1985). The emergence of native platform companies shows a similar pattern. While the move toward servitization is not new (Vandermerwe and Rada 1988), platforms reduce the transaction costs of the demand-side (passenger) and supply-side (driver) by providing them with an architecture of servitization that standardizes the interaction within an ecosystem (Hein et al. 2019).

Overall, the results validate that demand-dominated factors caused by the routinization of native platforms triggered the transition toward mass servitization through MSPs. As in the technology paradigm of mass production with dominant designs, such as the assembly line to the conveyer belt, the paradigm of mass servitization has also evolved from a monolithic architecture to a microservice architecture.

State of liminality: Transition from the old to the new trajectory

Proposition 4 suggested that incumbents eventually became aware of the demand pull-dominated trajectory and assimilated technologies used by native platforms, thereby mitigating the hesitation caused by uncertainty. We found evidence that uncertainty influenced the reluctance of assimilating the innovation path toward mass servitization as soon as the incumbent was aware of the new trajectory. First, interviewees within Alpha mentioned that mobility service platforms would not persist. However, during the evolution of native platform companies and the resulting demand, they found themselves in a state of liminality between the old and new trajectories, trying to make sense of this innovation path (Henfridsson and Yoo 2013). The Digital Solutions Manager of Alpha brings up the issue of not having a business case for a platform. This uncertainty illustrates that Alpha tries to assimilate to technologies in the trajectory toward mass servitization according to their current institutional logic, which is dominated by production processes and where they are unable to come up with a convincing business model. The same is true for the uncertainty regarding coopetition in Alpha's current ecosystem. Alpha would need to integrate competitors to provide a value-adding service. Alpha also found they were unable to cope with the data regulation laws to make the services work.

All three statements point toward issues that arise from applying a new trajectory to an obtuse institutional logic (Thornton and Ocasio 2008), where Alpha sees the need to transition from the old trajectory through a state of liminality to the new path toward mass servitization (Henfridsson and Yoo 2013). In this way, Alpha is currently looking for new technologies to help make sense of the innovation path co-shaping new opportunities going along with the mitigation of uncertainties (Garud and Karnøe 2003). One promising candidate is blockchain technology, which could provide a business model for servitization, create transparency and trust in an ecosystem that includes competitors and allow users to see which data are stored. Concerning the initial proposition, we argue that assimilating technologies of a new trajectory is no binary decision caused by increased demand. Instead, demand triggers the assimilation process of technologies in the trajectory and leads to a transition from the current trajectory through liminality to the new trajectory (Henfridsson and Yoo 2013; Garud and Karnøe 2003).

Implications, limitations and future research

One of the fundamental research issues in the platform literature is that it is still unclear how platforms emerge (de Reuver et al. 2017). This article uses the theoretical lens of technological trajectories and technology diffusion to shed light on the early phases of platforms and their subsequent evolution. We show that native platform companies assemble different technologies such as ecosystem integration through Web 2.0 functionality, smartphones, cloud computing and big data analytics toward an architecture of servitization. The four different technologies converge in a new combination followed by a pattern of specialization (Kim and Kogut 1996), resulting in the microservice architecture.

First, we show that native platforms act as a bricoleur (Lévi-Strauss 1966), making sense of contemporary technologies to solve a mobility service-related problem effectively. Intuitively, native platforms "stumbled upon" a new architecture of servitization through bricolage (Garud and Karnøe 2003; Ciborra 2009). Out of this continually improving architecture, native platforms create new demand in the form of the gig or sharing economy. The combination of technological advances and an increased market need (Dosi 1982) leads to a new trajectory toward mass servitization. Within this innovation path, the platform facilitates supply and demand through a core service that is supplemented by several supporting services such as payment, matchmaking and peer-to-peer-based ratings. The increasing number of followers of incumbents in the form of DriveNow (BMW), Car2Go (Mercedes Benz) and Toyota Mobility Service (Toyota) indicates the importance of the innovation path. When taking the robustness of our findings into consideration, we see similar patterns when looking at other MSPs in the field of social networks and accommodation platforms such as Airbnb (Hein et al. 2018a). Those findings are in contrast to other research as shown in the example of Sun Microsystems diffusing the new paradigm of distributed computing (Garud et al. 2002). Instead of getting legitimacy through network interactions to diffuse the paradigm, native MSPs reinforce the trajectory toward mass servitization by creating new demand. This example of native platforms acting as bricoleurs to create novel, disrupting innovations can also be applied to other research areas. In particular, we shed light on the resource orchestration theory by exemplifying how native platforms bundle and routinize new technologies to pioneer an architecture of servitization (Sirmon et al. 2011).

Second, the process model contributes to the platform literature by revealing how native platforms assemble and routinize novel technologies to establish an MSP as an architecture that creates and satisfies the increasing demand for servitization. The study shows that native platforms first make sense of existing technologies from the provision of their core service, followed by the process of bricolage to come up with an infrastructure that supports the innovation path toward mass servitization. The routinization of this architecture led to new demand and a diffusion toward incumbent firms. Besides, the concept of the platform owner acting as a bricoleur may lead to further fruitful implications in the platform domains of platform governance mechanisms (Tiwana et al. 2010; Hein et al. 2016; Schreieck et al. 2018) and tinkering of platform openness through control (Boudreau 2010; Benlian et al. 2015). BlaBlaCar, for example, adjusted its booking service process to mitigate the problem of direct bargaining between the driver and the passenger and to increase service reliability. They started with a premium model that privileged paying drivers. However, the model proved to be unsuitable as this discriminated against most drivers. Next, they adopted a monthly plan model that failed due to the too-sporadic character of facilitating commuting services. Ultimately, BlaBlaCar established a pay in advance service that creates the commitment to the ride and eliminated direct bargaining (BlaBlaCar 2018).

Third, we contribute to the technology and innovation management literature by showing that native MSPs act as bricoleurs to foster the exaptation of technologies (Eggers and Park 2018; Garud et al. 2016) and how incumbents dealt with the ambiguity of trajectory shifts (Henfridsson and Yoo 2013; Munir and Phillips 2005). Exaptation refers to the interpretation (sense-making) and usage of technologies in a different way than what was initially intended (Garud et al. 2016). The results reveal that native MSPs used contemporary technologies as a bricoleur to foster the exaptation of technologies. Furthermore, we show that incumbents first adopt each technology separately according to their institutional logic (Munir and Phillips 2005). They then became aware of the new trajectory toward mass servitization by recognizing the increased demand. The more they learned during the process of sense-making of the innovation path the more uncertainties were identified. This is consistent with the work of Meacham (1983) who states that more knowledge in a new domain increases "the number of uncertainties, doubts, questions and uncertainties." Eventually, the incumbent tried to mitigate the uncertainty with the help of new technologies as demonstrated with the blockchain technology.

We note several limitations in the study's selected research approach. The embedded multiple-case study based on archival data does not provide us with the insights needed to conclude the motives of the native companies to come up with a platform as an architecture for servitization. We faced the challenge to re-build a technological trajectory using archival data within three different timespans without performing any intervention through interviews. Archival data offers the advantage of just describing the current situation, avoiding the trap of hindsight bias and backward sense-making of interviewees (Fischhoff and Beyth 1975). However, this approach limits the explanatory power when answering why and how the native companies developed a platform. We propose that future research elaborates with the founders of native platforms on the adoption process of technological trajectories to establish a more in-depth understanding of the motives and process of combining several technologies. Next, we restricted the single-case study to one incumbent that is currently transforming toward an MSP. The research community would benefit from a longitudinal study on how the incumbent managed the transformation and shift between trajectories to contribute toward a more detailed understanding of how companies transition from the old trajectory through a state of liminality to the new trajectory of mass servitization. Furthermore, interviews with additional incumbents would increase the robustness of the findings.

Conclusion

As platform research focuses mainly on established MSPs (de Reuver et al. 2017; McIntyre and Srinivasan 2017), it is not yet understood how technology enabled MSPs to emerge. We use the theoretical lens of technological trajectories (Dosi 1982; Kline and Rosenberg 2010) and technology diffusion (Rogers 2003; Zhu et al. 2006) to contribute toward an increased understanding of the emergence of MSPs. Out of this literature, we derive four propositions that describe the emergence of platforms through risk-taking actors that exploit a new technological trajectory and the diffusion and internalization of incumbents. We validate the four propositions through an embedded multiple-case study subject to the three native mobility service platforms Uber, BlaBlaCar and Flixbus, and an incumbent in the field of mobility services that was transforming toward an MSP provider. The results show that native platforms do not assimilate to distinct technologies, but rather adhere to the principle of bricolage, i.e., assembling a variety of technologies ranging from Web 2.0 functionality, mobile devices, cloud computing and big data analytics. Those technologies aim to support the provision of mobility services, leading to an architecture of servitization. During the routinization of those technologies, native platforms came up with a microservice architecture. As proposed by the theory, the new technology indeed fostered the creation of new demand in the form of the gig or sharing economy. The combination of contemporary technologies and the created demand gave rise to an innovation path toward mass servitization, which in turn triggered the transformation of the incumbents to transform toward an MSP provider. Overall, our research shows that native platforms routinize an architecture of servitization (MSPs) to create and satisfy the increasing demand for convenient services. This interplay of technology push and demand pull factors shows the emergence of MSPs as a new technological trajectory toward mass servitization. Moreover, MSPs are likely to gain more traction through emerging technologies such as artificial intelligence, which further increases the degree of automation and blockchain technology that enhances the trust and transparency over data in an ecosystem of different actors.

Acknowledgements The authors would like to thank all anonymous reviewers and the editors for their helpful comments and suggestions. This work is part of the TUM Living Lab Connected Mobility (TUM LLCM) project and has been funded by the Bavarian Ministry of Economic Affairs, Energy and Technology (StMWi) through the Center Digitisation.Bavaria, an initiative of the Bavarian State Government.

References

Alt, R., & Klein, S. (2011). Twenty years of electronic markets research - looking backwards towards the future. *Electronic Markets, 21*(1), 41–51.

Alt, R., Abramowicz, W., & Demirkan, H. (2010). Service-orientation in electronic markets. *Electronic Markets, 20*(3–4), 177–180.

Antich, M. (2007). Analyzing Depreciation Trends: 2007 Vs. 2006. https://www.automotive-fleet.com/blog/market-trends/story/2007/11/analyzing-depreciation-trends-2007-vs-2006.aspx. Accessed 01.02.2018.

Baker, T., & Nelson, R. E. (2005). Creating something from nothing: Resource construction through entrepreneurial bricolage. *Administrative Science Quarterly, 50*(3), 329–366.

Benlian, A., Hilkert, D., & Hess, T. (2015). How open is this platform? The meaning and measurement of platform openness from the Complementors' perspective. *Journal of Information Technology, 30*(3), 209–228.

Berger, T., Chen, C., & Frey, C. B. (2018). Drivers of disruption? Estimating the Uber effect. *European Economic Review, 110*, 197–210.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly, 37*(2), 471–482.

BlaBlaCar (2018). Fail. Lern. Succeed. https://www.blablacar.com/blog/inside-story/fail-learn-succeed Accessed 01.02.2018.

Boudreau, K. (2010). Open platform strategies and innovation: Granting access vs. devolving control. *Management Science, 56*(10), 1849–1872.

Bouwman, H., Haaker, T., & De Vos, H. (2007). Mobile service bundles: The example of navigation services. *Electronic Markets, 17*(1), 20–28.

Burgelman, R. A., Maidique, M. A., & Wheelwright, S. C. (2008). *Strategic Management of Technology and Innovation* (Vol. 5). Irwin Chicago, IL: McGraw-Hill Education.

Butcher, D. (2005). Top Technology Trends of 2005. https://news.thomasnet.com/imt/2005/12/06/2005_top_techno. Accessed 01.09.2018.

Cannon, S., & Summers, L. H. (2014). How Uber and the sharing economy can win over regulators. *Harvard Business Review, 13*(10), 24–28.

Casprini, E., Paraboschi, A., & Diminin, A. (2015). Web 2.0 Enabled Business Models: An Empirical Investigation on the Blablacar. It Case. In *Proceedings of the Academy of Management Annual Meeting,* Briarcliff Manor, NY, 2015.

Chen, M. K., & Sheldon, M., (2016). Dynamic pricing in a labor market: Surge pricing and flexible work on the Uber platform. In *Proceedings of the 2016 ACM conference on economics and computation,* Maastricht, Netherlands,2016.

Christensen, C. (2016). The Innovator's dilemma: When new technologies cause great firms to fail. Boston, MA: Harvard Business Review Press.

Ciborra, C. U. (2009). Technology, Work and Globalization. In C. Avgerou, G. Lanzara, & L. Willcocks (Eds.), *Bricolage, Care and Information Systems* (pp. 206–220). Basingstoke, UK: Palgrave Macmillan UK.

Costantini, V., Crespi, F., Martini, C., & Pennacchio, L. (2015). Demand-pull and technology-push public support for eco-innovation: The case of the biofuels sector. *Research Policy, 44*(3), 577–595.

Dosi, G. (1982). Technological paradigms and technological trajectories. A suggested interpretation of the determinants and directions of technical change. *Research Policy, 11*(3), 147–162.

Drahokoupil, J., & Fabo, B. (2016). The platform economy and the disruption of the employment relationship. *ETUI Policy Briefs, 5*(1).

Eggers, J., & Park, K. F. (2018). Incumbent adaptation to technological change: The past, present, and future of research on heterogeneous incumbent response. *Academy of Management Annals, 12*(1), 357–389.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550.

Fischhoff, B., & Beyth, R. (1975). I knew it would happen: Remembered probabilities of once—Future things. *Organizational Behavior and Human Performance, 13*(1), 1–16.

Forbes (2013). 5 Surprising Marketing Trends for 2013. https://www.forbes.com/sites/thesba/2013/01/23/5-surprising-marketing-trends-for-2013/. Accessed 01.02.2018.

Fortt, J. (2004). 2004's Top Technology Trends. https://www.forbes.com/2004/01/02/102techtrendspinnacor_ii.html#144fc65511f5. Accessed 01.09.2018.

Fraud, B. (2014). Micro-Services at Blablacar. http://blablatech.com/blog/micro-service-at-blablacar. Accessed 01.02.2018.

Freeman, C. (2000). *The Economics of Industrial Innovation* (Vol. 3). London, UK: Routledge.

Gartner Inc. (2006). *Gartner's 2006 emerging technologies hype cycle highlights key technology themes*. Gartner Inc.

Gartner Inc. (2008). *Gartner highlights 27 technologies in the 2008 hype cycle for emerging technologies*. Gartner Inc.

Gartner Inc. (2009). *Gartner's 2009 hype cycle special report evaluates maturity of 1,650 technologies*. Gartner Inc.

Gartner Inc. (2012). *Gartner's 2012 hype cycle for emerging technologies identifies "tipping point" technologies that will unlock long-awaited technology scenarios*. Gartner Inc.

Gartner Inc. (2013). *Gartner's 2013 hype cycle for emerging technologies maps out evolving relationship between humans and machines*. Gartner Inc.

Garud, R., & Karnøe, P. (2003). Bricolage versus breakthrough: Distributed and embedded Agency in Technology Entrepreneurship. *Research Policy, 32*(2), 277–300.

Garud, R., Jain, S., & Kumaraswamy, A. (2002). Institutional entrepreneurship in the sponsorship of common technological standards: The case of sun Microsystems and Java. *Academy of Management Journal, 45*(1), 196–214.

Garud, R., Gehman, J., & Giuliani, A. P. (2016). Technological exaptation: A narrative approach. *Industrial and Corporate Change, 25*(1), 149–166.

Ghazawneh, A., & Henfridsson, O. (2013). Balancing platform control and external contribution in third-party development: The boundary resources model. *Information Systems Journal, 23*(2), 173–192.

Green, K., McMeekin, A., & Irwin, A. (1994). Technological trajectories and R&D for environmental innovation in Uk firms. *Futures, 26*(10), 1047–1059.

Gremm, C. (2017). Impacts of the German interurban bus market deregulation on regional railway services. In *In Proceedings of the International Conference Series on Competition and Ownership in Land Passenger Transport, Stockholm, Sweden.*

Grimaldi, R., Augustin, K., & Beria, P. (2017). Intercity coach liberalisation. The cases of Germany and Italy. *Transportation Research Procedia, 25*, 474–490.

Haddad, E. (2015). Service-oriented architecture: Scaling the Uber engineering codebase as we grow. https://eng.uber.com/soa/. Accessed 01.11.2017.

Hagiu, A., & Wright, J. (2015). Multi-sided platforms. *International Journal of Industrial Organization, 43*, 162–174.

Hein, A., Schreieck, M., Wiesche, M., & Krcmar, H. (2016). Multiple-Case Analysis on Governance Mechanisms of Multi-Sided Platforms. In *Proceedings of the Multikonferenz Wirtschaftsinformatik*, Ilmenau, Germany.

Hein, A., Böhm, M., & Krcmar, H. (2018a). Tight and Loose Coupling in Evolving Platform Ecosystems: The Cases of Airbnb and Uber. In Abramowicz W., & P. A. (Eds.), Business Information Systems. Bis

2018. Lecture Notes in Business Information Processing (Vol. 320, pp. 295-306). Berlin, Germany: Springer, Cham.

Hein, A., Scheiber, M., Böhm, M., Weking, J., & Krcmar, H. (2018b). Towards a Design Framework for Service Platform Ecosystems. In *Proceedings of the 26th European Conference on Information Systems*, Portsmouth, UK.

Hein, A., Weking, J., Schreieck, M., Wiesche, M., Böhm, M., & Krcmar, H. (2019). Value co-creation practices in business-to-business platform ecosystems. *Electronic Markets*, 1–16. https://doi.org/10.1007/s12525-019-00337-y .

Henfridsson, O., & Yoo, Y. (2013). The liminality of trajectory shifts in institutional entrepreneurship. *Organization Science, 25*(3), 932–950.

Herrmann, W. (2016). Flixbus-Cio Krauss: Der Usp Liegt in Den Algorithmen. https://www.computerwoche.de/a/flixbus-cio-krauss-der-usp-liegt-in-den-algorithmen. Accessed 01.02.2018.

Hicks, J. (1963). *The Theory of Wages* (Vol. 2). London, UK: Macmillan / St. Martin's Press.

von Hippel, E. (1976). The dominant role of users in the scientific instrument innovation process. *Research Policy, 5*(3), 212–239.

Hounshell, D. (1985). *From the American System to Mass Production, 1800–1932: The Development of Manufacturing Technology in the United States (Vol. 4).* Baltimore, MD: Johns Hopkins University Press.

IEEE Connected Vehicles (2016). Toyota Establishes a Mobility Services Platform and Announces Collaboration with a Car-Sharing Company. http://sites.ieee.org/connected-vehicles/2016/10/31/toyota-establishes-mobility-services-platform-announces-collaboration-car-sharing-company/. Accessed 01.03.2018.

Isenson, R. (1968). *Technology in Retrospect and Critical Events in science (project Traces). Illinois Institute of Technology/National Science Foundation*. Chicago.

Jaffe, A. B., & Stavins, R. N. (1995). Dynamic incentives of environmental regulations: The effects of alternative policy instruments on technology diffusion. *Journal of Environmental Economics and Management, 29*(3), 43–63.

Karhu, K., Gustafsson, R., & Lyytinen, K. (2018). Exploiting and defending open digital platforms with boundary resources: Android's five platform forks. *Information Systems Research, 29*(2), 479–497.

Kasman, A., & Duman, Y. S. (2015). Co2 emissions, economic growth, energy consumption, trade and urbanization in new Eu member and candidate countries: A panel data analysis. *Economic Modelling, 44*, 97–103.

Katz, M. L., & Shapiro, C. (1994). Systems competition and network effects. *Journal of Economic Perspectives, 8*(2), 93–115.

Kenney, M., & Zysman, J. (2016). The rise of the platform economy. *Issues in Science and Technology, 32*(3), 61–69.

Kim, D.-J., & Kogut, B. (1996). Technological platforms and diversification. *Organization Science, 7*(3), 283–301.

Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly, 23*(1), 67–94.

Kleinknecht, A., & Verspagen, B. (1990). Demand and innovation: Schmookler re-examined. *Research Policy, 19*(4), 387–394.

Kline, S. J., & Rosenberg, N. (2010). An overview of innovation. In N. Rosenberg (Ed.), *Studies on Science and the Innovation Process: Selected Works of Nathan Rosenberg (pp. 173–203).* Singapore. Singapore: World Scientific Publishing Co. Pte. Ltd.

Kooti, F., Grbovic, M., Aiello, L. M., Djuric, N., Radosavljevic, V., & Lerman, K. (2017). Analyzing Uber's Ride-Sharing Economy. In *Proceedings of the 26th International Conference on World Wide Web Companion, Perth, Australia, 2017* (pp. 574–582).

Kuhn, T. S. (1996). *The Structure of Scientific Revolutions (Vol. 3).* Chicago, IL: The University of Chicago Press.

Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management Review, 24*(4), 691–710.

Lee, C.-P., & Shim, J. P. (2007). An exploratory study of radio frequency identification (Rfid) adoption in the healthcare industry. *European Journal of Information Systems, 16*(6), 712–724.

Lévi-Strauss, C. (1966). *The Savage Mind.* Chicago, IL: University of Chicago Press.

Macmanus, R. (2006). 2006 Web Technology Trends. https://readwrite.com/2006/12/11/2006_web_technology_trends/. Accessed 01.02.2018.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., et al. (2011). Big data: The next frontier for innovation, competition, and productivity. https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation. Accessed 01.01.2018.

McIntyre, D. P., & Srinivasan, A. (2017). Networks, platforms, and strategy: Emerging views and next steps. *Strategic Management Journal, 38*(1), 141–160.

Meacham, J. A. (1983). Wisdom and the Context of Knowledge: Knowing That One Doesn't Know. In D. Kuhn, & A. John (Eds.), *On the Development of Developmental Psychology* (Vol. 8, pp. 111–134). Basel, Switzerland: Karger Publishers.

Messerschmitt, D. G., & Szyperski, C. (2005). *Software Ecosystem: Understanding an Indispensable Technology and Industry* (Vol. 1). Cambridge, MA: MIT Press Ltd.

Metcalfe, B. (2013). Metcalfe's law after 40 years of Ethernet. *Computer, 46*(12), 26–31.

Mowery, D., & Rosenberg, N. (1979). The influence of market demand upon innovation: A critical review of some recent empirical studies. *Research Policy, 8*(2), 102–153.

Munir, K. A., & Phillips, N. (2005). The birth of The'kodak Moment': Institutional entrepreneurship and the adoption of new technologies. *Organization Studies, 26*(11), 1665–1687.

Nappez, F., Blanc, N., & Schwarz, N. (2015). Blablacar tech, behind the scene. http://previous.blablatech.com/blog/BlaBlaTech-behind-the-scene. Accessed 01.02.2018.

Nelson, R. R., & Winter, S. G. (1977). In search of useful theory of innovation. *Research Policy, 6*(1), 36–76.

Nemet, G. F. (2009). Demand-pull, technology-push, and government-led incentives for non-incremental technical change. *Research Policy, 38*(5), 700–709.

O'Reilly, T. (2007). What is web 2.0: Design patterns and business models for the next generation of software. *MPRA Paper*, (7), 4578.

O'Reilly, C. A., III, & Tushman, M. L. (2008). Ambidexterity as a dynamic capability: Resolving the Innovator's dilemma. *Research in Organizational Behavior, 28*, 185–206.

Patton, M. Q. (2014). Qualitative Research & Evaluation Methods: Integrating theory and practice (Vol. 4). Thousand Oaks, CA: SAGE Publications Inc.

Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory. *Research Policy, 13*(6), 343–373.

Pearson, A. W. (1990). Innovation strategy. *Technovation, 10*(3), 185–192.

Perez, S. (2017). App Economy to Grow to $6.3 Trillion in 2021, User Base to Nearly Double to 6.3 Billion. https://techcrunch.com/2017/06/27/app-economy-to-grow-to-6-3-trillion-in-2021-user-base-to-nearly-double-to-6-3-billion/. Accessed 23.01.2018 2018.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives, 9*(4), 97–118.

Posselt, T., & Roth, A. (2017). Microfoundations of organizational competence for Servitization. *Journal of Competences*, *Strategy & Management, 9*, 85–107.

Raasch, C., Herstatt, C., & Lock, P. (2008). The dynamics of user innovation: Drivers and impediments of innovation activities. *International Journal of Innovation Management, 12*(3), 377–398.

Rajesh, R. (2016). *Spring Microservices*. Birmingham, UK: Packt Publishing Ltd.

Ranganathan, C., Seo, D., & Babad, Y. (2006). Switching behavior of Mobile users: Do Users' relational investments and demographics matter? *European Journal of Information Systems, 15*(3), 269–276.

Reinhold, E. (2016). Rewriting Uber engineering: The opportunities microservices provide. https://eng.uber.com/building-tincup/. Accessed 01.02.2018.

Rennings, K. (2000). Redefining innovation—Eco-innovation research and the contribution from ecological economics. *Ecological Economics,* 32(2), 319–332.

de Reuver, M., Sørensen, C., & Basole, R. C. (2017). The digital platform: A research agenda. *Journal of Information Technology, 33*(2), 124–135.

Rogers, E. M. (2003). *Diffusion of innovations* (Vol. 5). New York, NY: The Free Press.

Rose, I., & Wheeler, M. (2017). How Blablacar created a global transport network. https://www.bbc.com/news/business-38597504. Accessed 01.02.2018.

Rosenberg, N. (1969). The direction of technological change: Inducement mechanisms and focusing devices. *Economic Development and Cultural Change, 18*(1, Part 1), 1–24.

Rosenberg, N. (1976). *Perspectives on Technology.* Cambridge, UK: Cambridge University Press.

Saad, C. (2016). Introducing Uber trip experiences. https://www.uber.com/newsroom/trip-experiences-api/. Accessed 01.02.2018.

Sanchez, R., & Mahoney, J. T. (1996). Modularity, flexibility, and knowledge Management in Product and Organization Design. *Strategic Management Journal, 17*(S2), 63–76.

Schlesiger, C. (2016). Flixbus: Der Unheimliche Siegeszug Des Start-Ups. https://www.wiwo.de/unternehmen/dienstleister/flixbus-der-unheimliche-siegeszug-des-start-ups/14680498.html. Accessed 01.02.2018.

Schmookler, J. (1966). *Invention and Economic Growth.* Cambridge, MA: Harvard University Press.

Schreieck, M., Hein, A., Wiesche, M., & Krcmar, H. (2018). The Challenge of Governing Digital Platform Ecosystems. In C. Linnhoff-Popien, R. Schneider, & M. Zaddach (Eds.), *Digital Marketplaces Unleashed* (pp. 527-538). Heidelberg, Germany: Springer.

Sherwin, C. W., & Isenson, R. S. (1967). Project hindsight. *Science, 156*(3782), 1571–1577.

Singh, R., Mathiassen, L., & Mishra, A. (2015). Organizational path constitution in technological innovation: Evidence from rural telehealth. *MIS Quarterly, 39*(3), 653–665.

Sirmon, D. G., Hitt, M. A., Ireland, R. D., & Gilbert, B. A. (2011). Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects. *Journal of Management, 37*(5), 1390–1412.

Strauss, A., & Corbin, J. M. (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques* (Vol. 2). Thousand Oaks, CA: SAGE Publications Inc.

Sutter, J. (2009). The top 10 tech trends of 2009. http://edition.cnn.com/2009/TECH/12/22/top.tech.trends.2009/index.html. Accessed 01.02.2018.

Thornton, P. H., & Ocasio, W. (2008). Institutional Logics. In R. Greenwood, C. Oliver, & T. Lawrence (Eds.), *The Sage Handbook of Organizational Institutionalism* (pp. 99–128). London, UK: Sage Publications Ltd.

Tiwana, A., Konsynski, B., & Bush, A. A. (2010). Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. *Information Systems Research, 21*(4), 675–687.

Ulanoff, L. (2012). 11 Big Tech Trends You'll See in 2013. https://mashable.com/2012/12/06/tech-trends-2013. Accessed 01.02.2018.

Vandermerwe, S., & Rada, J. (1988). Servitization of business: Adding value by adding services. *European Management Journal, 6*(4), 314–324.

Vernon, R. (1966). International investment and international trade in the product cycle. *The Quarterly Journal of Economics, 80*(2), 190–207.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of Sensemaking. *Organization Science, 16*(4), 409–421.

Willing, C., Brandt, T., & Neumann, D. (2017). Electronic mobility market platforms–a review of the current state and applications of business analytics. *Electronic Markets, 27*(3), 267–282.

Wright, A. L., & Zammuto, R. F. (2013). Wielding the willow: Processes of institutional change in English County cricket. *Academy of Management Journal, 56*(1), 308–330.

Yin, R. K. (2017). *Case Study Research and Applications: Design and Methods* (Vol. 6). Thousand Oaks, CA: Sage Publications.

Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for innovation in the digitized world. *Organization Science, 23*(5), 1398–1408.

Zhu, K., Kraemer, K. L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: A technology diffusion perspective on E-business. *Management Science, 52*(10), 1557–1576.

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NAVIGATING ROLE CHANGES DURING THE TRANSITION TOWARD SERVICE PLATFORM ECOSYSTEMS

Research in Progress

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Abstract

In recent years, software platforms and their ecosystems have transformed entire industries, created new ones, and eradicated others. To remain competitive, traditional firms need to adapt to those changing conditions. However, there has only been sparse research on an ecosystem level about how firms with a Goods-Dominant logic that fosters value-in-exchange based on sequential value-add in dyadic business networks transition toward a Service-Dominant ecosystem that builds on value-in-use by integrating multiple actors into value co-creating activities. This study draws on a single in-depth case study within the context of a manufacturing company that implemented a software platform to facilitate the transition of roles from a business network toward a service ecosystem. We develop a preliminary process model that builds on the concept of liminality—being between an old and a new role—and role changes to illustrate how firms steer this transition. The results indicate that the manufacturer institutionalizes pre-defined roles for partners by incentivizing the adoption of the software platform. However, existing partners do not necessarily internalize pre-defined roles as expected, but also self-explore new roles based on the affordances of the software platform. This study provides first results on role transitions in emerging ecosystems via control and exploration.

Keywords: software platform, service ecosystems, value co-creation, role transformation, liminality.

1 Introduction

More and more companies adopt software platforms that enable them to complement the value-creation process of internal production with value co-creation activities within an ecosystem of actors (Evans and Gawer, 2016; Hein et al., 2019b). As an example, LEGO launched an engagement platform, where both employees and customers can actively engage in the value-creation process by designing new construction kits (Schlagwein and Bjørn-Andersen, 2014). In this case, LEGO complemented the internal production of plastic bricks with a software platform that utilizes ideas from an ecosystem of customers and employees. Through the software platform and services, such as virtual building tools, LEGO integrated active customer participation in their value-creation process.

In the light of platformization and value co-creation (Benlian et al.), an increasing number of traditional firms in the business-to-business sector see the need to respond to this development. Traditional firms adhere to a Goods-Dominant (G-D) logic that includes dyadic relationships with partners to achieve economies of scope and scale by providing value in exchange for goods, also referred to as value-in-exchange (Vargo and Lusch, 2008). In contrast, Service-Dominant (S-D) ecosystems build on value-in-use, where roles of producer and consumer are not distinct but fully integrated into the value co-creation process, leading to broader coverage of the value chain and a higher variety of complements (Lusch and Nambisan, 2015; Vargo and Lusch, 2004; Boudreau, 2012). Retaking the engagement platform of LEGO, the company managed to transition from a production company to also being a service ecosystem that utilizes the generativity of an ecosystem of customers and partners (Andersen and W Ross, 2016; Hein et al., 2019c). To cope with software platform-enhanced companies, manufacturing firms have begun to transition their business network from a G-D logic business toward an S-D ecosystem (Hein et al., 2019b).

The challenges faced, and methods used by firms who transition from business networks to service platform ecosystems are little understood (de Reuver et al., 2018). To notable exceptions that have focused solely on the firm level (Sebastian et al., 2017), sparse research has been done at the ecosystem level to reveal how firms transform their existing business network toward a service platform ecosystem. S-D ecosystems go far beyond the linear vision of dyadic business networks and sequential value add but call for a shift to fully integrate partners into value co-creating activities. When transitioning, firms must alter established roles in their business network, where roles are defined as positions in a social structure (Ashforth, 2000) to engage them in value-creating activities. An example is LEGO that used the engagement platform to supplement the role of customers as beneficiaries toward a more engaging role of co-innovators (Schlagwein and Bjørn-Andersen, 2014). As an increasing number of traditional G-D firms becomes aware of the need to utilize software platforms (Hein et al., 2019b), it becomes vital to understand how they initiate and facilitate the adoption of new roles in the emerging ecosystem. When taking the ecosystem level, it is not only the role of partners that need to change but also the role of the traditional company itself (Michel et al., 2008; Makkonen et al., 2019) that changes from the manufacturer also to be a service provider. In sum, the simultaneous transition of firms and their business network toward a service ecosystem that fully integrates partners into value-creating processes represents a growing challenge for companies.

This study is the first effort to shed light on the process of changing roles in an emerging S-D ecosystem to provide practitioners with guidance and scholars with a better understanding. Changing roles can be the transition of a firm that identifies as a manufacturer toward also being a service provider that integrates partners and customers into value-creating activities. Besides, changing roles can involve partners and consumers that actively take part in value co-creation activities. From behavioral research, role changes occur in a period of liminality where individuals feel sentiments of being *"in-between"* their old role and having clarity on what their new role will be (Ibarra and Obodaru, 2016; Ashforth, 2000). When it comes to facilitating role changes, a change can either be guided and supported (Ibarra and Obodaru, 2016) or self-initiated based on changing conditions (Ashforth, 2000). Considering both approaches, changes in roles can be highly institutionalized, self-guided, or somewhere in between (Ibarra and Obodaru, 2016; Noble and Walker, 1997). However, taking this literature, it is not clear how firms and partners in dyadic business networks explore and eventually commit to role changes that fully integrate all parties into value-creating activities. Hence, we examine *how firms initiate role changes based on the adoption of a software platform and how those changes unfold while transitioning from a G-D business network toward an S-D ecosystem.*

We draw on a single in-depth case study (Yin, 2017) within the context of a manufacturer that was adopting a service platform by integrating existing partners into value-creating activities. We examined the ecosystem as a level of analysis by interviewing both the platform owner—formerly a sole heating device manufacturer—and six partners comprising installers. By examining the tensions and role conflicts surrounding the previous and new roles, the transformation represents a significant change of life (Ibarra and Obodaru, 2016), requiring a liminal period of transition (Ladge et al., 2012; Noble and Walker, 1997). Embedded in a broader research endeavor, we develop a preliminary process model (Eisenhardt, 1989) that illustrates how platform owners guide the role transition of partners and their business toward a service-platform ecosystem. The process model demonstrates that the platform owner institutionalizes role transitions using a multi-actor narrative while providing a legitimate narrative that is also flexible to allow partners to explore new roles in a self-guided fashion.

2 Theoretical Foundations

This study builds on the concept of liminality (Turner, 1969) during the transformation of firms from a G-D traditional manufacturer to an S-D platform ecosystem. Traditional manufacturers rely on economies of scope by managing firm–customer dyads in sequential processes of adding value within the confines of their company. In contrast, service ecosystems follow an approach of actor engagement by co-creating value within an actor-to-actor (A2A) ecosystem that fully integrates a variety of actors

(Tiwana, 2015; Lusch and Nambisan, 2015). The transformation from a dyadic to a multi-level actor system (Brodie et al., 2019) reflects a shift from a familiar past of clearly defined roles toward an unfamiliar future where firms need to engage ecosystem actors to take new roles.

2.1 The transition from G-D Business Networks to S-D Ecosystems

In recent years, firms from various industries have undergone the transition from G-D business networks to S-D ecosystems to gain competitive advantage (Verma et al., 2012; Hein et al., 2019b). G-D logic refers to firms that produce tangible products providing value-in-exchange using the specialization of labor. Those firms retain their production process within the confines of a firm to increase efficiency and throughput as a primary paradigm. One example is a supply chain, where the focal firm uses its business network of suppliers to obtain production material. Firms adhering to this logic typically engage in dyadic relationships based on mutual commitments within the context of business networks (Anderson et al., 1994; Holm et al., 1999). To foster economies of scope and scale, firms optimize production processes by separating the control of actors in sequential, value-adding process steps (Vargo and Lusch, 2008; Vargo and Lusch, 2004). An example is an assembly line where a manufacturing company assembles different parts of various partners to an end product. To foster partner engagement, a firm must establish opportunities through defined tasks while strengthening partners' abilities and motivation to do the work (Bowen and Jones, 1986; Steers and Porter, 1974; Vroom, 1964).

In contrast, firms having an S-D logic rely on an A2A network, where actors apply specialized competencies to benefit other actors with value-in-use. Those A2A networks can be seen as ecosystems-as-a-structure comprising an "*alignment structure [of a] multilateral set of partners that need to interact in order for a focal-value proposition to materialize.*" (Adner, 2017: 42). The dominant means of interaction are software-based service platforms that represent an extensible codebase that provides core functionality to enable co-creation of value in an ecosystem (Tiwana et al., 2010; de Reuver et al., 2018). By providing technical means upon which actors in the A2A network can co-create value, software platforms unleash generativity via increased resource liquefaction and resource density (Lusch and Nambisan, 2015; Vargo and Lusch, 2008; Hein et al., 2019d). Additionally, the generativity of a service ecosystem results from a variety of partners, each contributing to spillover effects that increase the adoption of new customers (Boudreau, 2012; Parker et al., 2017). Consequently, the S-D logic does not view actors as dyadic relationships but as a system of multiple actors that co-create value (Lusch and Nambisan, 2015). Depending on the relationships in the A2A ecosystem, actors can perform multiple roles when engaging in value co-creation (Moeller et al., 2013). Consequently, theoretical concepts shifted from customer engagement toward actor engagement (Brodie et al., 2019). Actor engagement emerges within dynamic and iterative relationships in the ecosystem, where connectedness is an essential property and influenced by shared practices (Brodie et al., 2019).

However, little is known about how firms can actively steer role transitions from G-D to S-D logic (Verma et al., 2012; Makkonen et al., 2019), and how role changes unfold in those settings. Verma et al. (2012), for example, provide empirical evidence that both logics differ regarding actor engagement and value propositions. Furthermore, mechanisms such as framing relationships in a new way, inducing a collaborative strategy, and establishing targets for joint activities are essential mechanisms to steer the transition from G-D to S-D logic (Makkonen et al., 2019). Both studies delimitate from the literature on servitization and service transition strategies (Fang et al., 2008; Oliva and Kallenberg, 2003) by focusing on the concept of value-in-use. The concept results from joint co-creation in an ecosystem instead of referring to services provisioned as offerings. Whereas the latter study provides first insights on mechanisms that help to steer role transitions, it remains to be understood how the adoption of a software platform initiates role changes and how those changes unfold over time.

2.2 Liminality

A particularly useful concept to describe role transitions is the notion of liminality, which was developed in the field of anthropology to delimitate the stages of rituals between separation and reincorporation (Van Gennep, 2013). It addresses the experiences of individuals or institutions that are between two stages or at the limits of existing structures (Turner, 1969; Henfridsson and Yoo, 2013). Heightened states of reflexivity characterize liminality, wherein individuals or institutions *"are allowed to think about how they think"* (Turner, 1987: 102). For individuals, scholars predominantly have used the concept of liminality to describe the transition of roles via a "*process of disengaging from a central, behaviorally anchored identity while exploring new possible selves, and eventually, integrating an alternative identity."* (Ibarra, 1992: 3). An example of a liminal transition in an institutional context is the move of companies from one technological trajectory to another. In this regard, companies follow three action formation mechanisms that help them to disassociate from the old trajectory, imagine potentials of new trajectories, and exploration of a new trajectory after experimenting with alternative options (Henfridsson and Yoo, 2013).

Liminal transitions can be structured into three phases: separation, transition, and reincorporation (Conroy and O'Leary-Kelly, 2014; Van Gennep, 2013). The separation phase can be initiated by triggers such as events (Ashforth, 2000), traumata (Maitlis, 2009), and work changes (Pratt et al., 2006). During this phase, entities disassociate from their former selves to construct new identities (Ashforth, 2000; Maitlis, 2009). Next, the transition phase is guided by the process of making sense of identity, during which entities create a narrative that needs to be tested and validated (Ashforth, 2000; Ashforth et al., 2008). A key challenge is to create an *"ex-role"* (Ashforth, 2000), a former role in which one does no longer wants to reside with a feasible narrative about the self (Ibarra and Barbulescu, 2010). After finding a suitable narrative, the reincorporation phase conceptualizes a desirable end state where entities comply with their new identities (Ibarra and Barbulescu, 2010; Conroy and O'Leary-Kelly, 2014). Liminal periods can be either temporal, as in the case of changing roles (Ashforth, 2000), or permanent, as in the case of consultants who always operate at the boundaries of different firms and identify with neither (Czarniawska and Mazza, 2003).

External parties can guide liminal transitions through institutionalization, such as elders in a tribe, or they can be self-guided through exploration and commitment (Ibarra and Obodaru, 2016; Turner, 1969). An example in the institutional context is the adoption of a new technological trajectory (Henfridsson and Yoo, 2013) or the internationalization of new ventures (Prashantham and Floyd, 2019). The degree of institutionalization is continuous and is defined according to the bracketed time or duration of the period, the social guidance or support from communities, the legitimate narrative or culturally extant guidance, the predetermined progressive outcome or whether the new role has been pre-defined (Ibarra and Obodaru, 2016). Depending on the degree of institutionalization provided, institutions or individuals can have more or less freedom to explore new roles. Apart from the degree of institutionalization, liminal periods can be sequential, as in the case of role changes within the confines of a firm (Ibarra and Barbulescu, 2010), or cross-domain, such as with expectant mothers, where pregnancy changes work and non-work roles (Ladge et al., 2012).

We argue that the liminal period of role transitions from a dyadic G-D manufacturer to a multi-actor S-D service platform represents a unique context that can inform the theory of role changes (Ibarra and Obodaru, 2016) in service ecosystems (Lusch and Nambisan, 2015). Retaking LEGO, the transition toward a software platform ecosystem was triggered by the need to avert bankruptcy (Andersen and W Ross, 2016), hence, representing a significant change of life that triggered the transformation. During this transition, LEGO needed to manage not only a dyadic perspective of liminality, as shown in a recent study on outsourcing and how bonding between a company and a service provider can be increased (Nicholson et al., 2017). In contrast, LEGO needed to transition and integrate multiple actors at the same time to come up with a new value proposition. This interdependence between liminal role transitions is, to the best of our knowledge, a unique context that accounts for the multi-actor characteristics of S-D service platform ecosystems. Besides, the context of software platforms complements research on creative agency and liminality in knowledge-sharing communities, where the knowledge-sharing provider increases the creative agency of internal workers (Swan et al., 2016). In the context of software platform ecosystems, value creation does not take place within the organizational context as in the research of Swan et al. (2016) but through boundary resources such as APIs and SDKs

(Ghazawneh and Henfridsson, 2013; Hein et al., 2019d) that integrate autonomous actors (Hein et al., 2019a). Hence, the software platform is a critical means of integrating ecosystem partners guiding the liminal transition of roles and the creative agency of partners.

3 Methodology

This article follows a single case study (Yin, 2017; Siggelkow, 2007; Eisenhardt and Graebner, 2007) based on a phenomenon suitable for illustrating the contemporary challenge of how firms initiate role changes based on the adoption of a software platform ecosystem (Sebastian et al., 2017; de Reuver et al., 2018). Shaped by role conflicts and internal challenges during a liminal period, this case offers unusual access to this significant phenomenon (Eisenhardt and Graebner, 2007). The liminal period includes the transformation of Alpha, an incumbent in the European heating-systems industry, toward a service platform ecosystem to cope with new competition. During the transformation process, Alpha introduced a software platform that changed the interaction between long-lasting and well-established relationships with installers toward a loosely coupled structure where Alpha integrates installers in value-creating activities. This shift from dyadic relationships toward a multi-actor ecosystem also incorporated customers as a new data source. During this liminal period, Alpha reorganized social ties while offering new opportunities and motivations, as well as requiring new abilities to foster value co-creation. This phenomenon provides an extreme context for theory building because the interactions and role transitions are only visible during the liminal period (Eisenhardt, 1989; Pratt et al., 2006).

We conducted the explorative case study from mid-2017 to the end of 2018. It was structured along the liminal period of a transitional phase to observe the ambiguity of roles and former relationships at the genesis of a service ecosystem. The two main actors in the heating–manufacturing ecosystem were the heating-system provider, Alpha, which transformed into a software-platform owner, and the partners comprised of installers. The period of liminality was evident because both actors endured social alienation and withdrawal from extant business structures (Shomaker, 1989). Additionally, both actors transitioned from an ex-role to take on a new identity via the process of sensemaking. The liminal period started with the separation phase in early 2018 when Alpha recognized the entrance of new competition. As a reaction, Alpha implemented measures to transition to a service-platform ecosystem by changing long-established roles in the form of social structures and underlying value propositions. However, the new software platform directly integrated customers to mine data, which Alpha then used to co-create value-adding services with partners. Hence, this case provides us with the unique opportunity to derive initial insights on how firms both institutionalize the transition of roles and grant partners the freedom to explore new roles. During this period of liminality, the data are grounded in a context-dependent environment (Siggelkow, 2007; Benbasat et al., 1987).

3.1 Data Sampling and Data Collection

During this explorative study, we conducted 13 semi-structured interviews ranging 25–60 min within the context of a heating–manufacturing ecosystem (*Table 1*). We recorded, transcribed, anonymized, and sent back transcripts to the interviewees to verify the data and to get additional information. During the on-site interviews, we followed the guidelines of flexibility, specificity, and non-directionality to increase data quality (Flick, 2018). Because this study was part of an ongoing research endeavor, we gathered more data to understand how roles changed over time.

The interviews were grouped into ecosystem actors, represented by the incumbent Alpha, and partners, represented by independent institutions that sell, install, and maintain heating systems from Alpha and others. We used semi-structured interviews because they presented the opportunity to discover new concepts within the data: those that more-rigid collection methods would miss (Gioia et al., 2013). Regarding the sampling strategy, we located a representative group (Marshall, 1996) within Alpha that was intimately involved in the process of transformation to a software platform and who had contact with partners before the transformation started. For the sampling of the partners, we saw that they had maintained a long-established dyadic customer-vendor relationship with Alpha. Thus, we noted the effects of structural changes. All partners were independent firms having 2–20 employees.

Table 1. Description of data sources

<table>
<tr><th>Actor</th><th>Company</th><th>Interviewee</th><th>Actor</th><th>Company</th><th>Interviewee</th></tr>
<tr><td rowspan="7">Platform Owner</td><td rowspan="7">Alpha</td><td>Customer Support I</td><td rowspan="7">Partner</td><td>Beta</td><td>Managing Director</td></tr>
<tr><td>Customer Support II</td><td>Gamma</td><td>Managing Director</td></tr>
<tr><td>Head of Sales</td><td>Delta</td><td>Managing Director</td></tr>
<tr><td>Head of Strategy and Marketing</td><td>Epsilon</td><td>Managing Director</td></tr>
<tr><td>Managing Director</td><td>Zeta</td><td>Managing Director</td></tr>
<tr><td>Project Manager Digitalisation</td><td rowspan="2">Eta</td><td rowspan="2">Managing Director</td></tr>
<tr><td>Senior Project Manager IT</td></tr>
<tr><td colspan="6">Archival data, reports, and observations: Overall, we analyzed 21 sources, such as technical and marketing reports, websites, and on-site observations. We also visited a heating-engineering trade show to observe the reactions of installers to the Alpha exhibition booth.</td></tr>
</table>

The 16-question interview guideline was divided into three main sections. The first section was designed to provide insight into the interactions between Alpha and its partners. We paid particular attention to the different perspectives of the interviewees regarding their new roles and their ex-roles and to how those roles manifested in transactions with other actors (Alpha and partner) or customers using the heating system. With this approach, we derived process data (Langley, 1999) about the ex-roles, the liminal period, and the transition toward the new roles. The second section dealt with value creation before and during the transformation to a service ecosystem. Hence, the first two sections described the perceived process of transitioning from an ex-role and the value-creation during this period to a new role in a service ecosystem. The third section included design aspects of Alpha and the measures they undertook to institutionalize their transformation. For the partners, this section dealt with the perception of those actions. Additionally, we updated the questionnaire after interviews, revealing new insights.

Apart from semi-structured interviews as the primary data source, we triangulated the data (Klein and Myers, 1999) using direct observations and archival data retrieved from interviewees and internet-based research. During the survey, we conducted interviews at the Alpha worksite several times. We reflected upon preliminary results with employees of Alpha to gain assurance that the information about actions and roles was accurate. To triangulate the data, we reviewed technical reports on the software-platform designs, marketing reports, and company websites of Alpha and their partners.

3.2 Data Analysis

We used the software MAXQDA (release 18) to manage our data centrally. While collecting data, we engaged in constant comparison (Siggelkow, 2007) between prior and new case-study data, and we compared data from the literature. We accomplished this using an iterative approach of moving back and forth between coded data and existing theory. Furthermore, we applied the coding process of grounded theory (Glaser and Strauss, 1967). We started with the open coding of first-order constructs, followed by axial coding to establish relationships with the aggregation of themes in the process of selective coding. Last, we documented emergent topics and observations via the process of memoing.

Starting with open coding (Gioia et al., 2013; Glaser and Strauss, 1967), we used the language of interviewees to establish first-order codes. During this phase, we went back and forth between the data and literature on service ecosystems and liminality to triangulate between codes and theory (Gioia et al., 2013). Next, we explored relationships among the 147 first-order codes to categorize them into 18 second-order themes. Conceptual themes clarified as changing opportunities, motivation, and abilities from introducing a software platform. Aggregated themes highlighted the process of role changes in service ecosystems based on institutionalizing mechanisms that trigger the exploration and internalization of new roles.

4 Preliminary Results and Discussion

In early 2018, Alpha designed and implemented a software platform. The Head of Strategy and Marketing and the Senior IT Project Manager responsible for this transformation decided that the first step would entail the creation of an operational backbone, where all relevant data could be accessed from one platform. This technological platform was the basis for creating new business models and was referred to as the most important strategic decision in decades. In sum, the introduction of a platform was the *"flagship project that needed to convince Alpha and its partner network."* (Alpha Head of Strategy and Marketing).

After launching the software platform, Alpha was challenged to alter its role, including its interface with customers and installers. The reason for changing relationships was likely related to the new value proposition of being also a service provider rather than a sole manufacturer. The Alpha Managing Director emphasized: "*it is [Alpha's] main goal to create value by collecting and managing data with this platform."* As a consequence of this new value proposition, Alpha needed to change well-established relationships with installers. In particular, it had to transition from interacting with installers as a vendor selling its products to customers to a partnership that provides value-added services. By introducing their platform, Alpha changed their buyer-seller dyadic interaction to a multi-actor relationship that co-creates value based on new services. To motivate this adoption, Alpha further introduced incentives, such as monetary benefits, via bonus points, and a loyalty program that rewards customers with an extended warranty period. During this time, the role of Alpha shifted from being a vendor of heating systems to also being an orchestrator that facilitated interactions between customers and installers in the ecosystem. The Head of Sales explained that *"through the new services such as remote maintenance and the smart scan application, we were able to connect installers and consumers in new ways."* To trigger the internalization of new roles, Alpha incorporated different perspectives of ecosystem partners where services can be exchanged between all parties to create a compelling narrative that fits all actors. One way to enable installers to use the application was the use of sales representatives that helped, trained, and motivated installers to adopt the new services. During this time, Alpha also explored new ways of how the software platform could be used that they did not think about before, such as introducing matchmaking between installers and customers.

In turn, installers faced the challenge of altering their roles, including those of their relationship to Alpha and customers. Installers were no longer strictly independent institutions; they became more connected with Alpha. Installers used to sell and maintain heating devices from Alpha per customers' wishes. With the software platform, the installer and customer could access additional services such as remote maintenance and temperature control that increased the connectedness among the three parties. The Managing Director of Beta emphasizes that "*with the [software] platform, we can offer an 'all-round-carefree package' for our customers. [We] are now able to interact with our customers closely."* Consequently, the internal role of partners shifted from physical installers to hybrids that also provided services.

The initial results indicate how software platforms can create new opportunities that trigger the transformation of dyadic relationships in business networks toward a service ecosystem by enabling value-creating interactions in a period of liminality (see Figure 1).

The preliminary data shows that Alpha institutionalized the adoption of new roles through incentives, new services, training and guidance, boundary spanning, and developing a multi-actor narrative. Each of those practices triggered the process of external role negotiation, as shown in the example of new services such as remote maintenance, that allowed installers to offer a care-free package for customers, effectively adding the role of a service provider. Besides, the case illustrates that institutionalization could trigger the process of external self-exploration, where installers needed to make sense of new services based on their capabilities to explore new roles. Depending on the practices, the outcome can be increased motivation to trigger the role negotiation through incentives, new opportunities to self-explore and internalize a new role via new services, develop new capabilities by training and guidance, increase connectedness via boundary-spanning activities through sales representatives and control the process of self-exploration and role negotiation by providing a multi-actor narrative.

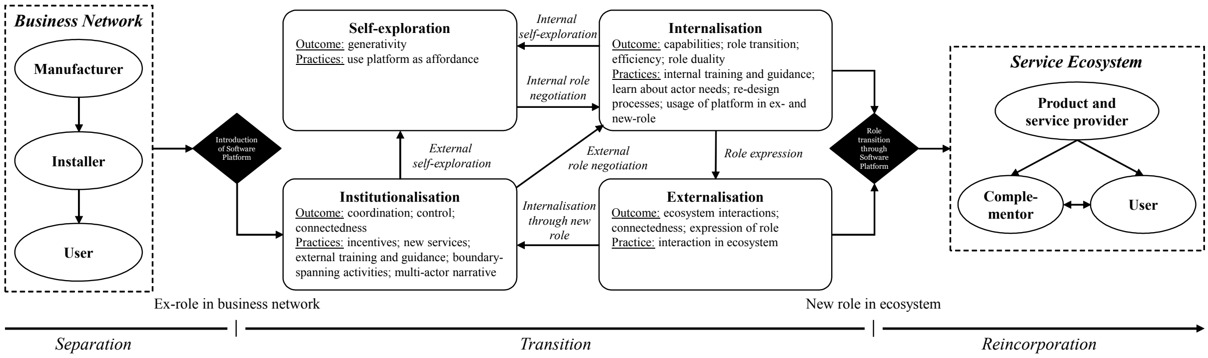

Figure 1. The process model of changing roles from business network toward service ecosystem

Both Alpha and the installers went through the process of self-exploration by actualizing affordances of the software platform dependent on internal capabilities. After identifying new opportunities, the actors negotiated the new role in the process of internalization. An example is Alpha that used the possibility to orchestrate demand between customers that needed to find installers and installers that could use the platform to find customers by introducing matchmaking services.

The process of internalization includes practices such as internal training and guidance, the re-design of internal processes, and the usage of the platform during liminality in their ex- and new role. Depending on the practices, internalization can either trigger internal self-exploration or role expression. An example of internal self-exploration are installers that internalized the use of the software platform to not only transition to a service provider but also found creative new ways of using the platform to provide customers with an all-round care-free package. An example of role expression is the shift toward a dual role, where Alpha developed new capabilities through training for their new role as a service provider. In addition, Alpha increased the efficiency of its former role as a manufacturer by optimizing internal sales and production processes. By doing so, Alpha expressed their new role and fostered interactions that increased the connectedness in the ecosystem. In turn, the new role triggered new institutionalizing practices, where installers could use the platform to interact with customers.

The concept of liminality provides valuable insights on the duration, legitimation, guidance, and outcome (Ibarra and Obodaru, 2016) of role changes from G-D business networks to S-D ecosystems. The preliminary results indicate that role transitions can have interdependent effects. For example, the platform owner became aware that some installers actualize affordances of the platform to provide care-free-packages for customers. The new services then triggered the self-exploration of the platform owner to internalize a new role as matchmaker, where installers with those packages can be matched with customers. The legitimation for those interdependencies is a multi-actor narrative, where the software-platform acts as means of interaction to integrate actors in value co-creation activities. In addition, we found two mechanisms to steer role transitions based on the affordance of the software platform: institutionalization and self-exploration. Last, the outcome of the liminal period is increased generativity that results from more diverse ecosystem roles, the degree of self-exploration, connectedness through the multi-actor narrative, the software platform as new means of interaction, and role duality as both Alpha and installers adopted an additional permanent role as a service provider.

In sum, this study provides first insights into role changes from G-D business networks to S-D service ecosystems. As this study is part of an ongoing research effort, we will continue the longitudinal study in the context of Alpha to refine existing concepts and to see how Alpha can keep actors in the self-exploration phase to increase the variety of roles adopted and consequently the generativity of the ecosystem. In addition, we aim to explore if too many roles adopted can cause tensions during the transition. More sophisticated results provide insights on how firms can institutionalize role changes by governing control and flexibility to increase the generativity in existing and emerging ecosystems.

References

Adner, R. (2017). "Ecosystem as structure: an actionable construct for strategy." *Journal of Management* 43 (1), 39-58.

Andersen, P. and J. W Ross. (2016). "Transforming the LEGO Group for the Digital Economy." Proceedings of the International Conference On Information. Dublin, Ireland.

Anderson, J. C., H. Håkansson and J. Johanson (1994). "Dyadic business relationships within a business network context." *Journal of Marketing* 58 (4), 1-15.

Ashforth, B. (2000). *Role transitions in organizational life: An identity-based perspective.* Mahawah, NJ: Routledge.

Ashforth, B., S. H. Harrison and K. G. Corley (2008). "Identification in organizations: An examination of four fundamental questions." *Journal of Management* 34 (3), 325-374.

Benbasat, I., D. K. Goldstein and M. Mead (1987). "The case research strategy in studies of information systems." *MIS Quarterly* 11 (3), 369-386.

Benlian, A., W. J. Kettinger, A. Sunyaev and T. J. Winkler "The transformative value of cloud computing: a decoupling, platformization, and recombination theoretical framework." *Journal of Management Information Systems* 35 (3), 719-739.

Boudreau, K. J. (2012). "Let a thousand flowers bloom? An early look at large numbers of software app developers and patterns of innovation." *Organization Science* 23 (5), 1409-1427.

Bowen, D. E. and G. R. Jones (1986). "Transaction cost analysis of service organization-customer exchange." *Academy of Management Review* 11 (2), 428-441.

Brodie, R. J., J. A. Fehrer, E. Jaakkola and J. Conduit (2019). "Actor engagement in networks: Defining the conceptual domain." *Journal of Service Research* 22 (2), 173-188.

Conroy, S. A. and A. M. O'Leary-Kelly (2014). "Letting go and moving on: Work-related identity loss and recovery." *Academy of Management Review* 39 (1), 67-87.

Czarniawska, B. and C. Mazza (2003). "Consulting as a liminal space." *Human Relations* 56 (3), 267-290.

de Reuver, M., C. Sørensen and R. C. Basole (2018). "The digital platform: a research agenda." *Journal of Information Technology* 33 (2), 124-135.

Eisenhardt, K. M. (1989). "Building theories from case study research." *Academy of Management Review* 14 (4), 532-550.

Eisenhardt, K. M. and M. E. Graebner (2007). "Theory building from cases: Opportunities and challenges." *Academy of Management Journal* 50 (1), 25-32.

Evans, P. C. and A. Gawer (2016). The rise of the platform enterprise: a global survey. *The Emerging Platform Economy Series.* New York, NY: The Emerging Platform Economy Series.

Fang, E., R. W. Palmatier and J.-B. E. Steenkamp (2008). "Effect of service transition strategies on firm value." *Journal of marketing* 72 (5), 1-14.

Flick, U. (2018). *An introduction to qualitative research.* London, UK: Sage Publications Ltd.

Ghazawneh, A. and O. Henfridsson (2013). "Balancing platform control and external contribution in third-party development: the boundary resources model." *Information Systems Journal* 23 (2), 173-192.

Gioia, D. A., K. G. Corley and A. L. Hamilton (2013). "Seeking qualitative rigor in inductive research: Notes on the Gioia methodology." *Organizational Research Methods* 16 (1), 15-31.

Glaser, B. G. and A. L. Strauss (1967). *Discovery of grounded theory: Strategies for qualitative research.* Chicago, IL: Aldine Transaction.

Hein, A., M. Schreieck, T. Riasanow, D. S. Setzke, M. Wiesche, M. Böhm and H. Krcmar (2019a). "Digital platform ecosystems." *Electronic Markets* (In print), 1-12.

Hein, A., M. Schreieck, M. Wiesche, M. Böhm and H. Krcmar (2019b). "The emergence of native multi-sided platforms and their influence on incumbents." *Electronic Markets* 29 (4), 631-647.

Hein, A., D. Soto Setzke, S. Hermes and J. Weking. (2019c). "The Influence of Digital Affordances and Generativity on Digital Platform Leadership." Proceedings of the International Conference on Information Systems. Munich, Germany.

Hein, A., J. Weking, M. Schreieck, M. Wiesche, M. Böhm and H. Krcmar (2019d). "Value co-creation practices in business-to-business platform ecosystems." *Electronic Markets* 29 (3), 503-518.

Henfridsson, O. and Y. Yoo (2013). "The liminality of trajectory shifts in institutional entrepreneurship." *Organization Science* 25 (3), 932-950.

Holm, D. B., K. Eriksson and J. Johanson (1999). "Creating value through mutual commitment to business network relationships." *Strategic Management Journal* 20 (5), 467-486.

Ibarra, H. (1992). "Homophily and differential returns: Sex differences in network structure and access in an advertising firm." *Administrative Science Quarterly* 37 (3), 422-447.

Ibarra, H. and R. Barbulescu (2010). "Identity as narrative: Prevalence, effectiveness, and consequences of narrative identity work in macro work role transitions." *Academy of Management Review* 35 (1), 135-154.

Ibarra, H. and O. Obodaru (2016). "Betwixt and between identities: Liminal experience in contemporary careers." *Research in Organizational Behavior* 36, 47-64.

Klein, H. K. and M. D. Myers (1999). "A set of principles for conducting and evaluating interpretive field studies in information systems." *MIS Quarterly* 23 (1), 67-94.

Ladge, J. J., J. A. Clair and D. Greenberg (2012). "Cross-domain identity transition during liminal periods: Constructing multiple selves as professional and mother during pregnancy." *Academy of Management Journal* 55 (6), 1449-1471.

Langley, A. (1999). "Strategies for theorizing from process data." *Academy of Management Review* 24 (4), 691-710.

Lusch, R. F. and S. Nambisan (2015). "Service innovation: A service-dominant logic perspective." *MIS Quarterly* 39 (1), 155-175.

Maitlis, S. (2009). Who am I now? Sensemaking and identity in posttraumatic growth. *In:* Roberts, L. M. and J. E. Dutton (eds.) *Exploring positive identities and organizations.* New York, NY: Psychology Press.

Makkonen, H., M. Saarikorpi and R. Rajala (2019). "A transition from goods-dominant to service-dominant exchange logic in a B2B relationship: A relationship positioning perspective." *Industrial Marketing Management* 81, 65-77.

Marshall, M. N. (1996). "Sampling for qualitative research." *Family Practice* 13 (6), 522-526.

Michel, S., S. W. Brown and A. S. Gallan (2008). "An expanded and strategic view of discontinuous innovations: deploying a service-dominant logic." *Journal of the Academy of Marketing Science* 36 (1), 54-66.

Moeller, S., R. Ciuchita, D. Mahr, G. Odekerken-Schröder and M. Fassnacht (2013). "Uncovering collaborative value creation patterns and establishing corresponding customer roles." *Journal of Service Research* 16 (4), 471-487.

Nicholson, B., R. Babin and S. Briggs (2017). "Exploring the effects of liminality on corporate social responsibility in inter-firm outsourcing relationships." *Journal of Information Technology* 32 (1), 47-61.

Noble, C. H. and B. A. Walker (1997). "Exploring the relationships among liminal transitions, symbolic consumption, and the extended self." *Psychology & Marketing* 14 (1), 29-47.

Oliva, R. and R. Kallenberg (2003). "Managing the transition from products to services." *International journal of service industry management*.

Parker, G., M. V. Alstyne and X. Jiang (2017). "Platform Ecosystems: How Developers Invert the Firm." *Management Information Systems Quarterly* 41 (1), 255-266.

Prashantham, S. and S. W. Floyd (2019). "Navigating liminality in new venture internationalization." *Journal of Business Venturing* 34 (3), 513-527.

Pratt, M. G., K. W. Rockmann and J. B. Kaufmann (2006). "Constructing professional identity: The role of work and identity learning cycles in the customization of identity among medical residents." *Academy of Management Journal* 49 (2), 235-262.

Schlagwein, D. and N. Bjørn-Andersen (2014). "Organizational learning with crowdsourcing: The revelatory case of LEGO." *Journal of the Association for Information Systems* 15 (11), 754-778.

Sebastian, I. M., J. W. Ross, C. Beath, M. Mocker, K. G. Moloney and N. O. Fonstad (2017). "How Big Old Companies Navigate Digital Transformation." *MIS Quarterly Executive* 16 (3), 197-213.

Shomaker, D. J. (1989). "Age disorientation, liminality and reality: The case of the Alzheimer's patient." *Medical Anthropology* 12 (1), 91-101.

Siggelkow, N. (2007). "Persuasion with case studies." *Academy of Management Journal* 50 (1), 20-24.

Steers, R. M. and L. W. Porter (1974). "The role of task-goal attributes in employee performance." *Psychological Bulletin* 81 (7), 434.

Swan, J., H. Scarbrough and M. Ziebro (2016). "Liminal roles as a source of creative agency in management: The case of knowledge-sharing communities." *Human Relations* 69 (3), 781-811.

Tiwana, A. (2015). "Evolutionary competition in platform ecosystems." *Information Systems Research* 26 (2), 266-281.

Tiwana, A., B. Konsynski and A. A. Bush (2010). "Research commentary—Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics." *Information Systems Research* 21 (4), 675-687.

Turner, V. (1969). *Liminality and communitas.* Chicago, IL: Aldine Publishing.

Turner, V. (1987). *The anthropology of performance.* New York, NY: Performance Arts Journal Publication.

Van Gennep, A. (2013). *The rites of passage.* London, UK: Routledge.

Vargo, S. L. and R. F. Lusch (2004). "Evolving to a new dominant logic for marketing." *Journal of Marketing* 68 (1), 1-17.

Vargo, S. L. and R. F. Lusch (2008). "Service-dominant logic: continuing the evolution." *Journal of the Academy of Marketing Science* 36 (1), 1-10.

Verma, R., I. Ng, G. Parry, L. Smith, R. Maull and G. Briscoe (2012). "Transitioning from a goods-dominant to a service-dominant logic." *Journal of Service Management* 23 (3), 416-439.

Vroom, V. H. (1964). *Work and motivation.* New York, NY: Wiley New York.

Yin, R. K. (2017). *Case study research and applications: Design and methods.* London, UK: Sage Publications, Inc.

Value co-creation practices in business-to-business platform ecosystems

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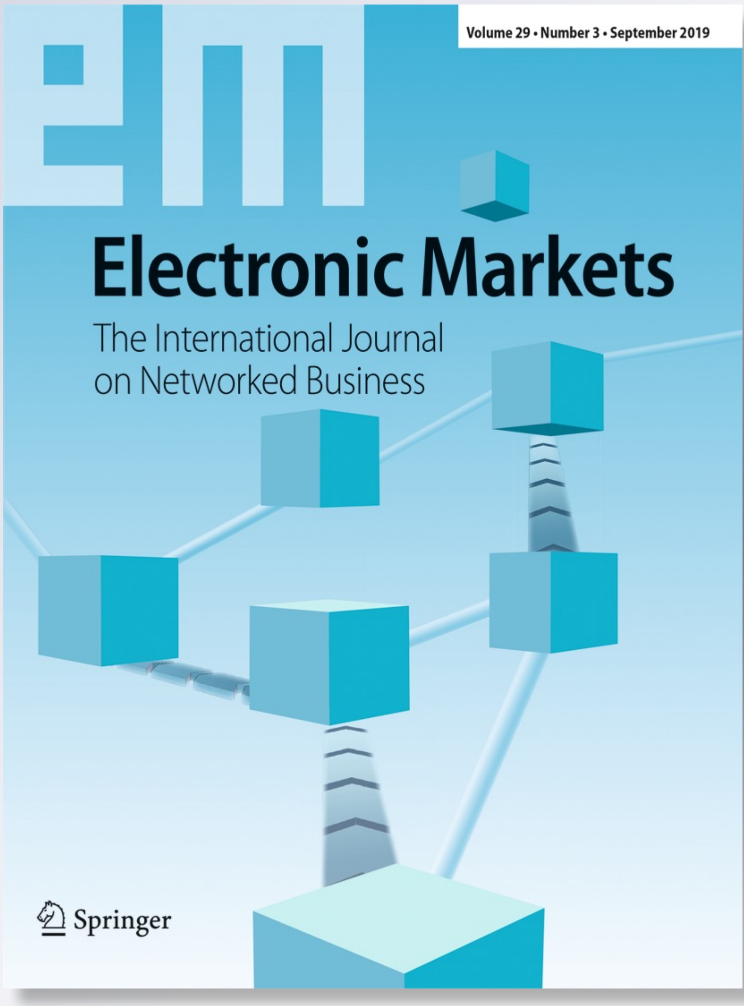
Electronic Markets
The International Journal on Networked Business

ISSN 1019-6781
Volume 29
Number 3

Electron Markets (2019) 29:503-518
DOI 10.1007/s12525-019-00337-y



Springer

Electronic Markets (2019) 29:503–518
https://doi.org/10.1007/s12525-019-00337-y

RESEARCH PAPER

Value co-creation practices in business-to-business platform ecosystems

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Received: 14 September 2017 / Accepted: 5 February 2019 / Published online: 19 February 2019

Abstract
Moving beyond value creation in individual companies, firms have integrated customers, partners, and stakeholders in a mutual value co-creation process. Examples are platforms such as Apple's App Store, where external developers use boundary resources provided on the platform to develop and share applications in an ecosystem. While value co-creation on business-to-consumer platforms is common practice, research on their business-to-business (B2B) counterparts is still sparse. The goal of this paper is to analyze how B2B platforms utilize value co-creation practices. We conduct a multiple case study in the context of emerging Internet of things (IoT) platforms highlighting that B2B platforms follow three standardized value co-creation practices. The platform encourages the supply side through the (1) integration of complementary assets, the demand-side through (2) ensuring platform readiness and connects both processes by (3) servitization through application enablement. We conclude by showing how platforms leverage different boundary resources in a process of standardization to develop a scalable infrastructure that explains how platforms enable value co-creation within their ecosystem.

Keywords Value co-creation · Digital platforms · Internet of things · Case study · Boundary resources · Standardization

JEL classification O320 Management of Technological Innovation and R&D

Introduction

The creation of economic value has shifted during the last decades from individual contributions by single firms to the integration of customer knowledge in product development (Edvardsson et al. 2012; Matthing et al. 2004) to the co-creation of value in complex service ecosystems (Skålén et al. 2015; Peppard and Rylander 2006; Prahalad and Ramaswamy 2004; Hippel and Katz 2002). For the latter, service platforms have emerged as a dominant model (Lusch and Nambisan 2015). Service platforms represent the center of an ecosystem of different actors and take advantage of network externalities by facilitating supply and demand (Lusch and Nambisan 2015; McIntyre and Srinivasan 2017; Hein et al. 2018c). The concept of ecosystems has changed the view from traditional inter-firm competition to a joint approach of coopetition – simultaneous competition and cooperation – between actors (Moore 1996; Adner 2006; Pereira et al. 2017).

Prominent examples of service platforms are application stores such as Apple's App Store and social media platforms such as Facebook, where complementors provide the majority of complementary products or services – applications in the case of the App Store and content in the case of Facebook. The complementors are part of the ecosystem that is continually enhancing the service platform and turning the value creation process into a joint value co-creation process (Parker et al. 2017). In this regard, owners of service platforms foster a loosely-coupled arms-length approach to integrating different

This article is part of the Topical Collection on The future of shared services

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parties into their ecosystem (Ghazawneh and Henfridsson 2013, 2015), while traditional companies use tight coupling in the form of strategic partnerships to co-create value (Orton and Weick 1990; Steensma and Corley 2000). This effect becomes apparent at the boundaries between a service platform and its ecosystem. The service platform provides boundary resources in the form of application programming interfaces (APIs) or software development kits (SDKs) to facilitate a scalable resource integration (Ghazawneh and Henfridsson 2013).

Research on value co-creation in service platforms mainly focuses on the business-to-consumer (B2C) market. Research objects are successful platforms such as Facebook (Lee et al. 2015), Uber (Teubner and Flath 2015), Airbnb (Zervas et al. 2017), or Apple's App Store (Eaton et al. 2015). In contrast, research on emerging business-to-business (B2B) platforms is still sparse (Sarker et al. 2012; Förderer et al. 2018). However, there are grounds to consider that value co-creation practices between B2C and B2B platforms differ. First, the service ecosystem of B2B platforms is more complex compared to their B2C counterpart. Internet of things (IoT) platforms, as an example in the B2B market, cannot solely rely on third-party developers to ensure value-adding services. The platform also needs to encourage the participation of sensor manufacturers, software and application companies, and consumers subject to different, inhomogeneous environments (e.g., machines, processes). Second, users are not private individuals but legal organizations, which use the platform for business-critical processes. Third, B2B services are more complex compared to B2C services. In the case of IoT platforms, the platform owner must provide device management, compatibility with sensors and machines, and communication protocols to the demand of industrial customers.

Accordingly, our research objective is to understand how B2B service platforms foster value co-creation. From a theoretical perspective, we draw on the service-oriented framework of Lusch and Nambisan (2015) to describe the actor-to-actor (A2A) ecosystem, and the value co-creation process connecting those actors. Based on the value co-creation practice, we adhere to the principle of boundary objects coined by Star (2010) to elaborate on the platform boundary resources (Ghazawneh and Henfridsson 2010, 2013) that enable the value co-creation practice. Methodically, we follow a multiple case study subject to three B2B service platforms in the field of IoT (Yin 2014). We show that IoT platforms transition toward an application enablement platform (AEP) through the standardization of three value co-creation practices: platform readiness on the user side, the integration of complementary assets on the demand side, and the servitization through application enablement as a core value-adding service. In addition, we illustrate that a potential consequence of those standardized practices are residual co-creation mechanisms.

Theoretical foundations

We combine two theoretical perspectives to describe value co-creation practices in B2B platforms. The service-dominant (S-D) logic elaborates on how platforms co-create value in A2A ecosystems (Lusch and Nambisan 2015). The theory of boundary objects (Star 2010) and boundary resources in the context of platforms (Ghazawneh and Henfridsson 2010, 2013) serves as a dynamic concept to illustrate how B2B platforms facilitate value co-creation with their ecosystem.

Service-dominant logic

The process of value creation has shifted from a goods-dominant (G-D) logic with a focus on tangible goods that are created in the confines of an organization to a joint process where value is co-created in an A2A ecosystem based on an S-D logic (Chesbrough 2006; Vargo et al. 2008; Vargo and Lusch 2004). The S-D logic focuses on the exchange of services during which one actor uses a set of skills and capabilities to benefit another actor. Lusch and Nambisan (2015) developed a framework along the three dimensions service ecosystem, service platform, and value co-creation to explain the nature of service innovation. The framework is well suited to describe value co-creation practices in B2B platforms, as each dimension addresses different issues and concepts related to platforms.

A service ecosystem is a community of interacting actors organized in an A2A network (Orlikowski 1992). Actors in the A2A network co-evolve their skills and roles in mutual dependency striving for effectiveness (Moore 1993; Adner 2006). We adopt the definition of service ecosystems proposed by Vargo and Lusch (2011) as a self-adjusted, self-contained system of regularly loosely coupled economic and social actors. A service ecosystem connects different actors through services that foster mutual value creation and a shared institutional logic. However, there are three issues that scholars and practitioners need to consider (Lusch and Nambisan 2015). First, the ecosystem needs to provide structural flexibility and structural integrity. Structural flexibility refers to how easily actors can collaborate within an ecosystem; it governs business agility (Tilson et al. 2010). Structural integrity describes the relationship between the actors within an A2A network and their degree of coupling, serving as an indicator for ecosystem engagement (Lewicki and Brinsfield 2009). Second, service ecosystems need to offer a shared worldview to bridge the cognitive distance between involved actors (Hendriks-Jansen 1996; Weick 1995). A shared worldview in the form of standards or institutional logic ensures that actors mutually interpret the integration of resources and that they align more quickly on resource exchange (Lusch and Nambisan 2015). Third, the service ecosystem needs to provide an architecture of participation. This architecture facilitates the interaction between actors by applying transparent rules and providing transparency with regard to the actor's contribution.

A service platform liquefies resources and enhances resource density to facilitate an efficient and effective exchange in a service ecosystem. We adopt the definition of Lusch and Nambisan (2015) for a service platform as a modular structure that combines tangible and intangible resources or components and coordinates the interaction of resources and actors. Resource liquefaction refers to the decoupling of information from a physical representation allowing it to be shared in turn fostering generativity (Normann 2001; Tilson et al. 2010). Resource density describes the speed with which resources can be mobilized for an actor (Normann 2001; Lusch et al. 2010). A layered-modular architecture facilitates either functional designs leading to different core value propositions or cross-design hierarchies creating new value propositions (Baldwin and Clark 2000). Such an architecture allows for the scalable coordination of service exchanges to generate more opportunities for value co-creation and service innovation. The modular architecture engenders the need for platform governance. The associated rules define the way interactions in the A2A network are governed, ranging from an open policy to restrictive rules (Lusch and Nambisan 2015; Benlian et al. 2015; Hein et al. 2016; Schreieck et al. 2018).

The co-creation of value describes the process of value creation between actors within a service ecosystem on a service platform. From the S-D-logic, actors can take different roles in the process of value creation. S-D logic differentiates between the service offerer and the service beneficiaries. The beneficiaries can take the roles of an ideator, designer, and intermediary (Lusch and Nambisan 2015). The ideator distributes knowledge about needs in a specific context and integrates it into new market offerings. The designer mixes and matches resources or knowledge to develop new services. The intermediary distributes and shares knowledge across multiple service ecosystems. Each role integrates existing resources and knowledge with peers in the ecosystem, resulting in new service opportunities. To optimize opportunities for value co-creation, the platform needs to establish transparency about who ecosystem actors are, what and whom they know, and what they can do (Schreieck and Wiesche 2017). There are three issues that scholars and practitioners should address (Lusch and Nambisan 2015). First, the platform needs to facilitate interaction in a service ecosystem. The more actors interact, the more they learn from one another, which determines what they can do as actors. Second, the institutional logic such as organizational structures, roles, and processes needs to be aligned with new value co-creation services. Third, clarifying and communicating the platform's rules and protocol is essential to resolving intellectual-property issues.

Boundary resources

Accounting for the issues raised by Lusch and Nambisan (2015), we introduce the principle of boundary resources to illustrate how a service platform facilitates the co-creation process in a service ecosystem and how boundary resources can help to resolve those issues. Star and Griesemer (1989) proposed the notion of boundary objects in the social sciences to explain how different groups interact in the absence of consensus.

A crucial step to make information compatible across divergent groups is standardization. The process of standardization provides a common ground between different groups by introducing a 'lingua franca.' In this regards, boundary objects help to provide a strong structure for individual needs and a weak structure to maintain a common identity across different groups (Star and Griesemer 1989). Table 1 illustrates a non-exhaustive list of four types of boundary objects. Each type provides a shared structure through interpretive flexibility, work processes, and movement between ill-, and well-structured representations.

Interpretive flexibility describes differences in the use and interpretation of objects. An example could be a map with which one group looks for camping sites, while the other group looks for hiking routes. The boundary object provides structural flexibility as every group can adapt it to their specific context. In addition, the map is robust enough for both groups to be able to exchange information about different locations. This characteristic fosters structural integrity, as specific knowledge can be shared between groups (Star and Griesemer 1989).

Work processes relate to the form in which data is organized (e.g., through routes, locations, GPS data). In a repository, for example, the archivist extracts metadata from a book and puts it into a standardized system or library. The archivist adheres to a standardized method or protocol by first liquefying information from physical resources (e.g., books) and then mobilizing the records (resource density) to a variety of users who can borrow or use it (Star and Griesemer 1989).

Last, there is the transition from ill- to well-structured representations. This characteristic illustrates that boundary objects are not a static concept but exist simultaneously in an abstract form across a variety of disciplines (ill-structured), while also being useful in a specific context for a distinct group (well-structured) (Star 2010). This characteristic is crucial when describing the origin and development of boundary objects.

Star (2010) emphasizes the development of boundary objects through the dynamic process of standardization (see Fig. 1). In an analogy to a map, people try to control the tacking back-and-forth between abstract and specific representations. An example is to standardize coordinates, databases, and different representations of maps in a geographical

Table 1 Types of boundary objects (according to Star and Griesemer (1989))

Type	Description	Example
Repositories	Repositories are specific arrangements of objects that are indexed in a standardized way. Objects are arranged as modules and can be used according to different purposes	Library, archive
Ideal type	Ideal types arise from different degrees of abstraction. They serve as a means of cooperating between different parties through the deletion of local contingencies from a real-world object	Species, atlas
Coincident boundaries	Coincidental boundaries share the same boundaries but are subject to different internal contents. An example is a map with which each party can work toward an individual goal but that also allows for collaboration and communication	Maps
Standardized form	Standardized forms are used to gather information that is compatible across divergent worlds. A benefit is the complexity reduction as local uncertainties are deleted	Standardized form, survey

information system (GIS). The former boundary object (map) becomes an infrastructure (GIS), which resolves the tension between local and global perspectives (Star and Ruhleder 1996). However, standardization tends to throw off residual categories, as the infrastructure cannot account for all possible interaction scenarios. In the process of residualization, new user groups inhibit the residual and begin to start a new boundary object. Out of this development, a cycle is born (Star 2010).

Platform research adopted the concept of boundary objects and coined it boundary resources to explain the arms-length relationship between the platform and its ecosystem through software development kits (SDKs) or application programming interfaces (APIs). Boundary resources use the innovation network literature to describe how B2C platforms govern their ecosystem (Ghazawneh and Henfridsson 2010, 2013) or how boundary resources emerge and evolve based on the interaction between different actors through the process of distributed tuning (Eaton et al. 2015). The boundary resources can enhance the scope and diversity of a platform like in the introduction of ARKit in the iOS ecosystem in the process of resourcing. Furthermore, the platform owner can increase the control over services in the process of securing (Ghazawneh and Henfridsson 2013). More recent research emphasizes the design of knowledge boundaries in B2B platforms (Förderer et al. 2018). While especially the latter study addresses the point of how a platform can design knowledge boundaries, it remains unclear how B2B platforms co-create value with their ecosystem. Thus, we adhere to the S-D logic and the three building blocks of a service platform, which connect a service ecosystem through value co-creation (Lusch and Nambisan 2015). We combine the three building blocks with the dynamic concept of boundary objects (Star 2010) to describe how IoT platforms transitioned toward an application enablement platform (AEP) by standardizing value co-creation practices.

Table 2 summarizes how boundary objects (Star and Griesemer 1989; Star 2010) and boundary resources in the context of platforms (Ghazawneh and Henfridsson 2010, 2013; Eaton et al. 2015) can account for issues raised in the S-D framework (Lusch and Nambisan 2015) to describe value co-creation practices in service platforms.

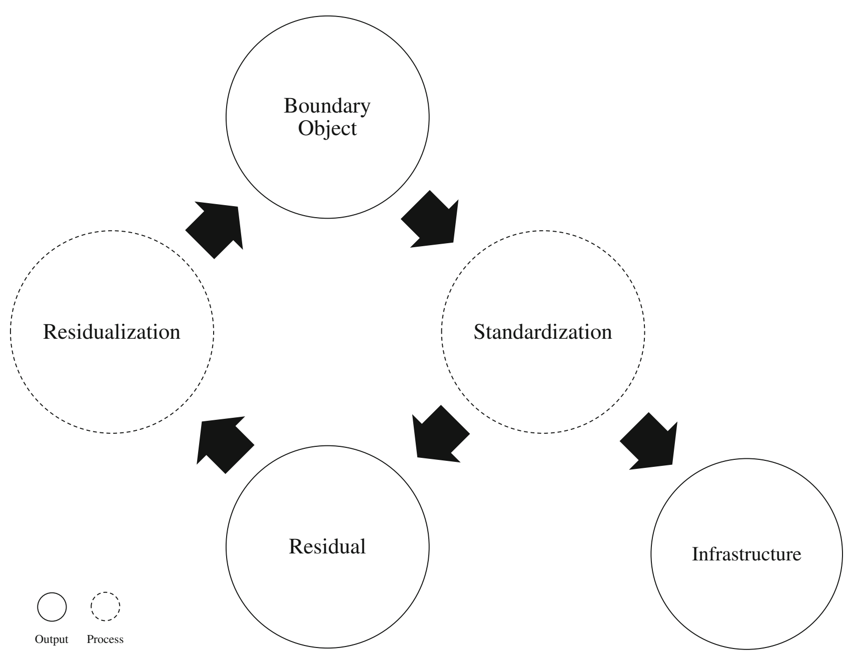

Fig. 1 Relationships between standards and residuals in the dynamic concept of boundary objects (Star 2010; Steger et al. 2018)

Research design

For the research design, we follow a multiple case research strategy. The method is particularly suitable, as it captures and describes the complexity of novel phenomena (Yin 2014; Stake 1995). The multiple case study covers three B2B IoT platforms that illustrate boundaries, features, and limitations, by putting the S-D framework and the concept of boundary objects into the context of the qualitative interviews, respective environments, and firms (Stake 1995; Merriam 1988). A cross-case analysis allows us to draw more robust conclusions on value co-creation practices by contrasting and replicating our findings from individual cases (Yin 2014).

Benbasat et al. (1987) provide guidance on whether the usage of a case study is appropriate. First, it is important to observe the utilization and development of value co-creating practices in B2B platforms in a context-dependent environment. Thus, we derive the data for the case studies through on-site interviews with the platform owners, as ecosystem collaborations cannot be observed from an external perspective (Eisenhardt and Graebner 2007). Second, the tremendous success of platform businesses such as Facebook and Uber show the significance and relevance of the research topic. While there are already established markets leaders in the field of B2C platforms, B2B and especially IoT platforms are not yet settled (Hein et al. 2018a). Thus, there is a clear link to the contemporary event of emerging B2B platforms. Additionally, neither control nor manipulation of the subject or event took place, as the case study describes the phenomenon in the view of a neutral observer. Lastly, the phenomenon enjoys a theoretical base building on value co-creation literature but focusing on B2B platforms that have received little attention so far. Furthermore, the value co-creation practices of B2B platforms are grounded in a real situation described by case studies (Siggelkow 2007).

We sampled B2B platforms in the IoT context with an already established ecosystem of actors. We chose IoT platforms, as they are an emergent phenomenon co-creating value with a variety of ecosystem partners (Shim et al. 2017). We gathered the data for each case through semi-structured interviews on the site of three IoT B2B platform owners. We focused on employees that are directly involved with ecosystem partners, as those could elaborate on the particular co-creation practices. We chose semi-structured interviews as they provide room for improvisation and exploration of the underlying phenomenon.

The interviews included questions subject to the actors in the service ecosystem, the boundary resources provided by the platform, and the process of value co-creation (Myers and Newman 2007). In the first part of the questionnaire, our questions focused on what actors contribute to the value co-creation process in the platform ecosystem. According to the

Table 2 Summary of S-D specific issues on value co-creation and how boundary resources cccount for them (own illustration based on concepts of Ghazawneh and Henfridsson (2013) and Lusch and Nambisan (2015))

S-D Dimension	S-D Issue	Boundary resources
Service ecosystem	Structural flexibility/integrity	Provide interpretive flexibility among groups. SDKs can provide a set of tools and boilerplate codes that can be used by actors to create plug & play solutions on the platform
	Shared worldview	Provide a weak structure connecting groups with a different institutional logic
	Architecture of participation	Standardized infrastructures provide an architecture of participation. Boundary resources can provide an architecture of participation in service ecosystems, which in turn influences the evolution of boundary resources through distributed tuning
Service platform	Resource density	Work processes (standardized methods) and digital interfaces such as APIs provide a process for liquefying information from physical sources. In the process of resourcing, the scope of the platform can then be enhanced via the liquified information
	Define rules of exchange	Work processes (standardized methods) provide a 'lingua franca' among ecosystem actors. Digital interfaces such as APIs provide a defined structure through payloads and secure interfaces in an ecosystem
Value co-creation	Facilitate interaction in ecosystem	Standardized infrastructures resolve the tension between local and global understanding, thus facilitating interactions. Digital interfaces and SDKs facilitate interactions in an ecosystem
	Adapt internal processes	Well- and ill-structured characteristic of boundary resources provides interpretive flexibility to account for internal processes
	Transparency on resource integration	Work processes (standardized methods) ensure transparency over (possible) ways on how to integrate resources. Digital interfaces such as APIs secure a clearly defined data structure

interviewees, those actors range from software developers to sensor manufacturers to consulting companies to business customers. Next, we asked specific questions on how the platform owner integrates those actors in the ecosystem. Typical examples are boundary resources such as APIs, SDKs, web interfaces, and boundary spanning activities like on-site collaborations. Last, we focused on the process of value co-creation. An example is how the different actors integrate sensors or software into the platform. Furthermore, we considered the complexity aspects on the side of the platform owner by asking open questions addressing their position on value co-creation.

In total, we conducted 11 face-to-face interviews (see Table 3) from November 2016 to February 2017. We recorded, transcribed, anonymized and sent back the transcriptions to the interviewees to provide additional comments. The final transcripts were then used for data analysis. The authors followed the guidelines of flexibility, non-direction, specificity and range during the interviews to increase the received value (Flick 2009) and paid attention to neutrality and a non-judgmental form of listening (Patton 1990; Walsham 1995).

As for the data analysis, we followed the coding mechanisms proposed by Strauss and Corbin (1996). We used the 11 interviews as data slices starting the process of open coding, where we coded the concepts and codes word-by-word. Examples are specific actors such as sensor manufacturing companies, types of interaction such as strategic partnerships with industry leaders or boundary resources through APIs. After that, we conducted axial coding to describe the relationships between codes. The results were constantly compared with already coded slices to derive similarities between actors, boundary resources, and value co-creation interactions. We documented changes in relationships via the process of memoing. Finally, we conducted a selective coding based on the theoretical constructs of the S-D framework (Lusch and Nambisan 2015) and dynamic process of boundary objects (Star 2010) to derive core categories that are robust along all three cases describing value co-creation practices (Urquhart 2012).

Results

The interviews indicate that B2B IoT platforms struggled with three issues when it comes to fostering value co-creation in their ecosystem. First, the ownership of products and services was unclear. This problem states that ownership rights for data, applications, and services are unclear from the partner's point of view, as described by the *Strategic Innovation Manger* of *Alpha*. Second, B2B customers account for special requirements, like the need for stable services, compliance with security, regulations, or high-quality standards. A *Developer* from *Beta* described, "*He [the customer] asked whether the solution is in conformance with the data protection laws for health insurance firms. He showed me how strict the regulations are.*" Third, B2B customers have an inhomogeneous and highly specialized landscape of machines, processes, and systems. The *Strategic Innovation Manager* of *Alpha* describes the fact that, "*There might be thousands of machines. Machines, sensors, and thousands of possible use-cases on top.*" Thus, developers need special insight into the customer's department, machines, and processes to work on IoT solutions.

To account for those problems, the platform owners introduced an application enablement platform (AEP). The AEP enables scalable resource integration by combining three value co-creation practices that foster interaction in its ecosystem. In each practice, there are at least two distinct actors, each

Table 3 Firms and interviewees (own illustration)

Organization (anonymized)	Description	Duration (mm:ss)	Role
Alpha	Alpha is a leading business-to-business IoT platform. They provide industry solutions through strategic partnerships and the combination of open services on their platform. The platform targets clients in the enterprise and SME sector.	53:20 66:25 54:02 40:40	Innovation Manager Business Development Head of Sales Director Machine-to-Machine Communication
Beta	Beta is one of the leading Cloud-Platform providers. Through acquisitions and contribution in Open Source software, Beta has established a scalable cloud architecture. This architecture is a prerequisite and the basis of the IoT platform. The IoT platform on top of this architecture provides several industry-specific solutions and building blocks in the area of IoT.	53:44 55:28 49:34 63:16 45:00 61:10	Knowledge Manager Consultant Sales Platform Architect Technical Consultant Platform Architect Application Developer
Gamma	Gamma is an IoT platform start-up. The firm focuses on OEMs in the automotive industry. They use technical and industry expertise to provide solutions for specific use-cases on their platform. Due to the company size, the number of interviewees was limited to the CEO.	86:22	Chief Executive Officer

subject to their own institutional logic and connected through boundary resources (see Table 4).

Integration of complementary assets

The co-creation practice *integration of complementary assets* describes relationships that target the supply-side of an IoT platform. Instead of creating each service, sensor, and application by themselves, platform owners aim to provide an infrastructure that enables partners to self-integrate their resources. Partners want their resources to be on the platform to access the installed base of users in the platform ecosystem and thus obtain market access. Therefore, the platform provides boundary resources like web interfaces, APIs, SDKs, and documentations to enable partners to integrate and develop complementary assets. In addition, the platform adheres to boundary spanning activities to align with industry partners to implement vertical solutions.

One role of a partner is a device manufacturer providing the hardware and integrating it into the platform to comply with the standards, applications, and services provided by the platform owner. For the platform, each new device integrated into the platform is beneficial for the installed base of customers. In turn, each new device increases the perceived value of customers to join the platform. This beneficial relationship between supply and demand underpins the positive cross-side network effects. The *Head of Sales* of *Alpha* illustrates this effect:

"*And then we have an ecosystem of hardware partners. [...] The primary motive of them [Hardware Partners] is to be integrated. In the end, it is a win-win situation. They are platform-ready [Platform services can be used by customers] and they can provide their solution to all of our clients, and our clients can use the convenient plug & play hardware.*" *(Head of Sales, Alpha)*

Besides hardware, services can be integrated into the platform. For example, external partners can offer a text-to-speech service on the platform. The integration of additional services and devices makes sure that the IoT device and application landscape becomes a modular part of the platform ecosystem. The resulting heterogeneity of service offerings in the ecosystems tackle the variety of the customers' landscapes, and provides an easy-to-use toolkit solution for them. The *Head of Business Development* of *Alpha* and several interviewees from *Beta* indicate that their clients utilize third-party applications and services that were integrated by partners into the platform. An example is the offering of text-to-speech services, which are integrated through standardized protocols and services to fit the toolbox solution.

The interviews indicate that not all practices apply to this standardized self-integration. The *Director of Machine-to-Machine Communication* of *Alpha* emphasizes that applications developed by customers are often too specific to be of any value for other customers. In those cases, the platform owner evaluates the applicability and value-add for other

Table 4 Value co-creating practices within application enablement platforms (own illustrationn.)

	Integration of complementary assets (demand-side)	Ensuring platform readiness (supply-side)	Servitization through application enablement (core practice)
Actors	Platform owner, partner, and customer	Customer, partner, and platform owner	Platform owner and customer
Institutional logic toward value co-creation	*Platform owner* wants to incorporate sensors, services, applications to increase the value of the platform	*Customer* wants to join the platform to benefit from services such as device management or data analytics	*Platform owner* wants to increase the profit by providing PaaS services and infrastructure including plug & play applications
	Partner wants to sell sensors, services, applications to an installed-base provided by the platform	*Platform owner* wants customers to join the platform to increase profits	*Customer* wants to develop toolkit solutions by providing department and end-customer insights/data
	Customer develops a specific application that could prove useful for other customers	*Partner* in form of consultancy firms want to ensure platform readiness for customers to increase profits	
Boundary resources	Web interface for self-service integration; APIs, SDKs, documentation for unique applications; boundary spanning activities like on-site offices for strategic partnerships	Documentation and how-to guides; consulting as boundary spanning activity	IoT platform that enables customers to develop applications
Example	Development of industry solutions with partners like manufacturing or automotive. Integration of new devices and services (e.g., text-to-speech)	Enabling customers to comply with platform standards like JSON and MQTT. Showing potential of platform utilization	Change from physical to remote maintenance to predictive maintenance

customers and abstracts the application to match a broader group of users.

Last, the *Knowledge Manager* of *Beta* points out that the platform is in close collaboration with industry leaders. Together they combine industry-specific knowledge with technological IoT expertise to create industry-specific vertical solutions. Those packages range from industries such as manufacturing to insurance to energy.

The seamless integration of partners into the standardized and modularized platform architecture further shows that customers need to adapt their environment to comply with the services, which leads to the next value co-creation practice within an AEP.

Ensuring platform readiness

The second value co-creation practice targets the demand-side by *ensuring customers' platform readiness*. The standardized value co-creation service follows a self-service integration logic. The platform provides documentations and how-to guides to enable customers to join the platform.

However, due to the complexity of each customer's processes, machines, and sensors involved, there are consultancy companies bridging the gap between the platform and customers. Customers provide insights into their products, services, and data, while the consulting company acts as a boundary spanner offering technical, IT, and strategic expertise. Together, they adjust the technical landscape to comply with the standardized platform infrastructure. Those collaborations show the potential of new, IoT-enabled solutions when joining the platform. The *Technical Solutions Leader* of *Beta* emphasized this point:

> "*[…] and if they [customers] now want to optimize their products or processes, they cannot do so due to the lack of software developers. If he [client] wants a solution from sensors to analytics to insights, he needs a competent partner. A typical example is our partner [IT consulting firm]. They enable the customer to join and use the platform.*" *(Technical Solutions Leader, Beta)*

The example shows that the practice of ensuring platform readiness is a co-creation process between external platform partners such as consulting firms and the client who is in need of technical change to comply with platform standards or wants to implement IoT applications.

Servitization through application enablement

The practice of *servitization through application enablement* describes the core co-creation practice between the platform owner and the customer. Both, the integration of complementary assets (supply) and the assurance of platform readiness (demand) are pre-conditions for this facilitating co-creation practice. The platform owner provides a standardized and modularized platform-as-a-service (PaaS) infrastructure including all the assets from the ecosystem. Customers use the PaaS infrastructure as a boundary resource, which they adopt to their institutional logic including machines, departments, and processes.

This practice enables customers to develop their own apps on a public, dedicated, or on-premises PaaS infrastructure, in addition to the plug & play applications that are offered on the platform. The offering of these three different deployment categories provides a solution for the ownership problem and considers external factors such as compliance with data privacy laws. With the option of a dedicated infrastructure, the customer can decide where the data center is located. *The Knowledge Manager* of *Beta* points out that it is important to have the data stored in countries with strict data protection laws. Firms also may run the system via an on-premises solution on their hardware.

Besides the technical infrastructure, the value co-creation practice also enables customers to build their applications with a toolkit solution. The *Head of Sales* of *Alpha* explains:

> "*We provide them with 70 - 80% of the solution - stable solutions in the field of mobile communication and device management […] we deliver 80% of the solution they need. The client can concentrate on their core business and their sensor data. This enables us to do what we do.*" *(Head of Sales, Alpha)*

Those toolbox services enable customers to create solutions through the combination of existing applications. A good example of a specific solution resulting from a toolkit application is provided by *Alpha*. Here, the *Head of Business Development* explains that a customer used a package for GPS tracking to build an application that helps their end-users in the maritime industry to track cargo ships. They used the non-specific tracking services to build the application. They added geo fences via drag & drop to be notified whenever ships leave or enter a harbor. The platform owner provided the customer with a toolkit of applications to build their own, value co-created solutions for unique scenarios. This example illustrates that new, differentiating activities (well-structured) result from the combination of abstract non-differentiating (ill-structured activities) offered by the platform owner. The *Strategic Innovation Manager* of *Alpha* describes this phenomenon as "*[...] a clever bundling of services may lead to innovations that did not exist before.*" A *Technical Consultant* of *Beta* concludes:

> "*[...] you always find something you can take advantage of. You do not need to invent everything [service/application] by yourself, which is a gain in time or inspires you to*

> *come up with new ideas. When you join our platform, you will find many services that you can combine, and you come up with new ideas as to how to develop a new business model.*" *(Technical Consultant, Alpha)*

Overall, the core value co-creation practice of an AEP facilitates the supply in the form of a toolbox solution of preconfigured applications, sensors, and services, and a demand side of customers that are ready to use those services. The modularity and standardization enable servitization – "*[…] so [that] our client can just use the service.*", as the *Head of Sales* of *Alpha* concludes.

Discussion

We discuss the findings along the three main value co-creation practices targeting the supply-side through the integration of complementary assets, the demand-side in the form of ensuring platform readiness, and the core value-adding service as servitization through application enablement. For each value co-creation practice, we identify value co-creation mechanisms that result from standardization and residualization of the co-creation practices (Star 2010).

From a theoretical perspective, we draw on the S-D framework (Lusch and Nambisan 2015) in combination with the dynamic concept of boundary objects (Star and Griesemer 1989; Star 2010) and boundary resources in the context of platforms (Ghazawneh and Henfridsson 2013) to describe how the platform implemented each value co-creation practice.

Supply-side value co-creation practice

The supply-side value co-creation practice of integrating complementary assets involves a supplying entity and an integrating entity. Both institutional logics are connected through boundary resources. Figure 2 shows the main value co-creation practice (gray box) and three instantiations or mechanisms in the form of self-service integration, integration through abstraction, and strategic integration.

Self-service integration describes the standardized process in which the partner uses the platform boundary resources in the form of documentation, how-to guides, APIs, and SDKs to integrate its products or services on the platform. The platform acts as an infrastructure that is both abstract to apply to a wide range of actors such as device manufacturers, service providers, or application developers, and specific to be applied to the institutional logic for each of the integration partners. The partners use APIs and SDKs as a standardized form to integrate products or services and to make them comply with platform standards. The standardized form provides a shared (data) format for integrating products or services (Star and Griesemer 1989). Also, partners use boundary resources such as documentations and how-to guides as coincident boundaries similar to a map to create new boundary resources like documentation, boilerplate code, and further information so that other users on the platform can use the integrated products or services. The newly created boundary resources, like boilerplate code, are vague, thus providing an ill abstraction to bridge the gap between the product or service and the users on the platform who are going to apply it to a variety of use cases. There are parallels to other industries (Weking et al. 2018a; Weking et al. 2018c). However, the IoT platform needs to bridge a wider gap when it comes to interpretive flexibility and the adaption of internal processes on the customer side compared to other platforms. While complementors in app stores only need to provide information on how to use the app, IoT complementors also need to provide the code on how to embed their product or service in a wide range of customer landscapes. The mechanism of self-service integration scales to the end of the platform, as the platform only provides the standardized work process and the partner collaborates in a loosely coupled relationship toward this goal.

Integration through abstraction is a residual value co-creation mechanism where the platform owner uses specific applications provided by customers to aggregate them toward broad applicability among users. Compared to the standardized mechanism of self-service integration, the integration through abstraction results from customers who want to monetize internally developed applications. First, customers use boundary resources such as APIs and SDKs as standardized forms to develop specific applications as ideal types for their own use. Customers then would like to monetize those applications on the platform. However, the application of the customer is too specific to the customer's situation to be of any use for other customers. Then, the platform owner steps in and aggregates the specific application as a new boundary resource in the form of an ideal type (Star and Griesemer 1989). Both parties work as a designer, the customer providing the idea in the form of a specific application, and the platform owner providing the standardized abstraction that can be offered to a variety of platform users. While the relationship is loosely structured as most of the interaction is done via standardized boundary resources, the relationship is not scalable, as both parties act as designers. There are similar value co-creation mechanisms as illustrated by the LEGO platform, in which customers can propose LEGO-specific boxes that are then produced and sold by the platform (Schlagwein and Bjørn-Andersen 2014). When comparing the LEGO with the IoT mechanism, the process on LEGO is already standardized and scalable for the platform, while the residual mechanism on the IoT platform still demands the effort of both parties to integrate the application.

Strategic integration is the second residual process and subject to the collaboration between the platform and a strategic partner. Both parties aim to develop a vertical solution that provides end-to-end support for industries such as automotive

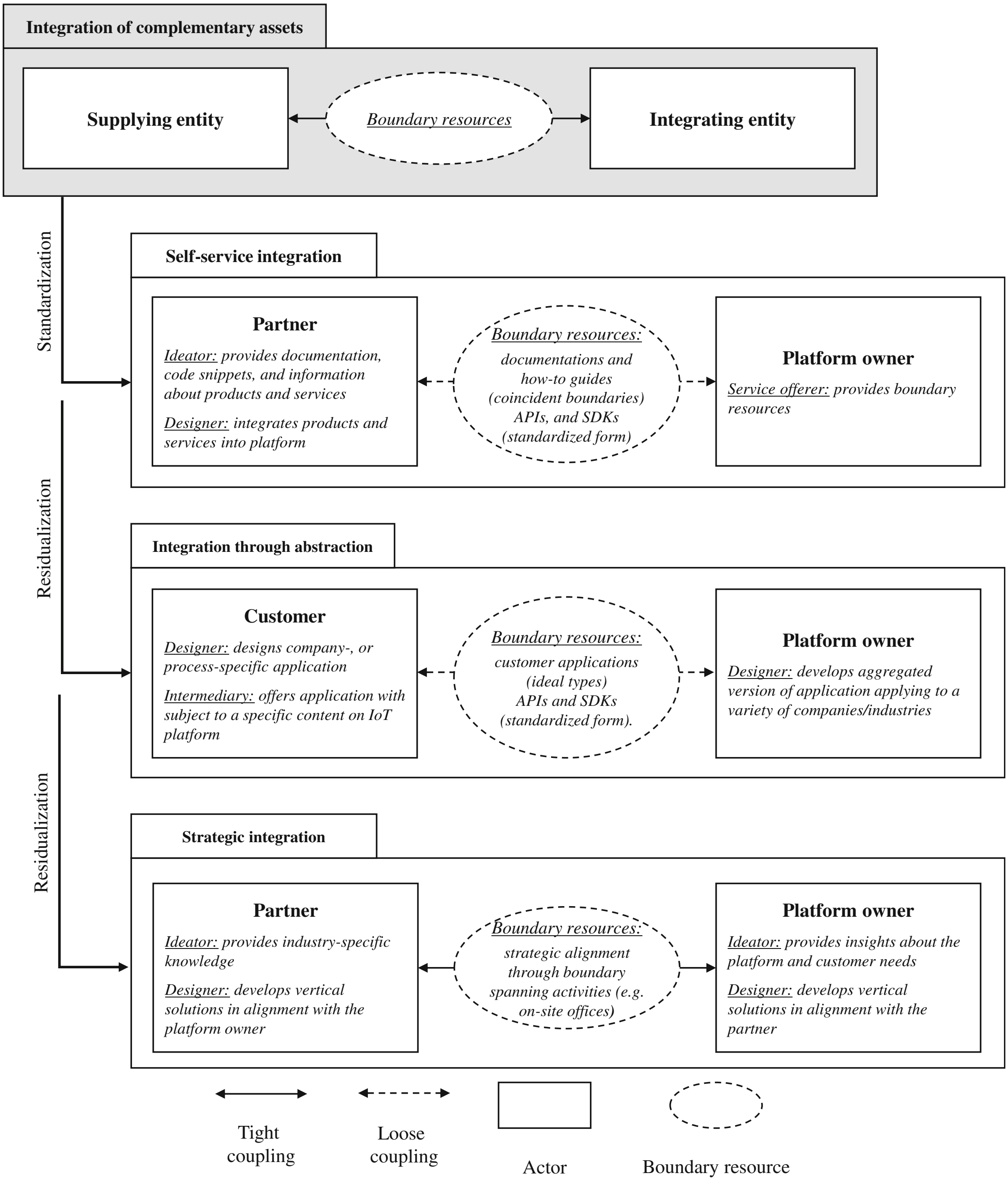

Fig. 2 Supply-side value co-creation practice of integrating complementary assets (own illustration)

or equipment manufacturing (Schreieck et al. 2017). Those industry solutions cover the full lifecycle from design, to supply, to production, to operations, and to maintenance. The scope of vertical solutions demonstrates the complexity of the development task and the mutual understanding needed of both parties. According to the interviews, the IoT platforms foster this strategic alignment through boundary spanning activities in the form of on-site offices, where personnel of both parties work together. There are various other examples of strategic partnerships that are used to increase the value of a platform such as the collaboration of Apple and IBM to tackle business applications. Due to the tight coupling partnership, the value co-creation mechanism scales on neither side (Hein et al. 2018b).

Demand-side value co-creation practice

The demand-side value co-creation practice of ensuring platform readiness involves a demanding and an enabling entity. Both institutional logics are connected through boundary resources. Figure 3 shows the main value co-creation practice (gray box) and two instantiations or mechanisms in the form of self-service readiness and supported readiness.

Self-service readiness describes the standardized value co-creation mechanism of a customer that uses platform resources to comply with platform standards. In this scenario, the platform provides transparency of a working process on how to comply with platform standards by providing boundary resources as co-incident boundaries such as documentation and how-to guides (Star and Griesemer 1989). Customers act as service beneficiaries by applying those boundary resources according to their institutional logic (e.g., machines, sensors, and uses cases) to update their infrastructure to comply with platform standards. The platform acts as an infrastructure, in which customers can opt in a loosely coupled relation to the platform. Thus, the co-creation mechanisms scale to the end of the platform owner, as the customers themselves need to ensure platform readiness. An example in the IoT context are customers who joins the platform, read the documentation and how-to guides, and set-up their infrastructure to support communication protocols such as MQTT. Similar self-service co-creation mechanisms can be found across a variety of industries. Companies usually provide boundary resources like manuals (e.g., app-development guidelines or assembly instructions) with the aim to create transparency over a working process through instructions on how to use and assemble products or services.

Supported readiness is a residual that results from the standardized mechanism of self-service readiness. The value co-creation mechanism mitigates relationships between customers and the platform that are not able to follow the self-service readiness mechanism. A reason is the low structural flexibility, where customers lack the capabilities to use available boundary resources to comply with platform standards. To mitigate this issue, customers collaborate with consultancies that act as boundary spanners in a tightly coupled relationship. The customer provides insights about machines, sensors, and potential use-cases, while the consultancy uses its knowledge about platform standards and feasible use-cases. As both parties need to establish a mutual understanding of each other's institutional logic, they need to work closely

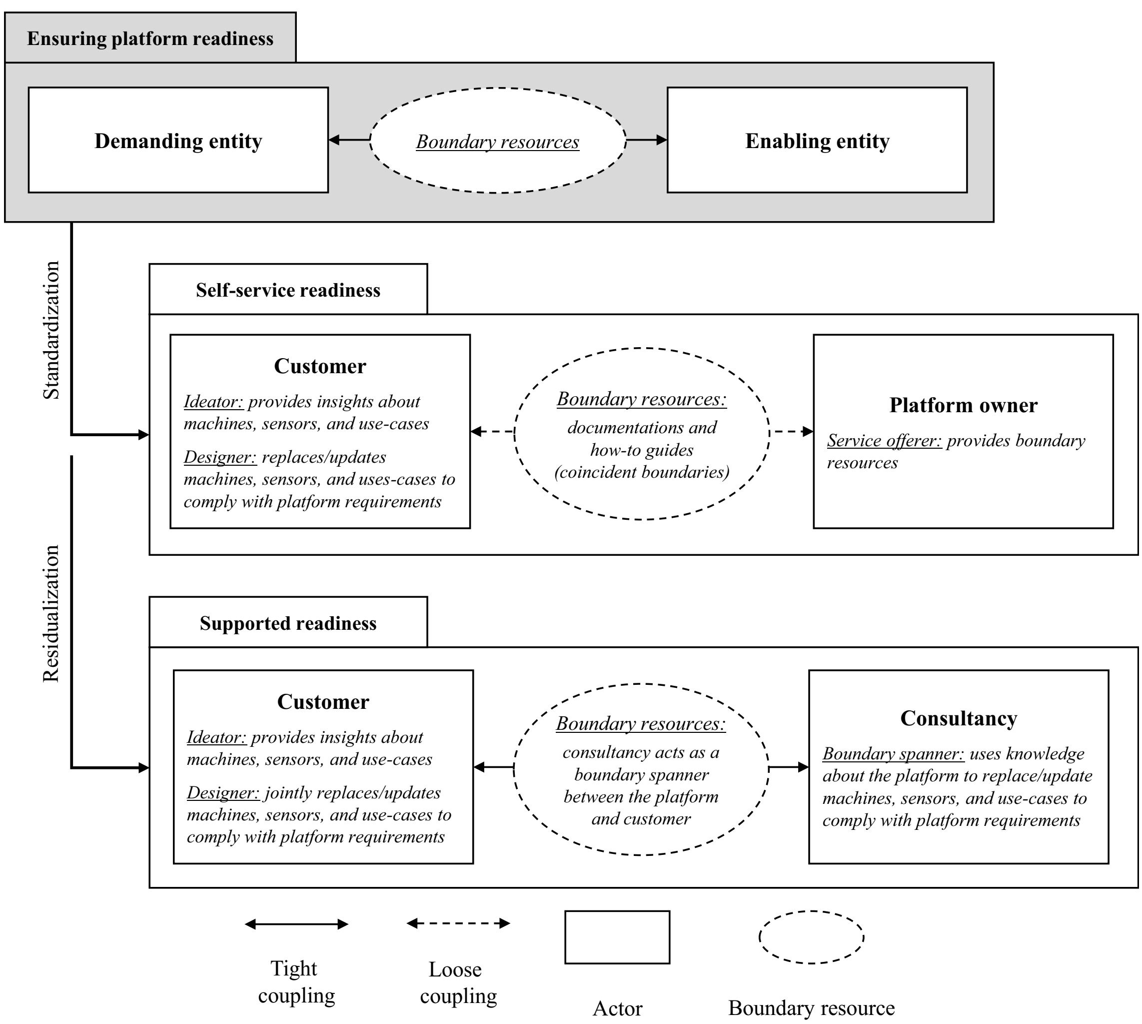

Fig. 3 Demand-side value co-creation practice of ensuring platform readiness (own illustration)

toward the common goal of ensuring platform readiness. Due to this tight-coupling collaboration, the value co-creation mechanisms scale on neither side. Again, similar mechanisms can be found in other industries. Apple, for example, uses employees from Genius Bars as boundary spanners to help customers use their products or services. In total, this supported readiness illustrates how IoT platforms bridge low structural flexibility by a boundary spanner.

Core value co-creation practice

Last, there is the core value co-creation practice of servitization through application enablement that combines demand- and supply-side practices. The IoT platform acts as a repository connecting customers with the applications and services on the platform. This set-up enables the customer to create his or her own applications (see Fig. 4). On the one hand, demand-side value co-creation practices ensure that customers meet the conditions to use the IoT platform in a plug & play manner. On the other hand, supply-side practices foster resource liquefaction by decoupling information that is available by ecosystem actors such as partners and providing it in an abstracted form on the platform. Furthermore, the platform makes sure that all products and services on the platform comply with the platform standards. In this sense, both value co-creation practices standardize demand and supply to enable the core value co-creation interaction. The customers use the IoT platform as a repository of abstract applications and services. Each application and service can be seen as an ideal type. On an abstract level, a wide range of customers can use each application or service autonomously. However, if a customer applies the app to a specific context, the interpretation of applications changes and transforms toward a specific application that fits the need of a distinct institutional logic. An example is the abstract application of setting-up geofences on a map, where a specific use case can be the tracking of cargo-ships in the maritime industry. In this process, customers combine the applications and services according to their institutional logic to foster generativity. The platform mitigates the problem of data ownership by allowing customers to use the IoT platform on a dedicated or on-premise solution. Also, the platform addresses special requirements targeting availability and security by enabling customers to create applications that fit their institutional logic.

In sum, we show that an AEP co-creates value in three distinct ways. First, the B2B platform tackles the problem of engaging a variety of actors through resource liquefaction on the supply side to make sensors, applications, and services available on the platform. Second, the platform accounts for the complexity of customers' institutional logic by ensuring platform readiness in a standardization process where customers comply with platform standards. Third, the platform facilitates interaction between the supply and demand side by enabling customers to use the AEP as an abstract plug & play toolkit according to their own, specific context. This shifts the satisfaction of special needs, like security, to the customer.

Implications, limitations, and future research

The study provides three implications for theory. First, we show that the S-D framework (Lusch and Nambisan 2015) and the dynamic concept of boundary objects (Star and Griesemer 1989; Star 2010) complement one another regarding the description of value co-creation practices. Boundary objects account for S-D related issues like structural flexibility or provide a shared worldview through a standardized work process that creates boundary objects. One example is the value co-creation process of ensuring platform readiness, where the platform provides boundary resources such as documentations and how-to guides to provide a structure for customers on how to adjust machines, sensors, and processes. Those boundary resources serve as coincident boundaries (e.g., maps) helping customers to comply with platform standards ensuring structural flexibility. The platform follows a similar mechanism on the supply side. Boundary resources such as APIs and SDKs enable a variety of ecosystem actors to integrate complementary assets on the platform. Thus, the platform fosters resource liquefaction and increases resource density, as the resulting applications and services can be shared and used in the platform ecosystem. Those applications and services are boundary resources that are abstract (ill-structured) to be interpreted among different groups and, at

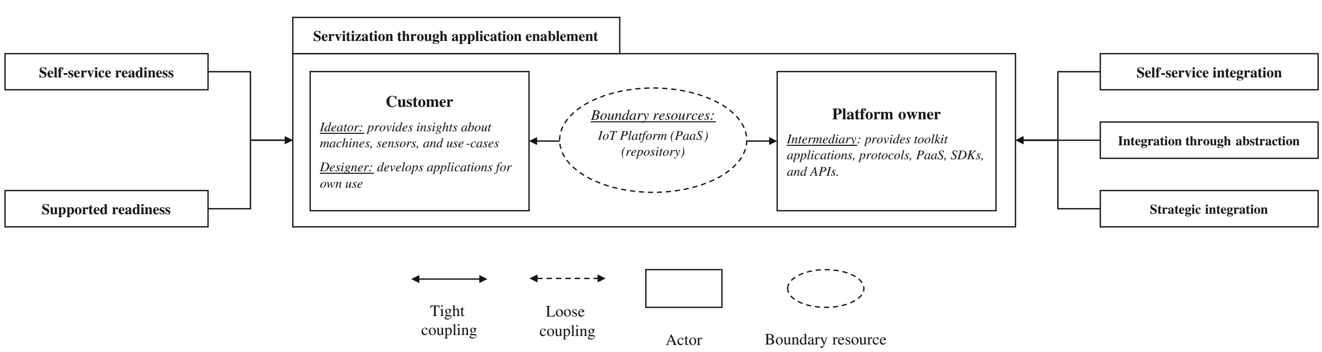

Fig. 4 Core value co-creation practice of servitization through application enablement (own illustration)

the same time, concrete (well-structured) in a specific institutional context. We show that the combination of S-D logic and boundary objects is a fruitful combination to account for potential issues in the value co-creation process such as providing structural flexibility (Lusch and Nambisan 2015). In addition, we supplement existing literature on platform boundary resources (Ghazawneh and Henfridsson 2013; Eaton et al. 2015) by showing how B2B IoT platforms use and combine different types of boundary objects (e.g., ideal types, coincident boundaries, standardized forms, and repositories) in the process of value co-creation.

Second, we show the importance of value co-creation practices in B2B IoT platforms to follow the dynamic process toward standardization (Star 2010). The case study presents insights on how platforms implement standardized work processes to achieve scalable value co-creation practices that foster network externalities (McIntyre and Srinivasan 2017). They do so by shifting the design effort outside of the platform to make ecosystem actors comply with the standardized process. Examples are the supply- and demand-side value co-creation mechanisms of self-service readiness and integration. In both cases, the customer/partner interacts in a loosely-coupled relationship (Orton and Weick 1990) by adhering to boundary resources such as documentation and how-to guides. They adjust their institutional logic to comply with platform standards. The loosely-coupled interaction scales to the end of the platform. Parker et al. (2017) call this effect "inverting the firm." This standardization of value co-creation practices offers another advantage in the form of increased resource density. When partners integrate their resources into the platform, they also comply with the standards required by the platform. The platform orchestrates those abstractions in a repository, which all other parties in the ecosystem can access. This compatibility fosters network externalities as once created application or service cannot only be used by one individual customer but by the whole ecosystem. In addition, this process fosters generativity in the network as parties can use and combine applications and services according to their institutional logic. The residual value co-creation mechanism of integration through abstraction captures the generativity caused by new applications that do not apply to platform standards transforming specific applications toward an ideal type. Through this feedback loop, customers benefit from applications created by peer customers. However, the residual process design effort lies on the platform side, limiting the scalability. In summary, we show that the dynamic standardization process of boundary objects can be applied to value co-creation practices in B2B IoT platforms. The process helps to explain how platforms act as infrastructures that engage their ecosystem to utilize network externalities (McIntyre and Srinivasan 2017; Constantinides et al. 2018; Weking et al. 2018b). Furthermore, we show that the standardization process fosters residual value co-creation mechanisms.

Third, the case study provides insights on B2B IoT value co-creation practices (Constantinides et al. 2018). While previous studies focused on customer service encounters (Giesbrecht et al. 2017) or sole platform to complementor relationships (Sarker et al. 2012; Förderer et al. 2018), we show how platforms account for a variety of ecosystem actors ranging from sensors manufacturers to software developers, and customers by fostering self-service value co-creation mechanisms. The platform controls the process of external contributions (Ghazawneh and Henfridsson 2013) and makes ecosystem actors comply with platform standards. Instead of controlling and integrating each product and service individually, the platform controls the input through strict rules and boundary resources, allowing for a scalable resource integration. To deal with the business-related requirements of customers, platforms take advantage of two different value co-creation mechanisms. On the one hand, the platform provides self-service readiness through boundary resources that make the customer adapt to platform standards. On the other hand, the platform conducts boundary-spanning activities to bridge the gap between customers that are not able to follow the self-service integration mechanism. Boundary spanning activities such as partnerships with consultancies in the form of supported readiness that help customers to align with platform standards. Those mechanisms aim to enable the customer to use the applications and services on the platform like a toolbox, where they can develop solutions to fit their individual needs and internal processes (institutional logic). Last, there is the complexity of IoT services that B2B value co-creation practices must account for. The value co-creation mechanism of strategic integration hints toward the fact that loosely-coupled relationships are not sufficient to standardize the complexity of vertical solutions (Schermuly et al. 2019). On the contrary, the platform relies on tight coupling and strategic partnerships with industry experts to develop an abstract representation of vertical solutions. Based on those industry-specific structures, loosely-coupled partnerships can extend the platform offering of new products or services (e.g., integrating a new sensor that supports a specific production step).

Furthermore, there are implications for practice. First, we show how B2B IoT Platforms integrate and facilitate value co-creation practices toward scalable resource integration and consumption. Second, practitioners can use the S-D framework (Lusch and Nambisan 2015) in combination with the theory of boundary objects (Star and Griesemer 1989; Star 2010) to analyze whether their value co-creation practices have potential for standardization. Thus, platform owner can design new value co-creation practices to shift the design effort outside of the platform, thus leveraging network externalities (Parker et al. 2017). In addition, we show that through the standardization of value co-creation practices, companies need to spend increased awareness of resulting residuals practices.

Last, the study faces limitations. First, the study might not be transferable to other industries because it builds on a multiple case study in the context of IoT platforms. Further studies can conduct additional case studies in industries that are evolving towards platform businesses to increase the generalizability across industries (Yin 2014). Second, the interviews cover only the platform owner perspective, which limits the robustness of the findings. While we tried to mitigate this limitation based on a sampling strategy that covers interviewees with profound customer interaction (e.g., sales lead and technical consultants), additional interviews with customers could reveal more insights about the perspective of ecosystem actors. Also, the findings are based on qualitative data, thus providing only fist hunches of possible value co-creation practices. Interesting areas for future research could develop a process model on how platforms foster the standardization of value co-creation practices and how residual value co-creation practices emerge. Such a model would provide answers about whether residuals originate as a consequence of workarounds or if they can be strategically designed to mitigate problems arising from structural flexibility (Eaton et al. 2015). Also, are residual value co-creation mechanisms going to be standardized as well and who is triggering this process? Furthermore, the study focuses only on the mechanisms that develop new products utilizing technology and value co-creation. As an extension, Alves et al. (2016) identified two additional clusters, namely the co-creation experience from the customer's point of view, and the relationships between customers and platforms, which are not considered in this case study. Thus, further interviews from the perspective of the customers and partners could provide important insights on those two aspects.

Conclusion

During the last years, we have seen a shift in how companies create value. Starting from value creation processes inside the firm, service platforms have emerged and turned the value creation process into a mutual value co-creation process with an ecosystem of actors. While there is research on how platform leaders in the B2C business such as Facebook or Apple co-create value, research on emerging B2B platforms is still sparse. In contrast to B2C platforms, B2B platforms need to establish value co-creation practices under more complex conditions. They need to encourage a variety of ecosystem actors and interact with customers that are harder to satisfy due to their requirements as legal entities, and in an often more complex environment. One particular example are IoT platforms that need to integrate sensor manufacturers, service and application developers, and industry customers by providing services that range from device management to database storage and data analytics.

We show that the combination of the service-dominant (S-D) framework of Lusch and Nambisan (2015) with the dynamic process of boundary objects (Star and Griesemer 1989; Star 2010) provides a fruitful combination to describe and analyze value co-creation practices. By combining those two theoretical perspectives, we can illustrate that IoT platforms follow a standardization process to encourage the supply and demand side to comply with industry standards. The resulting application enablement platform includes three main value co-creation practices: the integration of complementary assets representing the supply side, the assurance of platform readiness for the demand side, and servitization through application enablement as a core co-creation practice. The main achievement of platforms is the high degree of standardization of value co-creation practices by shifting the design effort to the ecosystem in turn leveraging network externalities. Also, we show that a consequence of the standardization process are residual value co-creation practices that result from customers and partners unable to comply with platform standards.

Acknowledgements The authors would like to thank all anonymous reviewers and the editors for their helpful comments and suggestions. This research is funded by the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) as part of the 'Collaborative Research Center 768: Managing cycles in innovation processes – Integrated development of product service systems based on technical products' (TP C1), and the Center for Very Large Business Applications (CVLBA)@TUM. Also, this work is part of the TUM Living Lab Connected Mobility (TUM LLCM) project and has been funded by the Bavarian Ministry of Economic Affairs, Energy and Technology (StMWi) through the Center Digitisation.Bavaria, an initiative of the Bavarian State Government.

References

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review, 84*(4), 98–107; 148.

Alves, H., Fernandes, C., & Raposo, M. (2016). Value co-creation: Concept and contexts of application and study. *Journal of Business Research, 69*(5), 1626–1633.

Baldwin, C. Y., & Clark, K. B. (2000). *Design Rules: The Power of Modularity (Vol. 1)*. Cambridge, MA: MIT Press.

Benbasat, I., Goldsteins, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly, 11*(3), 369–386.

Benlian, A., Hilkert, D., & Hess, T. (2015). How open is this platform? The meaning and measurement of platform openness from the Complementors' perspective. *Journal of Information Technology, 30*(3), 209–228.

Chesbrough, H. W. (2006). *Open innovation: The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business Press.

Constantinides, P., Henfridsson, O., & Parker, G. G. (2018). Introduction—Platforms and infrastructures in the digital age. *Information Systems Research, 29*(2), 253–523.

Eaton, B., Elaluf-Calderwood, S., Sorensen, C., & Yoo, Y. (2015). Distributed tuning of boundary resources: The case of Apple's Ios service system. *MIS Quarterly, 39*(1), 217–243.

Edvardsson, B., Kristensson, P., Magnusson, P., & Sundström, E. (2012). Customer integration within service development—A review of methods and an analysis of Insitu and Exsitu contributions. *Technovation, 32*(7–8), 419–429.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal, 50*(1), 25–32.

Flick, U. (2009). *An introduction to qualitative research*. London: Sage Publications.

Förderer, J., Kude, T., Schuetz, S. W., & Heinzl, A. (2019). Knowledge boundaries in Enterprise software platform development: Antecedents and consequences for platform governance. *Information Systems Journal, 29*(1), 119–144.

Ghazawneh, A., & Henfridsson, O. (2010). Governing third-party development through platform boundary resources. In *Proceedings of the 31st International Conference on Information Systems*, St. Louis, Missouri, USA.

Ghazawneh, A., & Henfridsson, O. (2013). Balancing platform control and external contribution in third-party development: The boundary resources model. *Information Systems Journal, 23*(2), 173–192.

Ghazawneh, A., & Henfridsson, O. (2015). A paradigmatic analysis of digital application marketplaces. *Journal of Information Technology, 30*(3), 198–208.

Giesbrecht, T., Schwabe, G., & Schenk, B. (2017). Service encounter Thinklets: How to empower service agents to put value cocreation into practice. *Information Systems Journal, 27*(2), 171–196.

Hein, A., Böhm, M., & Krcmar, H. (2018a). Platform configurations within information systems research: A literature review on the example of IoT platforms. In *Proceedings of the Multikonferenz Wirtschaftsinformatik*, Lünbeburg, Germany.

Hein, A., Böhm, M., & Krcmar, H. (2018b). Tight and loose coupling in evolving platform ecosystems: The cases of Airbnb and Uber. In W. Abramowicz & A. Paschke (Eds.), *Business Information Systems (BIS). Lecture Notes in Business Information Processing* (Vol. 320, pp. 295–306). Cham: Springer

Hein, A., Scheiber, M., Böhm, M., Weking, J., & Krcmar, H. (2018c). Towards a Design Framework for Service Platform Ecosystems. In *Proceedings of the 26th European Conference on Information Systems*, Portsmouth, United Kingdom.

Hein, A., Schreieck, M., Wiesche, M., & Krcmar, H. (2016). Multiple-case analysis on governance mechanisms of multi-sided platforms. In *Proceedings of the Multikonferenz Wirtschaftsinformatik*, Ilmenau, Germany.

Hendriks-Jansen, H. (1996). *Catching ourselves in the act: situated activity, interactive emergence, evolution, and human thought*. Cambridge, MA: MIT Press.

Hippel, V. E., & Katz, R. (2002). Shifting innovation to users via toolkits. *Management Science, 48*(7), 821–833.

Lee, K., Lee, B., & Oh, W. (2015). Thumbs up, sales up? The contingent effect of Facebook likes on sales performance in social commerce. *Journal of Management Information Systems, 32*(4), 109–143.

Lewicki, R. J., & Brinsfield, C. T. (2009). Trust, Distrust and Building Social Capital. In V. O. Bartkus, & J. H. Davis (Eds.), *Social Capital: Reaching out, Reaching In* (Vol. 1, pp. 275–303). Cheltenham, UK: Edward Elgar Publishing.

Lusch, R. F., & Nambisan, S. (2015). Service innovation: A service-dominant-logic perspective. *MIS Quarterly, 39*(1), 155–175.

Lusch, R. F., Vargo, S. L., & Tanniru, M. (2010). Service, value networks and learning. *Journal of the Academy of Marketing Science, 38*(1), 19–31.

Matthing, J., Sandén, B., & Edvardsson, B. (2004). New service development: Learning from and with customers. *International Journal of Service Industry Management, 15*(5), 479–498.

McIntyre, D. P., & Srinivasan, A. (2017). Networks, platforms, and strategy: Emerging views and next steps. *Strategic Management Journal, 38*(1), 141–160.

Merriam, S. B. (1988). *Case study research in education: A qualitative approach*. San Francisco, CA: Jossey-Bass.

Moore, J. F. (1993). Predators and prey: A new ecology of competition. *Harvard Business Review, 71*(3), 75–83.

Moore, J. F. (1996). *The death of competition: Leadership and strategy in the age of business ecosystems*. New York: HarperBusiness.

Myers, M. D., & Newman, M. (2007). The qualitative interview in is research: Examining the craft. *Information and Organization, 17*(1), 2–26.

Normann, R. (2001). *Reframing Business: When the Map Changes the Landscape* (Vol. 1). Chichester, UK: John Wiley & Sons.

Orlikowski, W. J. (1992). The duality of technology: Rethinking the concept of Technology in Organizations. *Organization Science, 3*(3), 398–427.

Orton, J. D., & Weick, K. E. (1990). Loosely coupled systems: A reconceptualization. *Academy of Management Review, 15*(2), 203–223.

Parker, G., Van Alstyne, M., & Jiang, X. (2017). Platform ecosystems: How developers invert the firm. *MIS Quarterly, 41*(1), 255–266.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Thousand Oaks, CA: Sage Publications.

Peppard, J., & Rylander, A. (2006). From value chain to value network: Insights for Mobile operators. *European Management Journal, 24*(2–3), 128–141.

Pereira, D., Leitão, J., & Devezas, T. (2017). Coopetition and Co-Innovation: Do Manufacturing and Service Providers Behave Differently? In *Industry 4.0* (pp. 397–431). Berlin, Heidelberg: Springer.

Prahalad, C. K., & Ramaswamy, V. (2004). Co-creation experiences: The next practice in value creation. *Journal of Interactive Marketing, 18*(3), 5–14.

Sarker, S., Sarker, S., Sahaym, A., & Bjørn-Andersen, N. (2012). Exploring value Cocreation in relationships between an Erp vendor and its partners: A revelatory case study. *MIS Quarterly, 36*(1), 317–338.

Schermuly, L., Schreieck, M., Wiesche, M., & Krcmar, H. (2019). Developing an industrial IoT platform – Trade-off between horizontal and vertical approaches. In *Proceedings of the 14th International Conference on Wirtschaftsinformatik*, Siegen, Germany.

Schlagwein, D., & Bjørn-Andersen, N. (2014). Organizational learning with crowdsourcing: The revelatory case of Lego. *Journal of the Association for Information Systems, 15*(11), 754–778.

Schreieck, M., & Wiesche, M. (2017). How Established Companies Leverage It Platforms for Value Co-Creation – Insights from Banking. In *Proceedings of the 25th European Conference on Information Systems*, Guimarães, Portugal.

Schreieck, M., Wiesche, M., & Krcmar, H. (2017). The Platform Owner's Challenge to Capture Value–Insights from a Business-to-Business It Platform. In *Proceedings of the 38th International Conference on Information Systems*, Seoul, South Korea.

Schreieck M., Hein A., Wiesche M., Krcmar H. (2018) The Challenge of Governing Digital Platform Ecosystems. In: Linnhoff-Popien C., Schneider R., Zaddach M. (eds) *Digital Marketplaces Unleashed*. Berlin, Heidelberg: Springer.

Shim, J., Avital, M., Dennis, A. R., Sheng, O., Rossi, M., Sørensen, C., et al. (2017). Internet of things: Opportunities and challenges to business, society, and is research. In *Proceedings of the 38th International Conference on Information Systems*, Boston, USA.

Siggelkow, N. (2007). Persuasion with case studies. *Academy of Management Journal, 50*(1), 20–24.

Skålén, P., Aal, K. A., & Edvardsson, B. (2015). Cocreating the Arab spring: Understanding transformation of service systems in contention. *Journal of Service Research, 18*(3), 250–264.

Stake, R. E. (1995). *The art of case study research*. London: Sage Publications.

Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, & Human Values, 35*(5), 601–617.

Star, S. L., & Griesemer, J. R. (1989). Institutional Ecology,Translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science, 19*(3), 387–420.

Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research, 7*(1), 111–134.

Steensma, H. K., & Corley, K. G. (2000). On the performance of technology-sourcing partnerships: The interaction between partner interdependence and technology attributes. *Academy of Management Journal, 43*(6), 1045–1067.

Steger, C., Hirsch, S., Evers, C., Branoff, B., Petrova, M., Nielsen-Pincus, M., Wardropper, C., & van Riper, C. J. (2018). Ecosystem services as boundary objects for transdisciplinary collaboration. *Ecological Economics, 143*, 153–160.

Strauss, A., & Corbin, J. (1996). *Grounded Theory: Grundlagen Qualitativer Sozialforschung (S. Niewiarra, Trans.)*. Weinheim: Beltz Psychologie Verlags Union.

Teubner, T., & Flath, C. M. (2015). The economics of multi-hop ride sharing. *Business & Information Systems Engineering, 57*(5), 311–324.

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Research commentary—Digital infrastructures: The missing is research agenda. *Information Systems Research, 21*(4), 748–759.

Urquhart, C. (2012). *Grounded theory for qualitative research: A practical guide*. London: Sage Publications.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing, 68*(1), 1–17.

Vargo, S. L., & Lusch, R. F. (2011). It's all B2b… and beyond: Toward a systems perspective of the market. *Industrial Marketing Management, 40*(2), 181–187.

Vargo, S. L., Maglio, P. P., & Akaka, M. A. (2008). On value and value co-creation: A service systems and service logic perspective. *European Management Journal, 26*(3), 145–152.

Walsham, G. (1995). Interpretive case studies in is research: Nature and method. *European Journal of Information Systems, 4*(2), 74–81.

Weick, K. E. (1995). *Sensemaking in Organizations* (Vol. 3): Thousand Oaks, CA: Sage Publications.

Weking, J., Brosig, C., Böhm, M., Hein, A., & Krcmar, H. (2018a). Business Model Innovation Strategies for Product Service Systems–an Explorative Study in the Manufacturing Industry. In *Proceedings of the 26th European Conference on Information Systems*, Portsmouth, United Kingdom.

Weking, J., Hein, A., Böhm, M., & Krcmar, H. (2018b). A hierarchical taxonomy of business model patterns. *Electronic Markets*, 1–22.

Weking, J., Stöcker, M., Kowalkiewicz, M., Böhm, M., & Krcmar, H. (2018c). Archetypes for Industry 4.0 Business Model Innovations. In *Proceedings of the 24th Americas Conference on Information Systems*, New Orleans, USA.

Yin, R. K. (2014). *Case study research: Design and methods*. Thousand Oaks, CA: Sage Publications.

Zervas, G., Proserpio, D., & Byers, J. W. (2017). The rise of the sharing economy: Estimating the impact of Airbnb on the hotel industry. *Journal of Marketing Research, 54*(5), 687–705.

The Influence of Digital Affordances and Generativity on Digital Platform Leadership

Short Paper

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Abstract

The increasing importance of digital platforms is undisputed. Digital platforms integrate and orchestrate an ecosystem of autonomous actors to co-create value instead of relying solely on internal innovation capabilities. To achieve this, the platform owner provides digital affordances through boundary resources that an ecosystem of complementors can use to create value-adding services. The platform combines internal innovation capabilities by providing digital affordances and utilizes external innovation capabilities between complementors that refer to the generativity of the ecosystem. However, it remains unclear how the provision of affordances and the interaction of complementors led to the tremendous success of digital platforms. To disentangle both internal and external innovation capabilities, we adhere to a fuzzy-set qualitative comparative analysis based on a set of 47 platforms. Preliminary results reveal four configurations of leading platforms that combine affordances of the platform and generativity in an ecosystem to point toward a fruitful area for future research.

Keywords: Digital platform ecosystems, platform leadership, generativity, affordances

Introduction

Digital platforms shifted the locus of value creation from inside the firm to an ecosystem of complementors (Parker et al. 2016a). An example is Apple's App Store, where the majority of applications originate from an ecosystem of third-party developers. The platform owner provides boundary resources such as software development kits (SDKs) to increase the digital affordances of the platform, where affordances represent opportunities for complementors to co-create value-adding complements (Ghazawneh and Henfridsson 2013; Nambisan et al. 2019). Those value-adding complements result from the actualization of affordances and can produce unprompted changes by autonomous actors, which defines the generativity of a digital platform ecosystem (Zittrain 2005). For example, Apple's provision of ARKit provides developers with new affordances or ways to develop applications. In turn, developers can use the generativity of the ecosystem by sharing their knowledge with peers to come up with novel applications in the field of augmented reality.

This interplay of providing digital affordances and the subsequent actualization of those affordances with an ecosystem of autonomous complementors illustrates that the success of digital platform ecosystems depends on both the internal innovation capabilities of the platform owner and the capabilities of external complementors in a digital platform ecosystem. Hence, by combining research on the internal facilitation (Baldwin and Woodard 2009; Tiwana et al. 2010) and the external actualization of affordances, which define generativity (Henfridsson and Bygstad 2013; Yoo et al. 2010), it is possible to understand why some platforms strive and others fail.

Research on the internal perspective of digital platforms (Baldwin and Woodard 2009; Tiwana et al. 2010) elaborates on how the platform owner can increase digital affordances of the technical platform (Nambisan et al. 2019). The measures to increase affordances include design criteria such as the malleability of the digital platform (Tilson et al. 2010; Tiwana et al. 2010) or the innovation capabilities of the platform owner represented by patents (Pavitt 1985). Research on the external perspective evaluates an ecosystem of autonomous actors (Adner and Kapoor 2016; Jacobides et al. 2018) and incorporates external measures such as the degree of knowledge sharing in an ecosystem (Dokko et al. 2014) or the autonomy of complementors (Ye and Kankanhalli 2018) that influence the generativity of a digital platform.

To synthesize both perspectives, scholars introduced new concepts such as the distributed tuning of boundary resources through the interaction of the platform owner and actors in the ecosystem (Eaton et al. 2015). These and other results (Henfridsson et al. 2018; Karhu et al. 2018) hint toward the complex and interdependent relationship between the provision of digital affordances through boundary resource development and their actualization by external complementors, which leads to generativity. However, on a holistic perspective, it is still unclear how the interplay of affordances and generativity influence the success of digital platforms (de Reuver et al. 2018). The importance of the provision of affordances, such as ARKit, to gain a competitive advantage is unclear. Alternatively, it is essential to know whether digital platforms depend more strongly on the capabilities of peers, like in the case of knowledge sharing, to utilize the generativity of the ecosystem. In addition, it is necessary to know whether platforms that depend on the provision of affordances are more successful than those that depend on the generativity of their ecosystem. To identify patterns of interaction between the internal and external innovation perspective, we pose the research question: *How do affordances and generativity influence the success of digital platforms?*

Owing to the complexity and interdependencies between affordances provided by the platform owner and generativity created by the ecosystem, we adhere to a fuzzy-set qualitative comparative analysis (fsQCA) (Fiss 2007; Ragin 2008) in the context of 47 digital platforms. The platforms are in different stages of a venture life cycle such as conceptualization, monetization, and growth stages (Fisher et al. 2016). To obtain more detailed results, we added platform cases that failed to establish a new venture and cases where the platform achieved platform leadership (Gawer and Cusumano 2002). On the basis of these stages, we use the concepts of affordances and generativity to derive patterns of successful digital platforms that increase our understanding of how leading platforms use the provision of affordances and the generativity of autonomous complementors to strive. The patterns of the interplay between internal and external innovation capabilities can further guide research toward a more nuanced understanding of platform leadership (Gawer 2014) and inform practitioners on the design criteria of digital platforms.

As part of an ongoing research effort, we preliminarily identify four configurations of affordances and generativity that foster digital platform leadership. However, this is only the first iteration to derive more robust and compelling results on interaction patterns between internal and external innovation capabilities in digital platform ecosystems. For future research work, we plan to conduct further interviews to refine and recalibrate the causal conditions of internal innovation as affordances and those of external innovation as generativity. In addition, we plan to extend the results toward the patterns of failing platform ecosystems.

Related Work

This study is based on the literature on digital platforms (Constantinides et al. 2018; de Reuver et al. 2018) and includes the internal construct of technological platforms (Baldwin and Woodard 2009; Tiwana et al. 2010) or digital infrastructures (Henfridsson and Bygstad 2013; Tilson et al. 2010), and the external construct of ecosystems (Adner and Kapoor 2016; Jacobides et al. 2018). From an internal perspective, the platform owner provides boundary resources to increase digital affordances, as shown by the example of Apple providing ARKit. From an external perspective, autonomous complementors in the ecosystem actualize the affordances by using the generativity of the ecosystem to develop value-adding complements. An example is combining capabilities of complementors to develop novel augmented reality applications.

The Provision of Affordances in Digital Platforms

Digital platforms are central to an ecosystem and orchestrate supply and demand between different actors (Parker et al. 2016a; Parker et al. 2016b). From a technical perspective, actors in the ecosystem access a digital infrastructure through boundary resources such as application programming interfaces (APIs) to create and cultivate digital goods or services (Constantinides et al. 2018; Ghazawneh and Henfridsson 2013). An example is the application platform iOS, where third-party developers use APIs and SDKs to develop applications. Then, the digital platform distributes the applications to an ecosystem of users. In the remainder of this paper, we refer to the construct of a digital platform as "*a set of digital resources—including services and content—that enable value-creating interactions between external producers and consumers"* (Constantinides et al. 2018; Parker et al. 2016b).

Digital platforms, like any other form of technology venture, pass through various stages of development (Evans 2009; Fisher et al. 2016). First, the conceptualization stage describes how new ventures act under uncertainty regarding the plausibility of their underlying technology and the targeted market segment. Second, the commercialization stage demonstrates how the new ventures decrease technological and market-based uncertainties and establish a plausible business model (Kazanjian 1988). Third, the growth stage indicates how the new venture exploits its technology to harvest short-term financial returns (Rajgopal et al. 2003). On the basis of the target market, ventures can either try to ignite the platform into a mass-market, as shown by the example of Facebook, or establish a niche as demonstrated by Dribble. Consequently, the aggressive ignition of a digital platform requires more capital than the slow growth in a niche market (Evans 2009). Last, there can be the stage of platform leadership that emphasizes how the platform establishes a central and dominant position in the market (Gawer and Cusumano 2002).

A crucial characteristic of digital platforms is the provision of digital affordances (Nambisan et al. 2019; Tan et al. 2016), which defines *"what an individual or organization with a particular purpose can do with a technology"* (Majchrzak and Markus 2013). The digital platform needs to be inherently malleable to provide new affordances; specifically, it can be reconfigured to adapt user needs and to prompt new technological advances (Yoo et al. 2010). In addition, digital platforms are built on a modular architecture that ensures composability by integrating new modules without compromising the entire system (Baldwin and Clark 2000; Tiwana et al. 2010). An example is Apple's introduction of the ARKit that complements the iOS platform and is now a breeding ground for third-party developers. This measure illustrates that the degree of malleability or ease with which a platform or modules can be reconfigured can create new affordances for the entire ecosystem (Tiwana et al. 2010). This observation also implies that the platform owner depends on the internal innovation capabilities to introduce new functionality that an ecosystem of complementors can use as new affordances. Studies that try to operationalize the internal innovation capability of a firm use metrics such as patents or the number of new products developed (Balkin et al. 2000; Romijn and Albaladejo 2002).

Furthermore, the platform owner provides boundary resources that enable an ecosystem of complementors to actualize affordances on the digital platform (Eaton et al. 2015; Ghazawneh and Henfridsson 2013). Boundary resources can be APIs that define the openness of digital platforms, SDKs that provide boilerplate code to decrease the cognitive distance between platforms and their ecosystems, and documentation that define work processes on how to use boundary resources (Hein et al. 2019; Karhu et al. 2018). In addition, boundary resources represent the joint effort of the platform owner and complementors to increase the generativity of a digital platform ecosystem. An example is the process of distributed tuning that describes the dynamics between the platform owner and the ecosystem actors on altering boundary resources (Eaton et al. 2015).

Establishing Generativity by Integrating Complementors

The creation of economic value shifted during the last decades from production within single firms to collaboration with individual customers to the co-creation of value in complex ecosystems. From a theoretical perspective, the integration of external actors into the value creation process of a firm goes back to the concept of lead-user integration (Von Hippel 1986) and was seized by other researchers as open innovation (Chesbrough 2012) and value co-creation (Prahalad and Ramaswamy 2004; Vargo and Lusch 2016; Vargo et al. 2008). In addition, the literature on digital platform ecosystems is inherently built on the integration of customers and other partners to leverage external innovation capabilities (Parker et al.

2016a). More recently, scholars in the field of strategy research emphasized the importance of ecosystems as a construct of scientific inquiry (Adner and Kapoor 2016; Jacobides et al. 2018). We follow Jacobides et al. (2018) who define ecosystems as *"a set of actors with varying degrees of multilateral, nongenetic, complementarities that are not fully hierarchically controlled."*

A crucial characteristic of a digital platform ecosystem is its generativity (Henfridsson and Bygstad 2013; Yoo et al. 2010), which defines *"a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences"* (Zittrain 2005). While the digital platform provides affordances in the form of digital infrastructure, the large variety of ecosystem actors fuels the generativity with individual innovation capabilities (Nambisan et al. 2019). An example is the application development industry, where more external complementors on the platform lead to a wider variety and number of complements on the platform (Boudreau 2012). Thus, the decision-making and work-method autonomy of complementors directly influence the number of innovative complements on the digital platform (Ye and Kankanhalli 2018). In addition, the degree of knowledge-sharing in the ecosystem is another factor that increases the creative generativity in the ecosystem (Dokko et al. 2014).

Furthermore, the degree of openness determines the boundaries of an ecosystem and, thus, the generative potential of the digital platform (Nambisan et al. 2019). Gawer (2014) classifies platforms as internal, supply chain, and industry platforms on the basis of the autonomy of agents and the degree of competition in the ecosystem. Internal platforms limit the ecosystem to internal employees with little competition, while technological platforms include an ecosystem of autonomous agents that can compete with one another. Restricting the degree of openness can further reduce competition and increase the control of the platform owner over the installed base of complements (Ghazawneh and Henfridsson 2013). In turn, relinquishing control and increasing the degree of openness can limit the platform owner's influence on complementors but fuel the generativity of the broader ecosystem (Remneland-Wikhamn et al. 2011).

Thus, the success of a digital platform can be operationalized through the different stages of platform development; digital affordances can be operationalized through the degree of malleability and internal innovation capabilities of the platform owner; generativity of the platform ecosystem can be operationalized through the degree of knowledge-sharing and the autonomy of complementors in the ecosystem. Finally, boundary resources align both perspectives and can be operationalized by APIs and the degree of platform openness and the cognitive distance through the provision of SDKs.

Method

This study builds on a fsQCA as a novel methodology for modeling complex and causal relations *"that are frequently better understood in terms of set-theoretic relations rather than correlation."* (Fiss 2007; Ragin 2008). The fsQCA has proven to be useful in conditions where the relationship between different causal conditions cannot be observed in isolation but can be classified as a *"conjunctural causation"* (Durand and Vaara 2009). In the context of digital platforms, both affordances provided by the platform and the interactions of an ecosystem to actualize those affordances to create generativity are needed to make a digital platform strive. To determine configurations of core and peripheral conditions of an outcome, such as platform leadership, the fsQCA uses logical minimization of a truth table that represents causal conditions such as affordances and generativity. The design of APIs refers to technological openness, and the design of SDKs describes cognitive distance between platform owner and complementors (Ragin 2008).

The fsQCA identifies differences and commonalities across a set of cases (digital platforms) to yield configurations that share the same outcome. Hence, we use a sampling strategy that incorporates digital platforms at different lifecycle stages ranging from failure, conceptualization, monetization, small growth in niche markets, ignition into mass markets, and platform leadership. On the basis of the recommendation of Ragin (2008), we selected 47 digital platforms, which we categorized as follows: six – failure stage, four – conceptualization stage, nine – monetization stage, thirteen – small niche market growth stage, eight – mass-market growth stage, and seven – platform leadership stage cases. As an empirical basis, we conducted 51 semi-structured interviews with the platform owners to gather information on how they provide affordances, how the ecosystem contributes to the generativity, and on the design of boundary resources. We triangulated the data with market reports, patent data, and archival data gathered in a period from mid-2018 to the end of the first quarter of 2019.

We use the literature on digital platforms to guide the calibration process of the causal conditions regarding the set membership. In particular, we integrate the internal perspective of the platform owner and the provision of affordances and the external perspective of ecosystem actors that foster generativity by identifying antecedents of platform failure and leadership. During the calibration process, we follow prior research (Ragin 2008) that defines 0 as full-non membership, 0.5 as maximum ambiguity, and 1 as full membership. In addition, we use qualitative data in the form of interview transcripts and quantitative data such as archival data from GitHub to calibrate hard to measure constructs, such as knowledge sharing in an ecosystem (Vasilescu et al. 2014). We followed the stepwise procedure of Basurto and Speer (2012) to calibrate the qualitative data starting with the operationalization of conditions, development of anchor points, conduction of content analysis, summarizing of the coded data, and determining the fuzzy-set scale. Because this contribution is part of an ongoing research endeavor, further iterations of interviews will provide new insights that help to recalibrate causal conditions to obtain more meaningful configurations.

Data Sources

Measuring the success of digital platforms can be a challenging task. For example, Uber is an undisputed platform leader in terms of market share even though in the year of 2018 its losses were greater than profits (Zaveri and Bosa 2019). However, niche markets may have a low degree of market penetration but sustainable profits. Hence, we decided to use digital platform lifecycle stages (OUT) as a proxy for platform success. We used market data from CrunchBase, empirical results from interviewees and market reports, and archival data to calibrate a platform's current lifecycle stage. The value of 0 means that the platform went bankrupt or failed, 0.2 refers to a newly emerging platform that tries to establish a concept, 0.4 refers to platforms that try to monetize their concepts, 0.6 refers to platforms growing into niche markets, 0.8 refers to platforms that rapidly ignite into mass markets, and 1 refers to platform leadership.

The first causal condition represents the platform owners' ability to file patents (PU) as a preliminary proxy of the ability to provide *digital affordances*. We code companies that filed patents subject to their digital platform as 1 and companies without patents as 0. During the next iteration of interviews, we plan to inquire on more sophisticated metrics such as the degree of the malleability of the technical infrastructure to refine the first results of the fsQCA.

We measure the *generativity* of a digital platform on the basis of the complementors' autonomy (CA) and the degree of knowledge sharing (KS). For the complementor's autonomy, we adhere to decision-making autonomy (Ye and Kankanhalli 2018). We differentiate between no autonomy, which refers to the internal provision of complements by the platform owner as 0 to a low degree of autonomy, which is represented by the tight coupling with few, strategic partnerships as 0.33, to a tight coupling with many contractually-bounded partners as 0.66, to high autonomy and loosely-coupled complementors as 1. In addition, on the basis of the active number of GitHub repositories, we determine the degree of knowledge-sharing (Vasilescu et al. 2014). We fuzzified the repositories on the basis of the direct method and the three anchor points (Ragin 2008) of 10 repositories, which indicate limited-knowledge sharing, 50 as the cross-over point, and more than 500 as a high degree of knowledge sharing. We selected the anchor points on the basis of the substantive knowledge of reviewing GitHub commits and issues discussed in the repositories.

Furthermore, we measure the use of *boundary resources* on the basis of the degree of cognitive distance (CD) between platform owner and complementor and the technological openness (TO) of APIs. The cognitive distance indicates the ease of providing new products or service on the platform by offering tools and information on how to interact. We coded a high degree of cognitive distance as 0, when the platform owner does not provide SDKs, code snippets, or documentation on how to interact with the platform; 0.33 if documentation, such as code snippets, or an internal developer website, is available; 0.66 if the platform owner provides SDKs that lack documentation; and 1 if the platform owner provides both documentation and SDKs. The degree of technological openness describes whether the platform is closed or open. We adhere to similar metrics to measure the cognitive distance that codes digital platforms: 0 if they provide no APIs or other ways to integrate complements; 0.33 if the platform does not offer APIs but has a restricted process to integrate complements; 0.66 if APIs are available but there is no further documentation; 1 if both APIs and documentation are available.

Analysis

On the basis of the five causal conditions and the calibrated fuzzy sets, the fsQCA proceeds with a three-step approach (Fiss 2007). First, we use the R package QCA to construct a truth table where each row includes zero to many cases that describe all logically possible combinations of causal conditions toward an outcome variable. Second, the fsQCA proceeds with a minimization of the truth table to derive cases that fulfill the minimum number of cases, and that adhere to a minimum consistency level required. We set the minimum number of cases to two and the consistency level to 0.80, which is above the suggested threshold of 0.75 (Ragin 2008). Last, the truth table algorithm calculates the consistency scores of raw consistency and proportional reduction in inconsistency (PRI), both of which determine the reliability of configurations. While the raw consistency gives credit for inconsistencies resulting from "near misses," the PRI accounts for cases that have simultaneous membership in both the complements and outcome. Similar to prior studies (Park et al. 2017), we set the cutoff for the raw consistency and PRI to 0.80. Table 1 shows the minimized truth table of succeeding digital platform configurations.

Table 1 Minimized truth table of succeeding digital platform configurations

PU	CA	KS	TO	CD	OUT	Number	Raw consistency	PRI consistency	Cases
0	1	1	1	0	1	2	1.00	1.00	37, 39
1	1	1	1	0	1	2	1.00	1.00	33, 43
1	1	1	1	1	1	8	.97	.97	22, 38, 41, 42, 44, 45, 46, 47
1	0	0	0	1	1	2	.96	.93	28, 34
1	0	0	0	0	1	2	.92	.86	35, 40

Preliminary Results, Discussion, and Next Steps

The preliminary results yielded by the intermediate solution of our analysis suggest that there are four configurations of sufficient conditions for the leading digital platforms (Table 2). We build on the notation introduced by Fiss (2011), who uses large circles to denote core conditions and small circles to denote peripheral conditions. Black circles indicate the presence of a condition, while crossed-out circles indicate its absence. Empty cells indicate that the condition is not relevant for a particular configuration.

Table 2 Configurations of the leading digital platforms

Theme	Configuration elements	Configurations for leading platforms Innovation	 Technology	 Transaction	 Integration
Affordances	Patent use	⬤	⬤		⊗
Generativity	Complementor autonomy	•	⊗	•	•
	Knowledge-sharing	⬤	⊗	⬤	⊗
Boundary resources	Technological openness	•	⊗	•	•
	Cognitive distance			⊗	⬤
Consistency		.97	0.91	1.00	0.80
Raw coverage		.35	.11	.17	.18
Unique coverage		.30	.11	.04	.10
Overall solution consistency		**.91**			
Overall solution coverage		**.68**			

The core conditions indicate that each configuration utilizes different aspects of affordances, generativity, and boundary resources. *Innovation platforms* rely both on the internal provision of affordances and the generativity of the ecosystem, which can be illustrated by the core conditions of patent use and knowledge sharing. In addition, innovation platforms indicate technological openness through the provision of APIs that complementors can use to co-create value-adding complements. Examples are application stores, where the platform provides boundary resources that an ecosystem of autonomous complementors can use to create new applications. In turn, each complementor has access to a variety of applications to obtain new ideas, which increases the generativity of the ecosystem.

Technology platforms depend solely on the internal provision of affordances, as indicated by the core condition of patent use indicates. In addition, technology platforms show the absence of complementor autonomy, knowledge-sharing, and technology openness. The occurs because technology platforms are closed and are only fueled by the internal innovation capabilities of the platform owner. The direct consequence is that the platform does not take advantage of the generativity of ecosystem partners, because the technology platform enables value-creating interactions only within the boundaries of the partners' company. Hence, partners do not mirror innovations back to the platform owner. The examples include technology platforms that aid ecosystem partners to co-create new applications using artificial intelligence.

Transaction platforms do not rely on the provision of new affordances. Rather, they rely on the generativity of a vibrant ecosystem, as shown by the core condition of knowledge sharing. The generativity is further fueled by the high autonomy of complementors and technological openness. In addition, the cognitive distance is high, as the main goal is the orchestration of generic services between the supply and demand and not the integration of innovative complements. The examples include digital platforms that focus on the convenient facilitation of generic goods and services such as marketplaces and transportation services.

Integration platforms do not utilize the provision of affordances and only partly take advantage of the generativity of their ecosystem. They are characteristics by the high degree of complementor autonomy, technological openness, and the absence of patents and knowledge sharing. A key characteristic is the low cognitive distance, which demonstrates that integration platforms try to make the provision of new complements as easy as possible. This configuration illustrates that integration platforms are reactive and either allow complementors to use the data provided by the platform or to integrate their services on a meta platform. Both cases can be illustrated on the basis of the case of mobility, where the platform can be the source of data due to open APIs and SDKs or the aggregator of mobility services acting as a meta platform.

The four configurations reveal how internal innovation capabilities or affordances and the external actualization of those affordances, which are represented as generativity, influence the success of digital platforms. First, innovation platforms rely on internal innovation capabilities by providing boundary resources that allow deep integration of complements into the digital platform (Ghazawneh and Henfridsson 2013). The complements are supermodular, which means that every new complement increases the overall value of the platform (Jacobides et al. 2018), which makes the platform less vulnerable to multi-homing effects and fuels the generativity of the ecosystem. However, innovation platforms need internal resources to keep up with the latest innovations and development to stay competitive. In addition, they need a malleable and composable infrastructure (Tiwana et al. 2010) to continuously provide new affordances to the ecosystem. Second, technology platforms depend solely on their internal resources to provide affordances to a closed set of ecosystem partners. The complements show a unique complementary, which means that companies need to use the platform to create new services (Jacobides et al. 2018). However, because the services are not mirrored back to the platform owner, the platform does not profit from the generativity of the ecosystem. Third, transaction platforms benefit from a first-mover advantage and strong indirect network effects (McIntyre and Srinivasan 2017). However, the interviews also revealed that they are prone to multi-homing effects because they do not have internal innovation capabilities and rely on generic goods and services. Fourth, integration platforms build on SDKs to reduce the cognitive dissonance and technological openness through APIs to enable autonomous actors to either integrate their services or to use the data provided. The integration foster supermodularity because new services increase the value of the platform. However, the boundary resources strictly define what services can be integrated, which limits the generativity of the ecosystem.

The intersection analysis reveals that only innovation platforms and technology platforms intersect; all other configurations are disjoint (Park et al. 2017). A reason for this intersection is that patents can be filed in transaction platforms to improve the efficiency of transaction platforms. However, patents are not used to mirror new affordances to the ecosystem, which indicates that patents need to be analyzed more carefully to determine the provision of affordances. By interpreting conditions as patterns of equifinality (Fiss 2011), the configurations reveal that transaction platforms can transition toward innovation platforms if they build internal innovation capabilities. However, technology platforms need to shift from the absence of technology openness, knowledge-sharing, and complementor autonomy toward fostering generativity by opening up the digital platforms (Ondrus et al. 2015). The configurations reveal the different pattern on how successful platforms utilize affordances and the generativity of an ecosystem. Research on digital platforms can use the four configurations to specify the term digital platform more carefully, hence, accounting for the different patterns of providing affordances and utilizing the ecosystem generativity through boundary resources. Besides, practitioners can use the results to learn how different platform configurations use internal and external innovation capabilities to be successful.

This study presents preliminary results and is part of a larger research endeavor. While we already conducted 51 interviews to establish theoretical sensitivity, more interviews are needed to refine and recalibrate variables. In addition, more specific questions that are informed by the preliminary results could help to provide additional information on the relationship between internal innovation capabilities and the provision of affordances, and the ecosystem that actualizes the affordances to create generativity.

References

Adner, R., and Kapoor, R. 2016. "Innovation Ecosystems and the Pace of Substitution: Re-Examining Technology S-Curves," *Strategic Management Journal* (37:4), pp. 625-648.

Baldwin, C. Y., and Clark, K. B. 2000. *Design Rules: The Power of Modularity*. Cambridge, MA: MIT Press.

Baldwin, C. Y., and Woodard, C. J. 2009. "The Architecture of Platforms: A Unified View," in *Platforms, Markets and Innovation,* A. Gawer (ed.). Cheltenham, UK: Edward Elgar Publishing Limited.

Balkin, D. B., Markman, G. D., and Gomez-Mejia, L. R. 2000. "Is Ceo Pay in High-Technology Firms Related to Innovation?," *Academy of Management Journal* (43:6), pp. 1118-1129.

Basurto, X., and Speer, J. 2012. "Structuring the Calibration of Qualitative Data as Sets for Qualitative Comparative Analysis (Qca)," *Field Methods* (24:2), pp. 155-174.

Boudreau, K. J. 2012. "Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation," *Organization Science* (23:5), pp. 1409-1427.

Chesbrough, H. 2012. "Open Innovation: Where We've Been and Where We're Going," *Research-Technology Management* (55:4), pp. 20-27.

Constantinides, P., Henfridsson, O., and Parker, G. G. 2018. "Introduction—Platforms and Infrastructures in the Digital Age," *Information Systems Research* (29:2), pp. 3-6.

de Reuver, M., Sørensen, C., and Basole, R. C. 2018. "The Digital Platform: A Research Agenda," *Journal of Information Technology* (33:2), pp. 124-135.

Dokko, G., Kane, A. A., and Tortoriello, M. 2014. "One of Us or One of My Friends: How Social Identity and Tie Strength Shape the Creative Generativity of Boundary-Spanning Ties," *Organization Studies* (35:5), pp. 703-726.

Durand, R., and Vaara, E. 2009. "Causation, Counterfactuals, and Competitive Advantage," *Strategic Management Journal* (30:12), pp. 1245-1264.

Eaton, B., Elaluf-Calderwood, S., Sorensen, C., and Yoo, Y. 2015. "Distributed Tuning of Boundary Resources: The Case of Apple's Ios Service System," *MIS Quarterly* (39:1), pp. 217-243.

Evans, D. S. 2009. "How Catalysts Ignite: The Economics of Platform-Based Start-Ups," in *Platforms, Markets and Innovation,* A. Gawer (ed.). Cheltenham, UK: Edward Elgar Publishing, pp. 99-128.

Fisher, G., Kotha, S., and Lahiri, A. 2016. "Changing with the Times: An Integrated View of Identity, Legitimacy, and New Venture Life Cycles," *Academy of Management Review* (41:3), pp. 383-409.

Fiss, P. C. 2007. "A Set-Theoretic Approach to Organizational Configurations," *Academy of Management Review* (32:4), pp. 1180-1198.

Fiss, P. C. 2011. "Building Better Causal Theories: A Fuzzy Set Approach to Typologies in Organization Research," *Academy of Management Journal* (54:2), pp. 393-420.

Gawer, A. 2014. "Bridging Differing Perspectives on Technological Platforms: Toward an Integrative Framework," *Research Policy* (43:7), pp. 1239-1249.

Gawer, A., and Cusumano, M. A. 2002. *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation*. Harvard Business School Press Boston, MA.

Ghazawneh, A., and Henfridsson, O. 2013. "Balancing Platform Control and External Contribution in Third-Party Development: The Boundary Resources Model," *Information Systems Journal* (23:2), pp. 173-192.

Hein, A., Weking, J., Schreieck, M., Wiesche, M., Böhm, M., and Krcmar, H. 2019. "Value Co-Creation Practices in Business-to-Business Platform Ecosystems," *Electronic Markets* (In print), pp. 1-16.

Henfridsson, O., and Bygstad, B. 2013. "The Generative Mechanisms of Digital Infrastructure Evolution," *MIS Quarterly* (37:3), pp. 907-931.

Henfridsson, O., Nandhakumar, J., Scarbrough, H., and Panourgias, N. 2018. "Recombination in the Open-Ended Value Landscape of Digital Innovation," *Information and Organization* (28:2), pp. 89-100.

Jacobides, M. G., Cennamo, C., and Gawer, A. 2018. "Towards a Theory of Ecosystems," *Strategic Management Journal* (39:8), pp. 2255-2276.

Karhu, K., Gustafsson, R., and Lyytinen, K. 2018. "Exploiting and Defending Open Digital Platforms with Boundary Resources: Android's Five Platform Forks," *Information Systems Research* (29:2), pp. 479-497.

Kazanjian, R. K. 1988. "Relation of Dominant Problems to Stages of Growth in Technology-Based New Ventures," *Academy of Management Journal* (31:2), pp. 257-279.
Majchrzak, A., and Markus, M. L. 2013. "Technology Affordances and Constraints in Management Information Systems (Mis)," in *Encyclopedia of Management Theory,* E. Kessler (ed.). Thousand Oaks, CA: SAGE Publications, p. 832.
McIntyre, D. P., and Srinivasan, A. 2017. "Networks, Platforms, and Strategy: Emerging Views and Next Steps," *Strategic Management Journal* (38:1), pp. 141-160.
Nambisan, S., Wright, M., and Feldman, M. 2019. "The Digital Transformation of Innovation and Entrepreneurship: Progress, Challenges and Key Themes," *Research Policy* (In print), pp. 1-9.
Ondrus, J., Gannamaneni, A., and Lyytinen, K. 2015. "The Impact of Openness on the Market Potential of Multi-Sided Platforms: A Case Study of Mobile Payment Platforms," *Journal of Information Technology* (30:3), pp. 260-275.
Park, Y., El Sawy, O. A., and Fiss, P. 2017. "The Role of Business Intelligence and Communication Technologies in Organizational Agility: A Configurational Approach," *Journal of the Association for Information Systems* (18:9), pp. 649-686.
Parker, G., Van Alstyne, M., and Jiang, X. 2016a. "Platform Ecosystems: How Developers Invert the Firm," *MIS Quarterly* (41:1), pp. 255-266.
Parker, G. G., Van Alstyne, M. W., and Choudary, S. P. 2016b. *Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You*. New York, NY: WW Norton & Company.
Pavitt, K. 1985. "Patent Statistics as Indicators of Innovative Activities: Possibilities and Problems," *Scientometrics* (7:1-2), pp. 77-99.
Prahalad, C. K., and Ramaswamy, V. 2004. "Co-Creation Experiences: The Next Practice in Value Creation," *Journal of Interactive Marketing* (18:3), pp. 5-14.
Ragin, C. C. 2008. *Redesigning Social Inquiry: Fuzzy Sets and Beyond*. Chicago, IL: Univ. of Chicago Press.
Rajgopal, S., Venkatachalam, M., and Kotha, S. 2003. "The Value Relevance of Network Advantages: The Case of E–Commerce Firms," *Journal of Accounting Research* (41:1), pp. 135-162.
Remneland-Wikhamn, B., Ljungberg, J., Bergquist, M., and Kuschel, J. 2011. "Open Innovation, Generativity and the Supplier as Peer: The Case of Iphone and Android," *International Journal of Innovation Management* (15:1), pp. 205-230.
Romijn, H., and Albaladejo, M. 2002. "Determinants of Innovation Capability in Small Electronics and Software Firms in Southeast England," *Research Policy* (31:7), pp. 1053-1067.
Tan, T. C. F., Tan, B., and Pan, S. L. 2016. "Developing a Leading Digital Multi-Sided Platform: Examining It Affordances and Competitive Actions in Alibaba.Com," *Communication of the AIS* (38), pp. 739-760.
Tilson, D., Lyytinen, K., and Sørensen, C. 2010. "Research Commentary—Digital Infrastructures: The Missing Is Research Agenda," *Information Systems Research* (21:4), pp. 748-759.
Tiwana, A., Konsynski, B., and Bush, A. A. 2010. "Research Commentary—Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics," *Information Systems Research* (21:4), pp. 675-687.
Vargo, S. L., and Lusch, R. F. 2016. "Institutions and Axioms: An Extension and Update of Service-Dominant Logic," *Journal of the Academy of Marketing Science* (44:1), pp. 5-23.
Vargo, S. L., Maglio, P. P., and Akaka, M. A. 2008. "On Value and Value Co-Creation: A Service Systems and Service Logic Perspective," *European Management Journal* (26:3), pp. 145-152.
Vasilescu, B., Serebrenik, A., Devanbu, P., and Filkov, V. 2014. "How Social Q&a Sites Are Changing Knowledge Sharing in Open Source Software Communities," *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing*, Baltimore, MD: ACM, pp. 342-354.
Von Hippel, E. 1986. "Lead Users: A Source of Novel Product Concepts," *Management Science* (32:7), pp. 791-805.
Ye, H., and Kankanhalli, A. 2018. "User Service Innovation on Mobile Phone Platforms: Investigating Impacts of Lead Userness, Toolkit Support, and Design Autonomy," *MIS Quarterly* (42:1).
Yoo, Y., Henfridsson, O., and Lyytinen, K. 2010. "Research Commentary—the New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research," *Information Systems Research* (21:4), pp. 724-735.
Zaveri, P., and Bosa, D. 2019. "Uber's Growth Slowed Dramatically in 2018." Retrieved 01.04.2019, 2019, from https://www.cnbc.com/2019/02/15/uber-2018-financial-results.html
Zittrain, J. L. 2005. "The Generative Internet," *Harvard Law Review* (119), pp. 1975-2039.

TOWARD A DESIGN FRAMEWORK FOR SERVICE-PLATFORM ECOSYSTEMS

Research paper

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Abstract

The emergence of digital platforms disrupts the way we communicate, interact, and utilize services. We increasingly find ourselves in a world shifting away from Goods-Dominant (G-D) toward Service-Dominant (S-D) logic. One crucial aspect of this is the way we will use mobility in the future. In the past, we relied on goods in the form of privately owned cars to travel from point A to point B. However, platforms such as Uber, Lyft, DriveNow, and car2go change the way we use mobility from owning a car to using mobility as a service (MaaS). Although we have gathered knowledge about how to optimize production processes in the G-D world, how to design successful platform ecosystems from an S-D perspective is unclear. In this article, we took a design science research approach to developing a framework that helps scholars to systematically compare, and practitioners to design, a mobility service platform ecosystem (MSPE). First, we started with a literature review to ground the artifact in S-D and MaaS research. We then developed the framework iteratively, drawing from literature and two case studies representing a public and private mobility platform. The resulting artifact is a first step toward providing a structural, reproducible framework to design MSPEs that ensures comparability across platform ecosystems.

Keywords: digital platforms, mobility as a service, mobility platform, platform ecosystem, service-dominant logic

1 Introduction

Digital platforms have changed the way we communicate, socialize, interact, consume, and share with one another. Examples range from Social Media platforms such as Facebook, through merchant platforms such as Amazon or eBay, to the sharing economy with its recent key players Airbnb and Uber. Those companies exploit network effects by connecting two or more interest groups within an ecosystem that a digital platform mediates (McIntyre and Srinivasan, 2017, de Reuver et al., 2016). The more Uber drivers there are on the platform, the better the coverage for potential passengers. Conversely, more passengers on the platform increases the number of possible rides for the drivers. Besides network effects, platform companies offer digital services, which allows them to transmit, capture, and monetize the various data sources within the ecosystem (Evans and Gawer, 2016).

As more and more physical goods become digital, platforms continue to affect the way we live. One particular aspect is connected mobility, where the shift of mobility from Goods-Dominant (G-D) to Service-Dominant (S-D) logic is omnipresent (Lusch and Nambisan, 2015, Harrington, 2002). When traveling from point A to point B, people are no longer restricted to using their own cars. They can also access mobility as a service (MaaS) through different providers including on-demand ridesharing platforms (Greenwood and Wattal, 2017). Current platforms exhibit different aspects of MaaS. These range from sharing cars, bikes, and rides to intermodal mobility services (Spickermann et al., 2014, Firnkorn and Müller, 2011, Teubner and Flath, 2015, Willing et al., 2017).

One critical question—how should digital platforms should be designed?—remains unanswered (de Reuver et al., 2016). Neither scientists nor practitioners currently have an artifact that helps them to create transparency about how to design a platform ecosystem. Although there are well-established theories pertaining to S-D-logic service innovation and platforms (Lusch and Nambisan, 2015, Barrett et al., 2016, Benlian et al., 2015, Tiwana, 2015), none provides the necessary guidance on how to decompose a platform ecosystem. Resolving this issue entails theoretical and practical implications. On the one hand, scientists would benefit from a tool with which they can model specific parts of a platform ecosystem thereby enabling them to systematically compare different platforms. The benefits are reproducible, comparable outcomes and increased scientific rigor when modeling platform ecosystems. On the other hand, the practitioners could benefit from having a design artifact that reduces the complexity of platform ecosystems and makes dynamics between different actors within a platform more transparent.

We adopt a design science research (DSR) approach (Gregor and Hevner, 2013, Hevner et al., 2004a) to developing a design framework for a configurable mobility service platform ecosystem (MSPE). To ensure practical relevance, we constrain the scope to a concise domain that is becoming increasingly important (Greenwood and Wattal, 2017, Willing et al., 2017). Further, we increase scientific rigor by carrying out a systematic literature review (SLR) to establish a knowledge base pertaining to MSPEs. We also engage in closely interlinked relevance, rigor, and evaluation cycles within two mobility service platforms (private and public) when creating the artifact (Hevner et al., 2004a, Hevner, 2007). In the remainder of this article, we start with the theoretical background as the basis for the artifact to be developed. We next explain the methods used to increase scientific rigor and the case studies to ensure practical relevance. After that, we describe the artifact in the form of three morphological boxes to design a configurable MSPE. We then demonstrate the artifact on the example of two case studies involving a private transportation operator operating in the field of floating carsharing services and a public transportation authority administering an intermodal mobility platform. Lastly, we discuss theoretical and practical implications, show avenues for future research, and highlight the research's limitations.

2 Theoretical Background

In this section, we describe the fundamental theories we use to develop a design framework for configurable MSPEs. We summarize S-D logic to emphasize the shift from tangible producer-consumer to intangible value-creation relationships and introduce S-D logic's three dimensions: service ecosystems, service platforms, and value co-creation. We then present the context from the MaaS perspective.

2.1 Service-Dominant Logic

Researchers have heretofore explained the institutional logic of how organizations and entrepreneurs interpret, learn, and advance mostly from a G-D-logic perspective (North, 1994, Vargo and Lusch, 2004, Vargo and Lusch, 2008). G-D logic elucidates effects, such as specialization and standardization, on tangible products or goods to benefit from control and efficiency (Vargo and Lusch, 2004, Vargo and Lusch, 2008). S-D logic focuses instead on the exchange of services during which one actor uses a set of skills and capabilities to benefit another actor. S-D logic focuses on services instead of products. As we are investigating the development a framework to design MSPEs, we apply S-D logic. Lusch and Nambisan (2015) made a remarkable contribution by conceptualizing S-D logic along three dimensions: service ecosystem, service platform, and value co-creation. Each dimension addresses different issues and concepts from the S-D-logic perspective.

2.1.1 Service Ecosystem

A service ecosystem is a community of interacting actors organized in an actor-to-actor (A2A) network (Orlikowski, 1992). Actors within the A2A network co-evolve their skills and roles, depending on each other to strive for effectiveness (Moore, 1993). Accordingly, we adopt the definition of service ecosystems proposed by Vargo and Lusch (2011) as a somewhat self-adjusted, self-contained system of regularly loosely coupled economic and social actors. A service ecosystem connects different actors through an exchange of services via mutual value creation and shared institutional logic. Lusch and Nambisan (2015) identify three issues that scholars and practitioners need to consider along this dimension. First, the ecosystem needs to provide structural flexibility and structural integrity. Structural flexibility is the ease with which actors can collaborate within an ecosystem; it governs business agility (Tilson et al., 2010). Structural integrity describes the relationship between the actors within an A2A network and their degree of coupling, fostering engagement within the ecosystem (Lewicki and Brinsfield, 2009). Second, service ecosystems need to offer a shared worldview to bridge the cognitive distance between two actors (Hendriks-Jansen, 1996, Weick, 1995). A shared worldview in the form of mutual standards or mental frameworks can ensure that actors mutually interpret the integration of resources and that they come together more quickly to exchange resources (Lusch and Nambisan, 2015). Third, the service ecosystem needs to provide an architecture of participation. This architecture facilitates the coordination and engagement of actors with the help of transparent rules and provides transparency vis-à-vis the actor's contribution.

2.1.2 Service Platform

A service platform liquefies resources and enhances resource density to facilitate efficient, effective service exchange in a service ecosystem. Resource liquefaction in this context refers to the decoupling of information from a physical good, form, or device (Normann, 2001). Resource density describes the speed with which resources can be effectively and efficiently mobilized for an actor (Normann, 2001, Lusch et al., 2010). A layered-modular structure facilitates either functional designs leading to different core value propositions or cross-design hierarchies creating completely new value propositions (Baldwin and Clark, 2000). Such an architecture also enables more scalable coordination of service exchanges, thus leading to more opportunities for value co-creation (Lusch and Nambisan, 2015). The modular architecture engenders the need for platform governance or protocols. The associated rules define the way interactions in the A2A network are governed, ranging from an open policy to closed, restrictive rules (Lusch and Nambisan, 2015, Hein et al., 2016, Schreieck et al., 2018, Schreieck et al., 2016a). We adopt the definition of Lusch and Nambisan (2015) for a service platform as a modular structure that combines tangible and intangible resources or components and coordinates the interaction of resources and actors.

2.1.3 Co-Creation of Value

The platform facilitating actors' interaction in a service ecosystem determines the co-creation process. From the S-D-logic perspective, actors can assume different roles and integrate a variety of resource types to create value. Accordingly, the definition provided by Lusch and Nambisan (2015) incorporates actors able to play different roles within the service ecosystem and relying on processes and activities needing resource integration. S-D logic differentiates ideator, designer, and intermediary actors. The ideator distributes knowledge about specific (customer) needs in a unique context, which he/she can then integrate into existing market offerings. The designer incorporates the ability to mix and match existing resources or knowledge to develop new services. The intermediary distributes and shares knowledge across multiple service ecosystems and serves as an intermediary. Each role integrates existing resources and knowledge with peers in the ecosystem, resulting in new service opportunities. However, uncertainty about who ecosystem actors are, what and whom they know, and what they can do negates potential opportunities. Lusch and Nambisan (2015) describe three issues that scholars and practitioners should address. First, they assert, the more actors interact, the more they learn from one another, which in turn determines what they can do as actors. The same is true for the communication channels. The more interactive the channels, the more plentiful the opportunities for resource integration and service exchange. Second, internal processes also need to foster value co-creation within the service ecosystem. Third, clarifying and communicating the platform's rules and protocol is essential to resolving intellectual-property issues (Lusch and Nambisan, 2015).

We structured our configurable-MSPE artifact along these dimensions to ensure that it rests upon the meta-theoretical foundations of S-D logic (Lusch and Nambisan, 2015).

2.2 Mobility as a Service

MaaS is a relatively new concept intended to characterize mobility in terms of new behaviors aided by technology and new transportation solutions (Jittrapirom et al., 2017). Hietanen (2014) provided one of the first definitions of MaaS. It defines MaaS as a mobility-distribution model for a service provider to satisfying users' transportation needs through a single interface. The model associates various transportation modes to offer a customized mobility package. New elements and characteristics have emerged over the years (Sochor et al., 2015, Atasoy et al., 2015). In this article, we draw on the work of Jittrapirom et al. (2017), who reviewed the literature on MaaS concepts and derived nine core characteristics from it (see Table 1).

Core characteristic	Description
1. Integration of transportation modes	Bringing together multi-modal transportation, which allows users to choose and facilitates their intermodal trips. Transportation modes: taxi, public transportation, carsharing, bike-sharing, ride-sharing, car-rental, on-demand services, long-distance buses, trains, flights, and ferries.
2. Tariff option	The MaaS platform distinguishes two tariffs for accessing mobility services. Mobility package: various transportation modes are bundled with a certain number of minutes/km/points for a monthly payment. Pay-as-you-go: users are charged for actual use of the service.
3. One platform	Digital platform facilitates the provision of mobility services to the end-user. Services: booking, trip planning, payment, ticketing, and real-time information. Additional services: weather forecasting, synchronization with personal-activity calendar, travel-history report, invoicing, and feedback.
4. Multiple actors	A MaaS ecosystem connects various actors through a platform. Actors: demanders of mobility, supplier of transportation services, and platform owners Additional actors: local authorities, payment clearing, and telecommunication and

	data-management companies
5. Use of technologies	Different technologies are combined to enable MaaS. Technologies: mobile computers, smartphones, mobile internet, GPS, e-ticketing, e-payment systems, database management systems, and internet-of-things technologies.
6. Demand orientation	MaaS reflects a user-centric design paradigm, which seeks to offer a transportation solution that fits the customer's perspective and context.
7. Registration requirement	Registration acts as a barrier to platform entry and is a prerequisite for offering personalized services.
8. Personalization	MaaS ensures personalization so that the system meets the customer's needs more effectively.
9. Customization	The customers' ability to modify offered mobility services according to their needs.

Table 1. Core mobility as a service characteristics (Jittrapirom et al., 2017)

In summary, the theoretical background covers S-D-service logic as the theoretical basis and core MaaS characteristics as the mobility context. The combination provides the theoretical foundation for the configurable-MSPE design framework.

3 Methods

Methods for building a configurable-MSPE framework are broken down into two phases. First, we conduct a structured literature review (SLR) identify the current theoretical perspective from which important characteristics are viewed when designing an MSPE. Second, we adopt a design science research (DSR) approach to developing the MSPE design framework based on those findings and two case studies.

3.1 Structured Literature Review

The SLR was approached as described by Webster and Watson (2002). Based on the research question about how to design a configurable-MSPE framework, we looked for publications covering platform- as well as mobility-service characteristics. We queried the Scopus and EBSCOhost databases using the search string "Platform" AND "Service" OR "Mobility" AND "Service." As the unfiltered combination of both search terms would yield an unmanageable number of research papers, we limited the results to top journals included in the IS Senior Scholars' Basket of the Association for Information Systems and ranked conferences: ICIS, ECIS, HICSS, PACIS, and WI. By imposing this restriction, we ensured that only peer-reviewed articles served as the basis for the artifact to be developed. Further, we balanced out high-quality journals' long review cycles of with the immediacy of conferences. The focus on IS literature is deemed appropriate because MSPEs are a common socio-technical phenomenon. Within the platform and mobility categories, we used the theory of Lusch and Nambisan (2015) to decide whether the publications cover the dimensions service ecosystem, platform/mobility services, and value co-creation. If we were able to associate a particular publication with one or more of those dimensions, then we included it in the resulting set of articles. We obtained 363 publications in an initial set of articles. During the first iteration, we scanned the titles and abstracts for the dimensions of Lusch and Nambisan (2015) and identified them as being either platform or mobility specific. During a second iteration, we searched forward and backward (Webster and Watson, 2002). During the last step, we allocated each paper to one of the two categories and the relevant dimensions. The result was 24 articles covering platform services and eight publications for mobility services.

3.2 Design Science Approach

For the design science approach, we adopted the methodology proposed by Hevner et al. (2004b) and Gregor and Hevner (2013). The resulting artifact aims to address the issue on how scholars and practitioners should design digital platforms in the context of mobility services. As guidance for scientific rigor, we followed the seven guidelines of Hevner et al. (2004a) for effective DSR in the field of information systems.

(1) *Design as an Artifact:* The artifact is going to be designed as a morphological box, allowing platform owners to individually configure different platform ecosystems in the context of mobility services (Zwicky, 1967). A morphological analysis captures the multidimensional, non-quantifiable character (Ritchey, 2006) of the MSPE design.

(2) *Problem Relevance:* Digital platforms are going to penetrate more and more aspects of our daily life (Evans and Gawer, 2016, Parker et al., 2016). Examples such as the mobility-service-platform Uber show that the disruptive potential also penetrates into how we use mobility as a service. Thus, reconstructing a blueprint on MSPEs provides valuable information about how platform ecosystems utilize mobility services.

(3) *Design Evaluation:* To show the artifact's usefulness, we draw on an observational evaluation method in the form of two case studies (Hevner et al., 2004a, Yin, 2014). The first case study involves a major carsharing-platform company. We complement the observations with the second case study based on a public-transportation platform in Germany.

(4) *Research Contributions:* We contribute with the DSR artifact in two ways. First, we build on the S-D logic of service innovation (Lusch and Nambisan, 2015) to develop a tangible artifact that helps to model different MSPE configurations. The model, represented by three morphological boxes, matches the key dimensions of Lusch and Nambisan (2015) and provides additional information in the context of mobility services. Second, the configurable MSPE offers practical contributions by allowing platform owners to model aspects of their platform to create transparency and to show potential for improvements.

(5) *Research Rigor:* The main theory for this research is grounded on the S-D logic of Lusch and Nambisan (2015). From there, we build on a structured literature review (Webster and Watson, 2002) combining aspects of platform-ecosystem research with mobility-service research to ensure scientific rigor.

(6) *Design as a Search Process:* We designed the DSR process in iterative steps to alternate between a theoretical and a practical lens (Gregor and Hevner, 2013). Starting with the initial framework as the result of the literature review, we cycle between interviews and theory within each case to create new artifact knowledge. If one case reaches theoretical saturation (no additional knowledge gain), the second case, with another context, is used the same way.

(7) *Communication of Research:* Like the contributions, communication of the research is also two fold. On the one hand, we express the findings for S-D logic, mobility service, and platform researchers. On the other, we provide a design framework for configurable MSPEs to practitioners (i.e., platform owners).

3.3 Case Study Research and Evaluation

For artifact creation, we follow a case-study research strategy. The method is particularly suitable as it captures and describes the complexity of environments and real challenges (Yin, 2014, Stake, 1995). The cases put the development process into the context of the qualitative interviews, their respective environment, and firms to provide relevance, boundaries, features, and limitations (Stake, 1995, Merriam, 1988). We use the theories represented in the theoretical background combined with the results of the SLR as prescriptive knowledge and a starting point for the DSR process. The case studies describe the application environment, where we derive descriptive knowledge in the form of an artifact (Gregor and Hevner, 2013). To ensure relevance and rigor, we execute three design cycles proposed by (Hevner, 2007, Sein et al., 2011). In the first iteration, we conduct a relevance cycle with the prescriptive knowledge by putting it into the context of mobility platforms through semi-structured interviews on the platform-owner side. Semi-structured interviews provide room for improvisation and exploration on the underlying phenomenon. The interviews adapted the dramaturgical model of Myers and Newman (2007). Regarding the sampling, we analyzed cases featuring mobility-platform ecosystems from the S-D logic perspective of service platforms, ecosystems, and value co-creation, as well as MaaS. Both case companies offer their mobility service in a variety of large cities in Germany with the target group of commuters, tourists, and local residents. For the interviewees, we were looking for technical and strategic employees representing the platform-owner perspective. We used MAXQDA software to code each transcript according to the grounded-theory coding process of open, axial, and selective coding (Strauss and Corbin, 1994) from the S-D-logic perspectives (Lusch and Nambisan, 2015). After that, we continued with a rigor cycle by grounding the new insights into our underlying theory in comparison with the current state of the artifact. Lastly, we updated the artifact within the design cycle (Hevner, 2007). We reran those cycles for every new interview partner, thereby iterating the building, intervention, and evaluation phase several times (Sein et al., 2011). The evaluation according to industry experts also satisfies the need for a cross-consistency assessment of the morphological boxes (Ritchey, 2006). Lastly, we described the final artifact that we grounded in the application environment, ensuring relevance and a continuous evaluation, as well as in the literature, increasing the scientific rigor.

Table 2 provides an overview of the two mobility-platform cases that we used to develop and evaluate the configurable-MSPE framework. In each case, we conducted six face-to-face interviews, transcribed, anonymized, and returned the results to obtain additional comments and to correct misunderstandings.

Case	Description	#	Role	Duration
Alpha	The private transportation operator is a market leader in providing mobility services as free-floating carsharing and value-added services for its customers in cities worldwide. The private transportation operator's main role is integrating parts of its existing mobility services and offering them to customers on the mobility-service platform. Customers use an application to allocate, reserve, book, and pay the free-floating car service.	1	Autonomous carsharing	00:52 h
		2	Mobility services, market development and rollout	00:59 h
		3	Mobile technologies in carsharing platforms	01:03 h
		4	CEO	01:09 h
		5	Project lead: embedded software platform carsharing	00:57 h
		6	Project lead: backend system carsharing	00:58 h
Beta	The public transportation operator runs the public transportation system in the city. It offers different mobility services and a wide range of transportation modes such as subway, bus, or bicycle to its customers. Moreover, in the specific case of the mobility-service platform, the public transportation operator's main role is platform provider. The public transportation operator offers access to the mobility-service platform for its end-customers via mobile applications and integrates private transportation operators.	7	Project lead: platform conception	00:38 h
		8	Project lead: transport and mobility management	00:53 h
		9	Manager urban planning and traffic management	00:38 h
		10	Manager in traffic economics	00:48 h
		11	Manager business development and strategy	00:30 h
		12	Project lead: mobility platforms	00:18 h

Table 2. List of interviewees for the design science research approach

4 Results

This section summarizes our final artifact: a configurable-MSPE design framework. The artifact is represented by three morphological boxes. The boxes (see Table 3, Table 4, and Table 5) correspond to the three main dimensions of Lusch and Nambisan (2015). Further, the boxes divide the dimensions into factors that summarize MSPE categories for the respective dimension. Each category consists of several concrete attributes covering several entities. The source in the last row indicates where each of the attributes originates. All attributes originate either from the literature or from the interviews. We marked new attributes and entities originating from the interviews with an asterisk (*). We also highlighted attributes that allow multiple selection with a superscript "x" (^{x}).

4.1 The Service Ecosystem

The service-ecosystems dimension includes different sets of actors participating in an MSPE. The actor category helps to determine the attributes of one or many actors placed into the service ecosystem to be created. Each actor has several attributes. The interviews reveal that the actor belongs to a *segment* represented by the entities *business*, *government*, and *consumer*. Furthermore, each actor plays a *role*. An actor can be a *platform sponsor*, a *platform provider*, a *complementor* (complementing products and services in the ecosystem), a *customer*, or a combination of roles. The attribute *motive* elaborates the actor's reason for joining the service ecosystem. Key *motives* are *access driven*, *ethical*, or *financial motives*. Finally, each actor plays a *MaaS role* that is specific to the context of MSPEs. According to the interviews, actors play mobility-specific roles such as *passenger*, *driver*, *owner*, *provider*, or *authority*.

Characteristics	Attributes	Entities							Source
Actor	Segment*	Business*	Government*	Consumer*					Interviews: 11
Actor	Role^{x}	Platform Sponsor	Platform provider (Intermediary)	Complementor (Designer)	Customer (Ideator)				(Kuebel and Zarnekow, 2014, Levina and Kranich, 2017, Jittrapirom et al., 2017) Interviews: 8
Actor	Motive^{x}	Access to customers	Access to resources	Financial benefits	Product/service based benefits*	Platform based benefits	Ethical benefits	Other*	(Frow et al., 2015, Pagani, 2013, Giessmann et al., 2014, Barrett et al., 2016) Interviews: 12
Actor	MaaS Role*^{x}	Passenger*	Driver*	Owner*	Provider*	Authority*			Interviews: 7

Table 3. Morphological box for the service-ecosystems dimension within MSPEs

4.2 Value Co-Creation

The next dimension is value co-creation. It covers the categories of mobility services, value creation, and value capture. The mobility-service category provides the mobility context and connects two or more actors in an *MSPE*. Within the morphological box, the first attribute defines the service's *geographical scope*. The different forms describe whether the service applies to a *neighborhood-wide, citywide, region-wide, countrywide, company-wide* or *global* scope. Next, the service conforms to a *service pattern* indicating the timeframe *deferred*, *immediate*, *recurrent,* or *ongoing*. The *nature* attribute adds the context of mobility. Forms of this attribute are *navigation* or *location-based information services*. Lastly, the service exhibits a certain degree of *openness* ranging from *public,* available for everyone within the service ecosystem, to a *private*, not publicly available service. The value creation category covers resource integration. It includes attributes such as the *form* of value co-creation. Entities range from *co-design* (collaborative design of intermodal transport modes) or *co-production* of transportation services (collaborative production of autonomous cars with partners) through *co-consumption* (shared transportation modes) and *co-promotion* of services to *co-pricing* (e.g., pay-what-you-want) and *co-integration* (including own resources such as cars) describing the value-co-creation outcome. The *cooperation channel* and *intensity* describe whether the partnership features *physical* or *digital* interaction in a tightly coupled *strategic alliance* or a *loose cooperation* fostered through boundary resources. Subsequently, the *business field* describes whether the service is vertical to the value chain or *complementary,* horizontal in the case of *substitutive* or a mix of both with the attribute *substitutive.* The *activity type* attribute defines how the actors integrate the resources into the value-creation process. Lastly, the *duration* indicates whether a *one-off* to a *continuous* service is involved. The value-capture category connects the mobility service to the platform by showing how the platform captures value. The *value source* indicates the actor from which the platform captures value. Subsequently, the attributes follow the same pattern as that of the *actor roles* on the platform. The *value stream* clarifies whether it is either *indirect* or *transaction*/*subscription-based*.

Characteristics	Attributes	Entities								Source
Mobility Service	Geographical Scope	Neighborhood-wide	Citywide	Region-wide	Countrywide*	Company-wide	Global			(Plenter et al., 2017, Täuscher and Laudien, 2017) Interviews: 12
	Service Pattern	Deferred	Immediate	Recurrent	Ongoing*					(Andersson et al., 2013, Plenter et al., 2017) Interviews: 7
	Nature^x	Trip planning	Navigation	Smart logistic	Parking	Sharing*	Location-based	Transportation*	Other*	(Schreieck et al., 2016c) Interviews: 8
	Openness	Public	Private							(Schreieck et al., 2016b, Leimeister et al., 2010, Benlian et al., 2015) Interviews: 8
Value Creation	Form	Co-Design	Co-Production	Co-Consumption	Co-Promotion	Co-Pricing	Co-Integration*	Other*		(Frow et al., 2015, Karpen et al., 2012, Jittrapirom et al., 2017) Interviews: 4
	Cooperation Channel*^{x}	Physical*	Digital*							Interviews: 7
	Cooperation Intensity	Ecosystem	Strategic alliance	Loose cooperation	Purchase					(Labes et al., 2013) Interviews: 6
	Business Fields	Complementary	Similar	Substitutive						(Labes et al., 2013) Interviews: 7
	Activity Type^x	Production	Aggregation	Comparison & Categorization	Integration	Consulting	Other*			(Leimeister et al., 2010) Interviews: 5
	Duration	One-off	Recurring	Continuous						(Frow et al., 2015) Interviews: 6
Value Capture	Value Source*	Platform Sponsor*	Platform provider*	Complementor*	Customer*					Interviews: 5
	Value Stream	Transaction-based	Subscription-based	Indirect*						(Täuscher and Laudien, 2017, Jittrapirom et al., 2017) Interviews: 5

Table 4. Morphological box for the value-co-creation dimension within MSPEs

4.3 Platform

Lastly, there is the platform, capturing value and connecting two or more actors within the service ecosystem through mobility services incorporating value-creation mechanisms. The categories *governance* and *architecture* describe different configurations within MSPEs. First, the governance *structure* shows whether the platform takes an *authority*-, *contract*-, or *trust-based* approach. The *control mechanisms* provide transparency about which forms of interaction are controlled. These are ranging from *input, output, behavior, social,* or *access* to some combination thereof. Under the *architecture* characteristic, *resource type* indicates the resources on which the platform is built. Entities are *hardware*, *software*, *data*, *know-how*, *human*, or *infrastructure* resources. *Focus* characterizes how the platform focuses on using those resources. The focus, for example, can be on building a *scalable infrastructure* or on providing an *extensible codebase* as a breeding ground for innovation. Lastly, the platform incorporates different *modules* to achieve the *focus*.

Characteristics	Attributes	Entities							Source
Governance	Structure[x]	Authority-based	Contract-based	Trust-based					(de Reuver and Bouwman, 2012) Interviews: 5
	Control Mechanisms[x]	Input	Output	Behavior	Social	Access*			(Manner et al., 2013) Interviews: 12
Architecture	Resource Type[x]	Hardware resource	Software resource	Data resource	Know-How resource	Human resource	Infrastructure resource*		(Labes et al., 2013, Plenter et al., 2017) Interviews: 12
	Focus*[x]	Modularity	Flexibility*	Scalability*	Extensibility*	Availability*	Performance*		(Pagani, 2013) Interviews: 7
	Modules*[x]	Ticketing and billing	Analytics	Monitoring	Filtering*	Matchmaking	Fleet-management*	Complementary Modules	(Schreieck et al., 2016c, Jittrapirom et al., 2017) Interviews: 12

Table 5. Morphological box for the platform dimension within MSPEs

5 Application and Discussion

The combination of all three dimensions provides a framework to design configurable MSPEs. Below, we discuss implications for theory and practice, limitations, and future research based on two concrete MSPEs resulting from the case studies: Alpha and Beta. Figure 1 and Figure 2 illustrate a simplification of the two MSPEs. They summarize the relationship between morphological boxes or dimensions. The most intuitive way to build an MSPE is to start with the actors from the platform owner's point of view. A service ecosystem is constrained to consist of at least two actors. The set of actors within a service ecosystem then relates to one or more value-co-creation services. Each value-co-creation service relates to one platform representing the center of an MSPE. Conversely, each platform can form the basis for several service ecosystems. All those instances combined result in an MSPE.

5.1 Case Alpha: Carsharing Ecosystem

Figure 1 illustrates a simplified MSPE for Alpha's carsharing platform. The carsharing ecosystem consists of the three actors: the carsharing-platform owner, the carsharing user, and an insurance company. Their motives are either to provide access to resources in the form of cars, to benefit from using the service via driving, or to insure drivers for monetary return. Two value-co-creation services connect the carsharing ecosystem. One of them incorporates the carsharing ride, which is immediately available globally and provides free-floating cars to offer private transportation from point A to point B. From the platform owner's perspective, the service co-integrates the ride data through a one-off loose cooperation (registration within the MSPE, but no further involvement) by data aggregation. In this value-co-creation service, the customer is the value source and is charged on a transactional basis. The platform facilitates interaction through a contract-based governance that controls access (who is allowed on the platform), output (where did the driver go and what does the car look like after the ride), and input (which resources in the form of cars does the platform accept). Regarding the infrastructure, the platform consists of hardware in the form of sharable cars, software, data, and know-how aimed at providing modularity (flexible on and off boarding of cars), availability, and performance through modules such as those for ticketing and billing, car filtering, analytics, and matching vehicles with drivers.

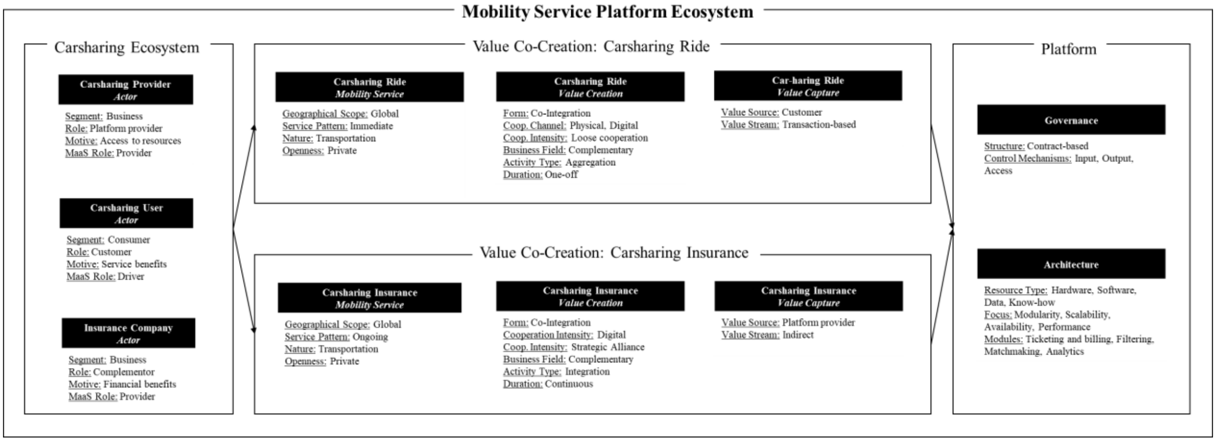

Figure 1. Application of the configurable mobility service platform ecosystem in the Alpha case study

5.2 Case Beta: Public Transportation Ecosystem

Figure 2 shows a similar MSPE for the public transport operator case, Beta. Within the service ecosystem, the platform owner operates a public transportation platform providing customers with access to its mobility infrastructure. A bike-sharing company incorporates its resources in the form of bikes to get access to the platform customers. One possible value-co-creation service is the integration of the bike-sharing company. The platform integrates the bike-sharing provider citywide, provides additional transportation services to customers, and parking possibilities for the bikes within the municipality. The platform owner co-integrates the bikes physically (ride) and digitally (booking) into their ecosystem, thus offering substitutive mobility services. The value source is the bike-sharing company, which is charged on a transaction basis. The platform's governmental character implies that authority-based governance mechanisms control the public-transportation infrastructure resources and that contractual mechanisms manage third parties on the platform. The platform furthermore controls input resources in the form of public-transportation infrastructure, third parties, and accessibility through a ticketing system. The platform's architecture consists of hardware (trains, buses), software, data, and transportation infrastructure (rails, roads) aimed at providing availability and performance. In the example illustrated, the platform uses the ticket and billing, monitoring, and filtering modules.

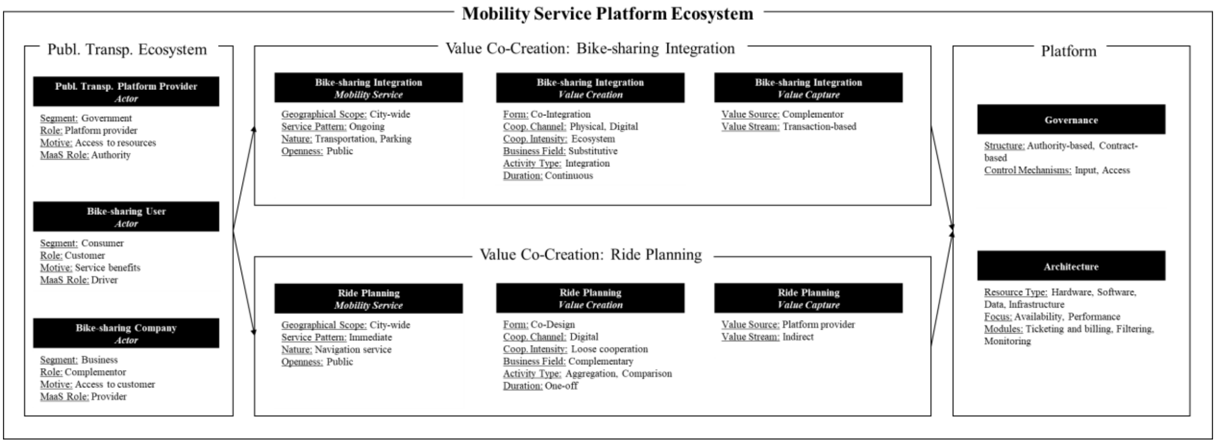

Figure 2. Application of the configurable mobility service platform ecosystem in the Beta case study

5.3 Implications, Limitations, and Future Research

During the continuous design and evaluation cycles between the interviews, we realized that the majority of interviewees still refer to producers and consumers from the G-D-logic perspective. Although Lusch and Nambisan (2015) provide a well-established theoretical framework from the S-D perspective, the approach is too theoretical, and thus too intangible, for building configurable MSPEs. We found that one way to shift the mind-set toward more S-D-logic-driven thinking was to provide a particular perspective (e.g., platform owner) and simplified MSPEs. With a concrete perspective, we wanted to solve the problem that actors within an ecosystem can be seen from various perspectives contributing all kind of resources. An actor other than a customer can be the value source in the example of carsharing rides in the Alpha case and the value-capture services. From the customer's perspective, the resource on the platform in the form of a car can also be a value source that offers a potential value, imparting mobility and flexibility by travelling from point A to point B. The same applies to value creation processes, where perspective influences the attributes within the service. One way to mitigate this situation is to purposely build the MSPE from a unique perspective. Accommodating all perspectives would increase the MSPE's complexity with each new actor in the ecosystem, leading to intransparency. Thus, we designed the two sample MSPEs from the platform owner's perspective to build on the platform companies' expertise. Moreover, MSPE simplification helps to increase understanding of the interaction within a limited set of actors connected via mobility services on a platform. In summary, focusing on a unique perspective and starting with a simplification have proven valuable for tackling MSPEs' complexity. The artifact reveals relationships and the systemic character of MSPEs thereby increasing ecosystem transparency—including that of the actors, services, and underlying platform.

The artifact could help advance theoretical understanding of platform ecosystems on three different levels. First, de Reuver et al. (2016) point out that researchers need to shed light on the question of how digital platforms should be designed. By differentiating successful from unsuccessful platform-ecosystem designs, researchers can decompose the designs into necessary and nice-to-have features. In this case, the artifact provides a systematic approach to building a platform ecosystem in the context of mobility services. Researchers can thus compare the fit of different designs or configurations through deviation within a similar context to show why some platforms survive whereas others fail (Venkatraman, 1989). Our simplified examples show similarities according to the A2A network and differences in value-creation mechanisms. In the Alpha case, the insurance company and the platform co-integrate the complementary insurance service, whereas the public-transportation company integrates substitutive mobility services in the form of bike-sharing into its ecosystem or city. Researchers can also use the artifact to document deviations within a specific ecosystem from a temporal perspective to examine the evolution over time (Moore, 1997). Because it ensures comparability, the artifact is also a first step toward enabling the conscious design of MSPEs (de Reuver et al., 2016). A second limitation of existing research is that platform ecosystems consider the availability of complementary services or products as being an exogenously triggered fact rather than a construct that can be strategically manipulated (McIntyre and Srinivasan, 2017). Practitioners and scientists can use the artifact to design, analyse, and modify a platform ecosystem to foster the integration of complementary goods and services. Returning to our examples, output control might reveal that customers can destroy cars, demonstrating the need for an additional co-creation process with insurance companies as actors.

The article also highlights practical implications. The design framework allows platform owners to configure their individual MSPEs, creating transparency and disclosing relationships between actors, mobility and value creation/capture services, as well as the facilitating platform. Thus, they can implement new actors, services, and platform functionalities to discover new solution spaces. Furthermore, platform owners can adjust the created ecosystem in response to key issues in the service ecosystem, platform, and along value-co-creation dimension (Lusch and Nambisan, 2015). As an example, the platform provider might identify weak structural integrity between the public transportation platform provider and the public transportation user. Based on that finding, the platform owner could design new value-co-creation services fostering structural integrity. Despite the implications, we want to highlight the limitations facing the study. We developed the design framework in the very specific context of mobility services to ensure practical relevance. The downside of this approach is the artifact's lack of generalizability. Some categories, such as the mobility services, are too context specific for application to other fields. One way to sort out this problem for future research might be to apply our artifact in another platform context like IoT or healthcare, where researchers need to take a similar approach to identifying specific attributes for the morphological boxes. Those findings would enhance the artifact's robustness and could lead to a more generally applicable framework for platform ecosystems. Future research could also address the need of practitioners for a guided process that helps them to apply the framework. This could also include integrating the framework into a comprehensive toolset for platform business-model development using methods such as the business model canvas (Osterwalder and Pigneur, 2010) or e³-value ecosystem modelling (Gordijn, 2002). Interfaces to these tools would improve the practical value of the MSPE design framework.

6 Conclusion

The shift from producing companies' taking a G-D-logic perspective, to a more S-D approach is indisputable (Lusch and Nambisan, 2015, Harrington, 2002). The concept of service platform from this development brought together different actors within an ecosystem and gained importance as a disruptive phenomenon (McIntyre and Srinivasan, 2017, de Reuver et al., 2016, Hein et al., 2018). One example is the platform company Uber, which uses network effects within an ecosystem of drivers and passengers to create and capture value. This and other examples, such as car- and bike-sharing platforms, illustrate the shift from using cars as products to a world in which we can use mobility as a service. However, how to design such a service-platform ecosystem has been unclear until now (de Reuver et al., 2016). Building on a design science research approach (Gregor and Hevner, 2013, Hevner, 2007, Hevner et al., 2004a), we developed a design framework for mobility service platform ecosystems (MSPEs). We started with the S-D-logic perspective of Lusch and Nambisan (2015) and mobility as a service (MaaS) concepts (Jittrapirom et al., 2017, Hietanen, 2014) as a theoretical backbone in the form of prescriptive knowledge. We then conducted a systematic literature review (Webster and Watson, 2002) to uncover additional knowledge pertinent to building the MSPE design framework. We developed the artifact through three recurring relevance, rigor, and design cycles (Hevner, 2007) according to the two cases, Alpha (carsharing platform) and Beta (public-transportation platform), drawing upon twelve interviews. Through the approach of building, intervening, and evaluating (Sein et al., 2011), we increase the scientific rigor and practical relevance of the resulting artifact. The developed artifact constitutes of three morphological boxes conforming with S-D logic (Lusch and Nambisan, 2015)—first, the service ecosystem containing two or more actors. Each of the service ecosystems relates to one or more value-co-creation services, which include a mobility, value creation, and value-capture service. Lastly, the platform facilitates the interaction of one or more service ecosystems and their connected value-co-creation services. The resulting MSPE framework provides a structural and repeatable approach to comparing different service ecosystems according to success or failure patterns.

7 Acknowledgements

This work is part of the TUM Living Lab Connected Mobility (TUM LLCM) project. It has been funded by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology (StMWi) through the Center Digitisation.Bavaria (ZD.B), an initiative of the Bavarian State Government.

References

Andersson, M., A. Hjalmarsson and M. Avital. "Peer-to-peer service sharing platforms: Driving share and share alike on a mass-scale." 34th International Conference of Information Systems (ICIS). 2013 Milan, Italy. Association for Information Systems, p.

Atasoy, B., T. Ikeda, X. Song and M. E. Ben-Akiva (2015). "The concept and impact analysis of a flexible mobility on demand system." *Transportation Research Part C: Emerging Technologies* 56**,** 373-392.

Baldwin, C. Y. and K. B. Clark (2000). *Design rules: The power of modularity.* MIT press.

Barrett, M., E. Oborn and W. Orlikowski (2016). "Creating value in online communities: The sociomaterial configuring of strategy, platform, and stakeholder engagement." *Information Systems Research* 27 (4)**,** 704-723.

Benlian, A., D. Hilkert and T. Hess (2015). "How open is this platform? The meaning and measurement of platform openness from the complementors' perspective." *Journal of Information Technology* 30 (3)**,** 209-228.

de Reuver, M. and H. Bouwman (2012). "Governance mechanisms for mobile service innovation in value networks." *Journal of Business Research* 65 (3)**,** 347-354.

de Reuver, M., C. Sørensen and R. C. Basole (2016). "The digital platform: a research agenda." *Journal of Information Technology***,** 1-12.

Evans, P. C. and A. Gawer (2016). The rise of the platform enterprise: a global survey. *In:* Evans, P. C. and A. Gawer (eds.) *The Emerging Platform Economy Sercies.* The Center for Global Enterprise.

Firnkorn, J. and M. Müller (2011). "What will be the environmental effects of new free-floating car-sharing systems? The case of car2go in Ulm." *Ecological Economics* 70 (8)**,** 1519-1528.

Frow, P., S. Nenonen, A. Payne and K. Storbacka (2015). "Managing co-creation design: A strategic approach to innovation." *British Journal of Management* 26 (3)**,** 463-483.

Giessmann, A., P. Kyas, P. Tyrvainen and K. Stanoevska. "Towards a better Understanding of the Dynamics of Platform as a Service Business Models." 47th Hawaii International Conference on System Sciences (HICSS). 2014 Manoa, Hawaii, USA. IEEE, p. 965-974.

Gordijn, J. "E 3-valuein a Nutshell." Proceedings of International Workshop on E-business Modeling, Lausanne. 2002. p.

Greenwood, B. N. and S. Wattal (2017). "Show me the way to go home: an empirical investigation of ride-sharing and alcohol related motor vehicle fatalities." *MIS Quarterly* 41 (1)**,** 163-188.

Gregor, S. and A. R. Hevner (2013). "Positioning and presenting design science research for maximum impact." *MIS Quarterly* 37 (2)**,** 337-355.

Harrington, D. (2002). "The Age of Access: The New Culture of Hypercapitalism Where All of Life is a Paid-For Experience." *The Journal of Education, Community, and Values* 2 (4).

Hein, A., M. Böhm and H. Krcmar (2018). Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms. *Multikonferenz Wirtschaftsinformatik.* Lüneburg, Germany.

Hein, A., M. Schreieck, M. Wiesche and H. Krcmar (2016). Multiple-case analysis on governance mechanisms of multi-sided platforms. *Multikonferenz Wirtschaftsinformatik.* Ilmenau, Germany.

Hendriks-Jansen, H. (1996). *Catching ourselves in the act: Situated activity, interactive emergence, evolution, and human thought.* MIT Press.

Hevner, A. R. (2007). "A three cycle view of design science research." *Scandinavian Journal of Information Systems* 19 (2), 4.

Hevner, A. R., S. T. March, J. Park and S. Ram (2004a). "Design science in information systems research." *MIS Quarterly: Management Information Systems* 28 (1), 75-105.

Hevner, A. R., S. T. March, J. Park and S. Ram (2004b). "Design science in information systems research." *MIS Quarterly* 28 (1), 75-105.

Hietanen, S. (2014). "Mobility as a Service - the new transport model?" *Eurotransport* 12 (2), 2-4.

Jittrapirom, P., V. Caiati, A.-M. Feneri, S. Ebrahimigharehbaghi, M. J. A. González and J. Narayan (2017). "Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges." *Urban Planning* 2 (2), 13-25.

Karpen, I. O., L. L. Bove and B. A. Lukas (2012). "Linking service-dominant logic and strategic business practice: A conceptual model of a service-dominant orientation." *Journal of Service Research* 15 (1), 21-38.

Kuebel, H. and R. Zarnekow. "Evaluating platform business models in the telecommunications industry via framework-based case studies of cloud and smart home service platforms." 20th Americas Conference on Information Systems (AMCIS). 2014 Savannah, Georgia, USA. p.

Labes, S., K. Erek and R. Zarnekow. "Common patterns of cloud business models." 19th Americas Conference on Information Systems (AMCIS). 2013 Chicago, Illinois, USA., p.

Leimeister, S., M. Böhm, C. Riedl and H. Krcmar. "The Business Perspective of Cloud Computing: Actors, Roles and Value Networks." 18th European Conference on Information Systems (ECIS). 2010 Pretoria, South Africa. p. 56.

Levina, O. and L. Kranich. "Mobility and the Internet of People: A Morphological Analysis." 13th IEEE International Conference on Internet of People. 2017 San Francisco, USA. p. 915-920.

Lewicki, R. J. and C. T. Brinsfield (2009). Trust, distrust and building social capital. *In:* Bartkus, V. O. and J. H. Davis (eds.) *Social capital: Reaching out, reaching in.* Edward Elgar Publishing.

Lusch, R. F. and S. Nambisan (2015). "Service Innovation: A Service-Dominant Logic Perspective." *MIS Quarterly* 39 (1), 155-175.

Lusch, R. F., S. L. Vargo and M. Tanniru (2010). "Service, value networks and learning." *Journal of the Academy of Marketing Science* 38 (1), 19-31.

Manner, J., D. Nienaber, M. Schermann and H. Krcmar. "Six Principles for Governing Mobile Platforms." 11th Wirtschaftsinformatik. 2013 Leipzig, Germany. p. 86.

McIntyre, D. P. and A. Srinivasan (2017). "Networks, platforms, and strategy: Emerging views and next steps." *Strategic Management Journal* 38 (1), 141-160.

Merriam, S. B. (1988). *Case Study Research in Education: A Qualitative Approach.* San Francisco: Jossey-Bass.

Moore, J. F. (1993). "Predators and prey: a new ecology of competition." *Harvard Business Review* 71 (3), 75-83.

Moore, J. F. (1997). *The death of competition : leadership and strategy in the age of business ecosystems.* New York: Harper Business.

Myers, M. D. and M. Newman (2007). "The Qualitative Interview in IS Research: Examining the Craft." *Information and Organization* 17 (1), 2-26.

Normann, R. (2001). *Reframing business: When the map changes the landscape.* John Wiley & Sons.

North, D. C. (1994). "Economic performance through time." *The American Economic Review* 84 (3)**,** 359-368.

Orlikowski, W. J. (1992). "The duality of technology: Rethinking the concept of technology in organizations." *Organization Science* 3 (3)**,** 398-427.

Osterwalder, A. and Y. Pigneur (2010). *Business model generation: a handbook for visionaries, game changers, and challengers.* John Wiley & Sons.

Pagani, M. (2013). "Digital business strategy and value creation: Framing the dynamic cycle of control points." *MIS Quarterly* 37 (2).

Parker, G. G., M. W. Van Alstyne and S. P. Choudary (2016). *Platform revolution: How networked markets are transforming the economy--and how to make them work for you.* WW Norton & Company.

Plenter, F., E. Fielt, M. Hoffen, F. Chasin and M. Rosemann. "Repainting the business model canvas for peer-to-peer sharing and collaborative consumption." 25th European Conference on Information Systems (ECIS). 2017 Guimaraes, Portugal. AIS Electronic Library (AISeL), p. 2234-2249.

Ritchey, T. (2006). "Problem structuring using computer-aided morphological analysis." *Journal of the Operational Research Society* 57 (7)**,** 792-801.

Schreieck, M., A. Hein, M. Wiesche and H. Krcmar (2018). The Challenge of Governing Digital Platform Ecosystems. *Digital Marketplaces Unleashed.* Springer.

Schreieck, M., M. Wiesche, A. Hein and H. Krcmar. "Governance of nonprofit platforms–Onboarding mechanisms for a refugee information platform." SIG GlobDev Ninth Annual Workshop. 2016a. p.

Schreieck, M., M. Wiesche and H. Krcmar. "Design and Governance of Platform Ecosystems-Key Concepts and Issues for Future Research." 24th European Conference on Information Systems (ECIS). 2016b Istanbul, Turkey. p. ResearchPaper76.

Schreieck, M., M. Wiesche and H. Krcmar. "Modularization of digital services for urban transportation." 22nd Americas Conference on Information Systems (AMCIS). 2016c San Diego, USA., p.

Sein, M. K., O. Henfridsson, S. Purao, M. Rossi and R. Lindgren (2011). "Action design research." *MIS Quarterly* 35 (1)**,** 37-56.

Sochor, J., H. Strömberg and I. M. Karlsson (2015). "Implementing mobility as a service: challenges in integrating user, commercial, and societal perspectives." *Transportation Research Record: Journal of the Transportation Research Board* (2536)**,** 1-9.

Spickermann, A., V. Grienitz and A. Heiko (2014). "Heading towards a multimodal city of the future?: Multi-stakeholder scenarios for urban mobility." *Technological Forecasting and Social Change* 89**,** 201-221.

Stake, R. E. (1995). *The Art of Case Study Research.* London: Sage.

Strauss, A. and J. Corbin (1994). "Grounded theory methodology." *Handbook of qualitative research* 17**,** 273-85.

Täuscher, K. and S. M. Laudien. "Uncovering the Nature of Platform-based Business Models: An Empirical Taxonomy." 50th Hawaii International Conference on System Sciences (HICSS). 2017 Manoa, Hawaii, USA. p.

Teubner, T. and C. M. Flath (2015). "The economics of multi-hop ride sharing." *Business & Information Systems Engineering* 57 (5), 311-324.

Tilson, D., K. Lyytinen and C. Sørensen (2010). "Research commentary—Digital infrastructures: The missing IS research agenda." *Information Systems Research* 21 (4), 748-759.

Tiwana, A. (2015). "Platform desertion by app developers." *Journal of Management Information Systems* 32 (4), 40-77.

Vargo, S. L. and R. F. Lusch (2004). "Evolving to a new dominant logic for marketing." *Journal of Marketing* 68 (1), 1-17.

Vargo, S. L. and R. F. Lusch (2008). "Service-dominant logic: continuing the evolution." *Journal of the Academy of Marketing Science* 36 (1), 1-10.

Vargo, S. L. and R. F. Lusch (2011). "It's all B2B… and beyond: Toward a systems perspective of the market." *Industrial Marketing Management* 40 (2), 181-187.

Venkatraman, N. (1989). "The concept of fit in strategy research: Toward verbal and statistical correspondence." *Academy of management review* 14 (3), 423-444.

Webster, J. and R. T. Watson (2002). "Analyzing the past to prepare for the future: Writing a literature review." *MIS Quarterly*, xiii-xxiii.

Weick, K. E. (1995). *Sensemaking in organizations.* Sage.

Willing, C., T. Brandt and D. Neumann (2017). "Electronic mobility market platforms–a review of the current state and applications of business analytics." *Electronic Markets* 27 (3), 267-282.

Yin, R. K. (2014). *Case study research: Design and methods.* Thousand Oaks, CA: Sage Publications.

Zwicky, F. (1967). The morphological approach to discovery, invention, research and construction. *New methods of thought and procedure.* Springer.