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Digital Transformation from an Inter-Organizational Perspective: Managing the Co-evolution of Platform Owners and Complementors in Platform Ecosystems

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Abstract

Problem Statement: The innovative use of digital technologies led to a disruption of well-established business models in many industries. To prevent from being disrupted, organizations are required to transform, we refer to as digital transformation. Yet, studies about digital transformation initiatives primarily focus on an intra-organizational perspective, such as the transformation of business processes, and disregard partnerships in the ecosystem. However, digital transformation initiatives substantially influence organizations' surrounding ecosystems and the partnerships inside them, particularly in digital platform ecosystems that rely to a large extent on co-creation between platform owners and complementary partners. As complementary partners contribute to the value of the digital platform ecosystems, platform owners need to find mechanisms to enable them to adapt. Therefore, we draw on the lens of co-evolution theory that states two or more organizations reciprocally affect each other's evolution. Hence, this thesis aims to develop an empirical understanding of how platform owners can manage the co-evolution of complementors in digital platform ecosystems in digital transformation initiatives.

Research Design: To address this gap, we first reviewed IS, management, and organization science literature on digital transformation, prior organizational transformation, and co-evolution in ecosystems to integrate the status quo and derive avenues for future research. Based on the results, we examine digital transformation from an inter-organizational perspective in five ecosystems. We used Crunchbase data and selective other databases to access organizational data, qualitative content analysis using inductive category formation to derive generic roles of actors in the ecosystems and the value streams between them, and used the e^3 value methodology to visualize the ecosystems. Afterwards, we validated the ecosystems by interviewing industry experts. Further, we use quantitative similarity measures to cluster the organizations in the five ecosystems in order to detect similarities among the ecosystems. Ultimately, we conduct an in-depth case study, and a multiple case study covering four platform owners, to identify the mechanisms platform owners use to manage the co-evolution of their complementary partners in digital platform ecosystems.

Results: With this thesis, we first clarify the notion of digital transformation, comprising of twelve heterogeneous schools of thought. By synthesizing insights from literature, we show that digital transformation builds on digital innovation and largely neglects the ecosystem perspective. To enrich discussion on digital transformation, we found twelve schools of thought to discuss the phenomenon appropriately. Second, we model the automotive, blockchain, financial, insurance, and IIoT ecosystem. In sum, we coded 3478 organizations, coded 96 generic roles, and interviewed 31 industry experts, to develop the five ecosystems. The similarity measures to cluster the organizations in the five ecosystems led to 15 clusters, of which one cluster is at the core of all five ecosystems, five are intertwined, and ten ecosystem-specific. Third, we derive mechanisms on how platform owners manage the co-evolution of complementors. Thee in-depth case study of Microsoft Azure, revealed different owner- and partner-centric mechanisms. Drawing on the findings of the multiple case study, we found 29 mechanisms that platform owners use, organized in four steps. Using the 29 mechanisms, platform owners 1) align, 2) enable, 3) support, and 4) motivate partners to develop new complements on, or transform established complements to, the new digital platform ecosystem, while continuously maximizing the ecosystem attractiveness.

Contribution: Our results contribute, first, to the literature on digital transformation. By highlighting the ecosystem perspective, we discuss to go beyond a new organizing logic due to digital innovation. We also see that IS neglects some of the specific natures of digital transformation as found by management and organization science scholars. Further, we discuss the idea of a combined method of qualitative and quantitative techniques in order to analyze ecosystems. Second, we contribute to literature on digital platform ecosystems, particularly from a co-evolution lens. The findings of our developed ecosystems allow discussing the generative nature of digital infrastructures underlying all ecosystems, driving the variety of actors in digital platform ecosystems. Ultimately, we found that co-evolution of complementary partners allows platform owners to achieve self-renewal of digital platform ecosystems.

Study Limitations: This thesis has, amongst others, three main limitations. First, the findings of our literature reviews are limited regarding the literature search and coding of the articles. Second, the developed ecosystems are limited based on the underlying qualitative data and coding we employed. However, multiple persons coded the articles for the literature review and organizations for the ecosystems, and we discussed the discrepancies until we reached consensus. Moreover, we established acceptable intercoder reliability for the ecosystems and drew on industry experts for external validation. Third, the case studies we conducted are limited regarding generalizability and reporting bias, given the unique context of each. To account for this limitation, we used triangulation and publicly available material.

Future Research: Our findings suggest five avenues for future research. First, we suggest integrating multiple schools of thought when examining digital transformation. Particularly, we found that some specific natures of digital transformation, such as transformational leadership or organizational identity, is rarely studied in IS literature. Second, future research should measure the success of digital transformation initiatives. To do so, we would favor a configurational method like fsQCA, in contrast to case studies, because this would allow examining the interplay of organizational and environmental factors to derive patterns for successful digital transformation initiatives. Third, we suggest examining the impact of blockchain technology on other ecosystems, as on an ecosystem level, it has the potential to extend or substitute existing products or services. Fourth, we would be curious to identify partnership patterns in digital platform ecosystems, for example, through the development of a taxonomy. Such a taxonomy would allow us to re-evaluate if the identified mechanisms for platform owners to manage the co-evolution of complementary partners are suitable for all partnerships. Fifth, we propose to take the perspective of complementary partners on co-evolution in digital platform ecosystems. It would be interesting to see how complementary partners can be strengthened to increase their power, or which regulatory actions for the digital platform economy can be deployed.

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ACP	Azure Cloud Platform
AMICS	Americas Conference on Information Systems
API	Application Programming Interface
BaaS	Blockchain as a Service
CaaS	Car as a Service
CON	Conference
CDO	Chief Digital Officer
CEO	Chief Executive Officer
CIO	Chief Information Officer
COO	Chief Operating Officer
CRM	Customer Relationship Management
DLT	Distributed Ledger Technology
DT	Digital Transformation
ECIS	European Conference on Information Systems
ERP	Enterprise Resource Planning
ETF	Exchange-Traded Fund
fsQCA	Fuzzy Set Qualitative Comparative Analysis
GI EMISA	Gesellschaft für Informatik, Enterprise Modeling and Information Systems Architectures
HP	Hosting Partner
IaaS	Infrastructure as a Service
IP	Intellectual Property
IPO	Initial Public Offering
IS	Information Systems
IoT	Internet of Things
IIoT	Industrial Internet of Things
ISV	Independent Software Vendor
IT	Information Technology
JCSM	Journal of Competences, Strategy & Management
JNL	Journal
LSA	Latent Semantic Analysis
LSP	Licensing Solution Provider
M	Method
MaaS	Mobility as a Service

M&A	Merger & Acquisition
O	Outcome
OEM	Original Equipment Manufacturer
OS	Operating System
OT	Organizational Transformation
P	Publication
P2P	Peer-to-Peer
PaaS	Platform as a Service
PACIS	Pacific Asia Conference on Information Systems
PDU	Practice Development Unit
RBV	Resource-Based View
RQ	Research Question
SaaS	Software as a Service
SDK	Software Development Kit
SEC	Securities and Exchange Commission, United States
SI	System Integrator
SMEs	Small and Medium-Sized Enterprises
TF-IDT	Term Frequency-Inverse Document Frequency
VAR	Value Added Reseller
VHB	Verband der Hochschullehrer für Betriebswirtschaft

Part A

1 Introduction

"*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)

This quote from SAP regarding its digital platform ecosystems with more than 13,000 partners illustrates the growing importance of managing partnerships in digital platform ecosystems. Hence, this doctoral thesis aims to build an empirical understanding of how ecosystems are changing in digital transformation initiatives and how platform owners can manage the co-evolution of complementors in platform ecosystems in this context. By providing a theoretically grounded understanding, the thesis fills various gaps in digital transformation and ecosystem research. The following chapter motivates this doctoral thesis and contains detailed problem statements for the three research questions that guided this research project.

1.1 Motivation and Goal of the Thesis

Digital platform ecosystems are creating and redesigning whole industries, accelerating innovation, and generating large profits (Jacobides et al. 2018; de Reuver et al. 2017; Tiwana 2014). The owners of digital platforms achieve this by enabling the functionality of products and services to be extended and redesigned by partners in the surrounding ecosystem (Tiwana 2015; Parker et al. 2016).

So, these ecosystems consist of digital platforms and applications specific to it as well as the stakeholders of the platform, platform owners, and complementors (Tiwana 2014). Platform owners rely on partners to gain access to customers, or complementary resources and capabilities (Sarker et al. 2012; Lusch/Nambisan 2015). Therefore, partners may contribute additional value for customers, e.g., in the form of complementary applications on the platform (Tiwana 2014). This reflects a viable business since some of the most successful companies, in terms of market capitalization, profitability, users, or brand value, operate as digital platform ecosystems (Staykova 2019), such as Apple iOS, Google's Android, Microsoft Azure, SAP Cloud Platform, or newcomers like Uber, PayPal, Airbnb, or Ethereum. Just consider that seven out of the ten companies with the highest market capitalization for 2019, as highlighted by Forbes, are digital platform ecosystems.

Hence, digital platforms that have the capacity to combine and deploy innovative technologies in new ways create the potential to radically change the way organizations are doing business in their respective ecosystems, which led to a disruption of many well-established business models (Lucas/Goh 2009; Rai/Tang 2014). A vivid example of an industry that has been disrupted is the video rental business: Blockbuster was operating more than 10,000 stores at its peak and had a market value of more than $5 billion in 2002 (Downes/Nunes 2013b). However, Netflix completely disrupted video rental business through its transformation from a DVD-by-mail subscription service to a video streaming platform in 2007, based on the cloud infrastructure of Amazon Web Services (Izrailevsky 2016). Blockbuster did not transform its business model and filed for bankruptcy only three years later (Downes/Nunes 2013b; Satell 2014). Summarized, we refer to the organizational transformation to prevent such a disruption through the innovative use of digital technologies as digital transformation (Weill/Woerner 2015; Vial 2019).

Studies about digital transformation are primarily concerned with an intra-organizational perspective on transformations, such as processes, products, and services, organizational structures, or the business model (see, e.g., Karimi/Walter 2015; Kaltenecker et al. 2015). However, digital transformations initiatives also substantially influence inter-organizational partnerships, particularly in digital platform ecosystems, where value is co-created among multiple stakeholders (Sarker et al. 2012; Ceccagnoli et al. 2014).

So, platform owners must maximize the attractiveness of the platform to existing and potential partners. Doing this, platform owners leverage sources of innovation beyond their organizational boundaries (Eaton et al. 2015; Ghazawneh/Henfridsson 2013; Yeow et al. 2018). Together with partners in their ecosystem, they innovate in an environment characterized by both competition and cooperation to satisfy customer needs (Sarker et al. 2012; Hannah/Eisenhardt 2017). In this way, the success of a platform ecosystem is contingent on the combined capabilities and business models of both the owner and the partners (de Reuver et al. 2017).

Hence, platform owners of digital platform ecosystem need to maintain, develop and invest further in its ability to evolve in order to detect on time the upcoming changes and to adapt to them (Staykova/Damsgaard 2018). However, current research has largely disregarded the context in which digital platform ecosystem operate (de Reuver et al. 2017), such as digital transformation. While some studies have investigated what triggers platform evolution (Dattée et al. 2018; Ojala/Lyytinen 2018; Eaton et al. 2015), they fail to explain the mechanisms which lead to changes in the digital platform ecosystem (Staykova/Damsgaard 2018). Notably, there is little explanation of how firms, such as platform owners and complementors, mutually co-evolve (Jacobides et al. 2018). Following Staykova (2019), we understand co-evolution as "simultaneous changes within the digital platform ecosystem and in parallel with its environment."

In sum, IS research has established a basic understanding of co-evolution in digital platform ecosystems, building on work on platform-based markets. However, we experienced that the understanding was not sufficient and specific enough to address the challenges that platform owners of already established ecosystems face when shifting towards a digital platform strategy. On the one hand it has been shown that co-evolution occurs on multiple levels, e.g., between platform architecture and platform governance (Tiwana et al. 2010), control and generativity (Eaton et al. 2015; Ghazawneh/Henfridsson 2013), generativity and variety (Um/Yoo 2016; Tiwana 2015; Boudreau 2012), and IS capabilities and strategies (Tan et al. 2015). On the other hand, there are many challenges platform owners must solve to successfully manage the co-evolution of their complementors, such as balancing control rights with the autonomy of ecosystem actors (Ghazawneh/Henfridsson 2013; de Reuver et al. 2017), or the provision of boundary resources, such as application programming interfaces (APIs) or toolkits such as software development kits (SDKs), to integrate and enable partners to provide complementary products or services (Ghazawneh/Henfridsson 2013; Eaton et al. 2015). Therefore, the goal of this thesis is to develop an empirical understanding of how platform owners can manage the co-evolution of complementary partners in digital platform ecosystems in the context of transformation initiatives. We identify three reasons for this gap that we aim to address with this thesis.

First, the literature on digital transformation and co-evolution in ecosystems is scattered among various disciplines. Regarding digital transformation, scholars from information systems (IS), management, or organization science contribute to a growing body of knowledge concerning this phenomenon (e.g., Fitzgerald et al. 2013; Majchrzak et al. 2016; Agarwal et al. 2010; Rowe 2018). Yet, within and in-between these literature streams, there is considerable disagreement regarding what the characteristics of an organization's digital transformation are. This is reflected in inconsistencies, overlapping and contradictory definitions, and different and heterogeneous schools of thought. However, the diversity of theories and concepts from different disciplines often encourage compartmentalization of perspectives that do not enrich each other. Because we lack clarity about the exact nature of digital transformation, it is difficult to compare, analyze, and discuss the phenomenon appropriately. Providing a structured overview of the literature, drawing on digital transformation articles and prior organizational transformation studies, to analyze the underlying schools of thought of digital transformation and to discuss their differences to prior organizational transformation approaches is thus the first essential basis for this thesis and will help to derive insights on digital transformation. This is also observable for the notion of co-evolution in ecosystems, where co-evolution has been studied from various perspectives. For example, co-evolution may occur on multiple levels, e.g., business processes, or regulatory authorities (Koza/Lewin 1999; Lewin/Long 1999). However, we still lack a clear and structured understanding of how co-evolution unfolds in digital transformation initiatives on the ecosystems level. So, providing a unified understanding of how co-evolution unfolds in digital platform ecosystems is thus the second essential basis for this thesis.

Second, we lack a structured analysis of how digital transformation in digital platform ecosystems materializes (Hanelt et al. 2015b; Kaltenecker et al. 2015). As the first step towards this goal, we require a structured analysis of digital platform ecosystems that are in a digital transformation, which needs to uncover its inherent actors and the value streams between (Puschmann 2017; Jacobides et al. 2018; Adner 2017). While there are ecosystem analyses of single industries (see Adner 2017) or companies, e.g., Cisco, (Li 2009), a complete analysis of the digital transformation on the ecosystem level is missing, which is difficult due to its macro-level perspective consisting of a plethora of different organizations (Puschmann 2017). Additionally, the dynamics of digital transformation may be discordant in different industries. Therefore, we also lack a structured analysis of how digital transformation unfolds in multiple digital platform ecosystems (Jacobides et al. 2018; Vial 2019). This requires a generic approach to consider and incorporate all relevant actors of an industry, e.g., the financial, insurance (Puschmann 2017) or automotive industry (Hanelt et al. 2015a).

Third, we lack a thorough analysis of strategies for platform owners to manage the transformation of complementary partners (Jacobides et al. 2018; Puschmann 2017). We already know how to launch and how to govern digital platform ecosystems (Hein et al. 2016; Huber et al. 2017; Mattila/Seppälä 2017; Schreieck et al. 2016; Tiwana 2014; Tiwana et al. 2010; Stummer et al. 2018). In platform governance, the platform owner needs to balance control rights with the autonomy of ecosystem actors (Ghazawneh/Henfridsson 2013; de Reuver et al. 2017). Mechanisms such as input and output control, decision rights, and ownership status govern the evolutionary dynamics of an ecosystem (Tiwana et al. 2010; Tiwana 2014). Most frequently, platform owners govern their complementors through boundary resources, such as APIs or toolkits such as SDKs to integrate and enable an ecosystem of actors to provide complementary products or services (Ghazawneh/Henfridsson 2013). Hence, platform owner's activities go beyond designing, developing, and distributing products and services to include decisions for governing complementary innovation by orchestrating the behavior and contribution of complementors (Boudreau/Hagiu 2009; Foerderer et al. 2018). On the other hand, complementors contribute to digital platform ecosystems in order to access external resources and capabilities, such as the platform owner's ability to provide integrated systems, to innovate systems, commercial capital and reputation (Kude et al. 2012). However, we do not know how to manage the co-evolution of complementary partners in an already established platform ecosystem which is transforming due to a digital innovation. This implies a balancing between cooperative and competitive mechanisms to motivate partners to co-evolve in line with the platform owner, e.g., to go cloud if a cloud platform, is introduced compared to an on premise solution. Also it remains unclear how such a process of co-evolution can to be governed.

These three gaps guided us when formulating the following research questions addressed within this thesis.

1.2 Research Questions

Overall, we aim to develop an empirical understanding of how platform owners can manage the co-evolution of complementors in digital platform ecosystems in digital transformation initiatives. We will answer the following research questions along this thesis:

> ***RQ1***: *What does literature contribute to our understanding of co-evolution in platform ecosystems in digital transformation initiatives?*

This research question entails a two-step approach. First, as the term digital transformation has been interpreted differently, we conduct a transdisciplinary review of the literature (Webster/Watson 2002) spanning the IS, management, and organization science literature to clarify its notion. Second, we seek to understand how co-evolution materializes in digital platform ecosystems.

Therefore, we also conduct a literature review spanning the same disciplines. Both literature reviews will also help to link our findings to literature. This research question is the foundation for the subsequent research questions and answering it will provide a theoretical background for the empirical studies conducted to answer the subsequent research questions.

> ***RQ2***: *Which generic configuration patterns emerge in the digital transformation of platform ecosystems?*

Based on this research question, we aim to empirically analyze how digital transformation takes place on an ecosystem level. This research question also consists of a two-step approach. First, we aim to visualize digital platform ecosystems in digital transformation. Therefore, we follow a three-step approach. First, we need to identify the relevant actors of an ecosystem. Second, the value streams between them need to be identified. Third, to visualize the ecosystem and the interplay of its actors, we need to visualize the ecosystem using a suitable modeling technique. Afterward, to check for its robustness, the ecosystem has to be evaluated with experts from the respective ecosystem.

The goal is to follow this approach in multiple industries, e.g., the automotive, financial, and manufacturing industry, to detect configuration patterns about the digital transformation of platform ecosystems. Following a theoretical sampling technique (Yin 2014), we chose industries with a high degree of co-creation between platform owners and complementors.

Based on the developed ecosystems, we aim to identify generic configuration patterns emerging in digital platform ecosystems. Therefore, we use quantitative similarity measures. Methodologically this enables comparison between industries to clarify whether an emergent phenomenon is idiosyncratic to a single ecosystem or consistently replicated by several ecosystems (Eisenhardt 1989). The results of this research question inform the third research question which focuses on platform owners.

> ***RQ3***: *What are mechanisms for platform owners to manage the co-evolution of complementors in platform ecosystems in digital transformation initiatives?*

This research question targets to identify mechanisms platform owners can use to manage the co-evolution of their complementors. Conducting multiple case studies on the successful management of co-evolution of complementary partners, the goal of this research question is to theorize how co-evolution occurs between platform owners and complementors.

Based on the context of this thesis – digital transformation – four criteria are relevant for the selection of adequate digital platform ecosystems. First, the ecosystem has to be in a well-established industry, as digital transformation means the transformation of an incumbent into an organization with digital processes, product, services, or business model (Vial 2019; Fitzgerald et al. 2013). Second, a platform owner is at the core of the value creation. Third, an ecosystem of complementary partnerships that co-create value based on the digital platform exists. Fourth, the digital platform transformed the value creation and/or capture in the respective ecosystem.

By empirically studying several of such cases, we can better understand the specific situation of platform owners that seek to transform an already existing partner ecosystem, i.e. in light of a digital transformation initiative, such as Microsoft introducing the Azure cloud platform (ACP), or Finning introducing the Finsight monitoring platform.

1.3 Structure of the Thesis

This cumulative dissertation consists of three parts. Part A gives an overview of the thesis by introducing the problem statement, providing an overview of the research objective, and structure of the dissertation (Chapter 1). It introduces the basic terms in the area of ecosystems, and coevolution (Chapter 2) and finally describes the research methods and strategy deployed in this thesis (Chapter 3).

Part B consist of the nine peer-reviewed publications (Chapter 4-12). We divided Part B into two parts: B1 for accepted papers, and B2 for papers that are currently under review and hence not yet published. While the first two publications review the literature on digital transformation, and co-evolution in business ecosystems (Chapter 4, 5), four publications analyze the digital transformation in different industries (Chapter 6-10). Chapter 10 introduces another ecosystem, explains our new method detailed, and examines all ecosystems to identify generic clusters for the digital transformation in platform ecosystems. After we understood how digital transformation takes place on an ecosystem level, we have a closer look to understand how platform owners mange the co-evolution of their complementors. Therefore, we conduct an in-depth case study at Microsoft (Chapter 11), and a multiple case study among several platform owners (Chapter 12).

Part C concludes the thesis in four chapters. First, the results are summarized (Chapter 13), and discussed in detail afterwards (Chapter 14). Afterwards, a discussion on the theoretical and practical contributions of this work is (Chapter 15), and the limitations of this thesis are elaborated (Chapter 16). Ultimately, several anchor points for fruitful avenues of future research are illustrated (Chapter 17).

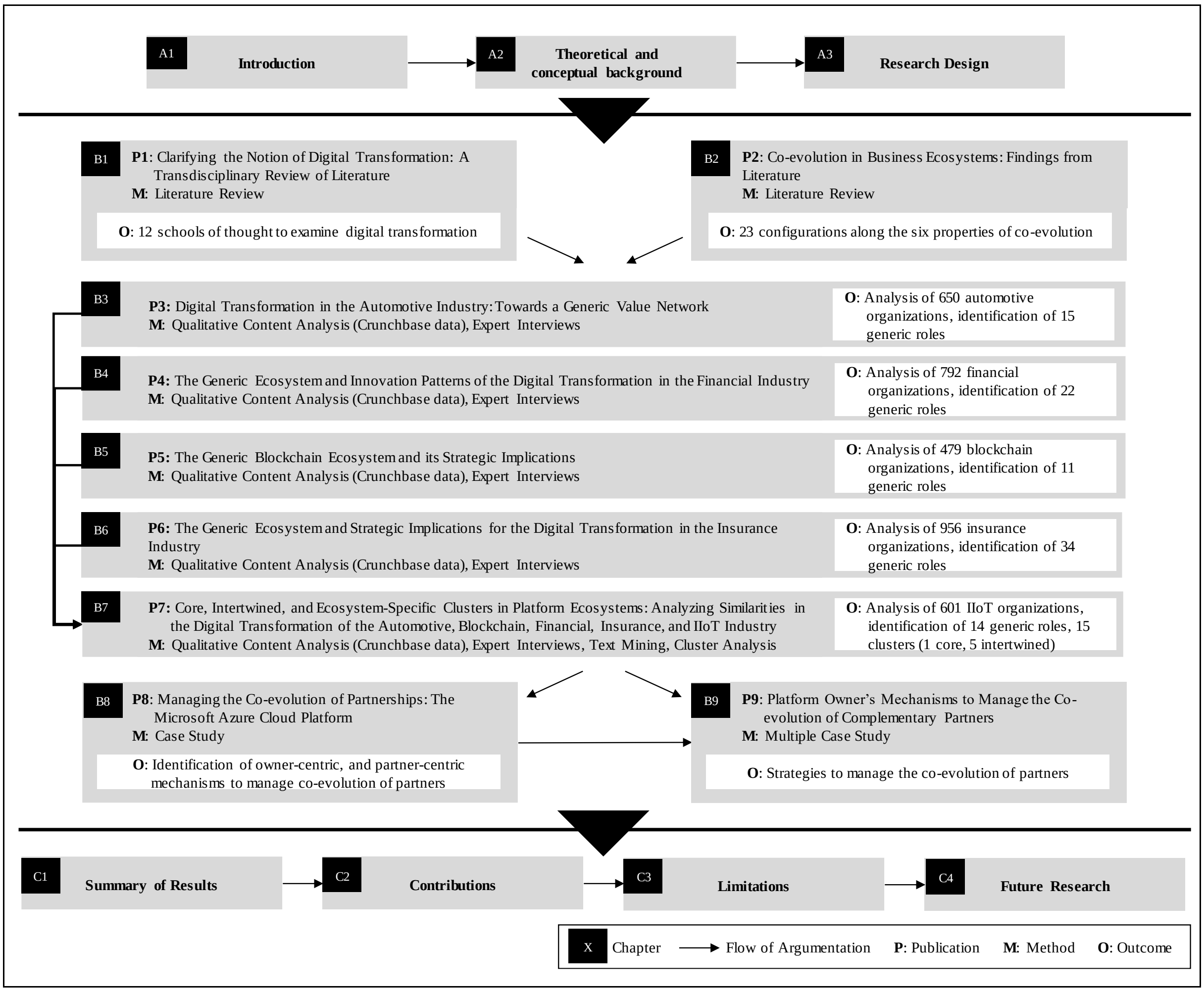

Figure 1. Thesis Structure

In the following paragraphs, we summarize the nine publications embedded in part B1 (accepted publications) and B2 (publications under review). In doing so, the research problem, the methodological approach, and the main contributions of each publication (P) are briefly outlined:

- **P1:** The first paper, "*Clarifying the Notion of Digital Transformation: A Transdisciplinary Review of Literature*," offers useful terminological and conceptual groundwork. Based on a systematic literature review, the authors focus on the contributions made in two partly overlapping disciplines: management and organizational science, and information systems research. Their transdisciplinary review of the literature on digital transformation, spanning 175 articles, thus highlights how organizations respond to digital transformation. In so doing, they identify no fewer than twelve schools of thought on the phenomenon. The authors show that research into digital transformation builds on existing schools of thought as well as creating new ones, such as digital innovation and ecosystems.

- **P2:** The second paper, "*Co-evolution in Business Ecosystems: Findings from Literature*" structures extant literature among the properties of co-evolution, thereby offering conceptual groundwork. The work is based on a systematic literature review in IS, management, and organization science literature, spanning 44 articles. Following the six properties of co-evolution, a framework for the co-evolution in business ecosystems, comprising of 23 configurations is developed.

- **P3:** The third paper, "*Digital Transformation in the Automotive Industry: Towards a Generic Value Network,*" presents the first generic value network of the automotive industry using the e^3 value modeling method. The generic value network is developed by analyzing 650 companies reported in the Crunchbase database, comprising of 15 generic roles and the value streams between the roles, and represents the ecosystem of the automotive industry. We validated our findings with six industry experts. Our results show the central role of mobility service platforms, emerging disruptive technology providers and the dissemination of industries, e.g., as OEMs collaborate with mobile payment providers, which all shape the digital transformation of the automotive industry.

- **P4:** The fourth paper, "*The Generic Ecosystem and Innovation Patterns of the Digital Transformation in the Financial Industry,*" provides a structured overview of the digital transformation in the financial industry. As with digital technologies like mobile payments, robot advisors, and distributed ledgers, Fintechs are challenging the prevailing position of traditional financial institutions. By analyzing 792 Fintechs, this paper visualizes the 22 generic roles and value streams within the financial ecosystem using the e^3 value method. We validated our findings with four industry experts. Moreover, we identify and discuss seven inter-organizational innovation patterns of the digital transformation in the financial industry: elimination of intermediaries, enhance transparency, cloud-based services, service aggregation, service integration, prosumption, and creation of a parallel universe. Thereby this paper contributes to digital transformation and ecosystem literature by examining the digital transformation of the financial industry from an inter-organizational perspective. Further, this paper also analyzes the influence of blockchain technology on the financial ecosystem.

- **P5:** The fifth paper, "*The Generic Blockchain Ecosystem and its Strategic Implications,*" provides a structured overview of the blockchain ecosystem. The emergence of this technology has the potential to transform entire industries, such as banking, insurance, or the Internet of Things (IoT). By analyzing 479 blockchain companies reported in the Crunchbase database, this paper visualizes the current blockchain ecosystem using the e^3 value method. Thereby, we identified 11 generic roles in the ecosystem. We validated our findings with five industry experts. Moreover, three strategic implications where blockchain is fundamentally different from prior technologies are discussed: governance, trust, and openness. Scholars can apply the generic ecosystem for future research, while practitioners can use the model to identify possible disruptive actors or potential business opportunities.

- **P6:** The sixth paper "*The Generic Ecosystem and Strategic Implications for the Digital Transformation in the Insurance Industry,*" provides a structured overview of the digital transformation in the insurance industry. By analyzing 956 InsurTechs, this paper visualizes the 34 generic roles and value streams within the insurance ecosystem using the e^3 value method. We validated our findings with seven industry experts. Moreover, we compare the strategic implications for traditional insurance organizations to the innovation patterns discovered in the finance paper (P4).

- **P7:** The seventh paper "*Core, Intertwined, and Ecosystem-Specific Clusters in Platform Ecosystems: Analyzing Similarities in the Digital Transformation of the Automotive, Blockchain, Financial, Insurance, and IIoT Industry*," first provides a structured overview of the manufacturing ecosystem in digital transformation due to the Industrial Internet of Things (IIoT). By analyzing 601 organizations, we identified 14 generic roles. We validated our findings with nine industry experts. Furthermore, this paper targets to examine the similarities of digital transformation in five platform ecosystems: automotive, blockchain, financial, insurance, and IIoT. Our analysis, the strengths of conceptual modeling using e3 value are combined with a cluster analysis based on text mining. As a result, we identified 15 clusters. Cluster 01 is the core cluster, containing roles of organizations from all five ecosystems. Clusters 02-05 are intertwined, as they include roles from at least two ecosystems. Clusters 06-15 are ecosystem-specific and only include roles found in one ecosystem.

- **P8:** The eight paper "*Managing the Co-evolution of Partnerships: The Microsoft Azure Cloud Platform*," is an in-depth case study on the transformation of Microsoft's partner ecosystem due to the introduction of Azure. Prior to the roll out of Azure, Microsoft's value creation was contingent on the co-creation of products and services with a very large partner base that delivered those products and services on the customers' premises. For its cloud strategy to be successful, Microsoft had to motivate those partners to join and grow the Azure ecosystem, and to deliver the next generation of Microsoft products and services in the cloud. In its successful transformation, Microsoft adopted a two-phase change program based on six lessons learned. Phase One was based on two direct owner-centric mechanisms to grow the Azure partner base. Phase Two was based on four partner-centric mechanisms to shift the locus of control to the partners.

- **P9**: The ninth paper "*Platform Owner's Mechanisms to Manage the Co-evolution of Complementary Partners*," provides 29 mechanisms for platform owners to manage the co-evolution of their complementary partners based on the findings of a multiple case study among four platform owners. We organized the mechanisms into three stages. First, platform owners start with mechanisms to align with partners by determining future business opportunities, and enable partners by developing necessary new capabilities. This is are relevant for the time before the development of new complements or the transformation of established complements. Second, platform owners support partners to develop new complements. Third, and relevant for the time after the development of new complements or transformation of established complements to the new digital platform, platform owners motivate partners to engage and grow in the new ecosystem. During all steps, platform owners maximize the ecosystem attractiveness through various mechanisms. These mechanisms are particularly relevant for the self-renewal of digital platform ecosystems.

No.	Authors	Title	Outlet	Type
P1	Riasanow, Soto Setzke, Böhm, Krcmar	Clarifying the Notion of Digital Transformation: A Transdisciplinary Review of Literature	JCSM 2018 (accepted)	JNL (VHB: C)
P2	Riasanow, Flötgen, Greineder, Möslein, Böhm, Krcmar	Co-evolution in Business Ecosystems: Findings from Literature	GI EMISA 2019 (accepted)	CONF (VHB: C)
P3	Riasanow, Galic, Böhm	Digital Transformation in the Automotive Industry: Towards a Generic Value Network	ECIS 2017 (accepted)	CON (VHB: B)
P4	Riasanow, Flötgen, Soto Setzke, Böhm, Krcmar	The Generic Ecosystem and Innovation Patterns of the Digital Transformation in the Financial Industry	PACIS 2018 (accepted)	CON (VHB: C)
P5	Riasanow, Burckhardt, Soto Setzke, Böhm, Krcmar	The Generic Blockchain Ecosystem and its Strategic Implications	AMCIS 2018 (accepted)	CON (VHB: D)
P6	Greineder, Riasanow, Böhm, Krcmar	The Generic Ecosystem and Strategic Implications for the Digital Transformation in the Insurance Industry	GI EMISA 2019 (accepted)	CONF (VHB: C)
P7	Riasanow, Jäntgen, Hermes, Böhm, Krcmar	Core, Intertwined, and Ecosystem-Specific Clusters in Platform Ecosystems: Analyzing Similarities in the Digital Transformation of the Automotive, Blockchain, Financial, Insurance, and IIoT Industry	EM (revise & resubmit)	JNL (VHB: B)
P8	Riasanow, Schwaab, Böhm, Yetton, Krcmar	Managing the Co-evolution of Partnerships: The Microsoft Azure Cloud Platform	MISQ Executive (revise & resubmit)	JNL (VHB: B)
P9	Riasanow, Urmetzer, Flötgen, Möslein, Böhm, Krcmar	Platform Owner's Mechanisms to Manage the Co-evolution of Complementary Partners	JSIS (submitted)	JNL (VHB: A)

JCSM: Journal of Competences, Strategy & Management (before: Journal of Competence-based Strategic Management); AMCIS: Americas Conference on Information Systems; ECIS: European Conference on Information Systems; GI EMISA: Gesellschaft für Informatik Enterprise Modeling and Information Systems Architectures; PACIS: Pacific Asia Conference on Information Systems;

JNL: Journal; CON: Conference;

VHB: German Academic Association for Business Research.

Table 1. Overview of Embedded Publications

1.4 Remarks on Format

The formatting styles of the original publications were different from one another. For the purpose of consistency, the original research works have been reformatted for this thesis, applying a uniform formatting style. The tables and the figures were redesigned and unified throughout the entire document. Furthermore, the tables and the figures were numbered sequentially across all parts of the thesis. Consequently, the numbering of figures, tables, and in-text-references differ from the original publications. The original section numbering in the publications was substituted by the overarching structure of the present document. Each major part (A to B) comprises a unique numerical structure of sections and subsections. For the purpose of simplicity, all references to other sections of the same part omit the indication of the part number. Minor editorial revisions to the original publications were also made (e.g., adaptation of reference styles, orthographical and minor grammatical revisions).

2 Conceptual Background

In this section, we shed light on the theoretical concepts that we build on in this thesis. We first define the phenomenon of digital transformation, provide an overview of its characteristics, and digital innovation as driving force of digital transformation. Second, we provide background on digital platform ecosystems, its perspectives, characteristics, related concepts of ecosystems, and co-evolution in particular.

2.1 Digital Transformation

The market for information technologies is constantly evolving and giving rise to disruptive digital technologies, such as 3D printing, data analytics, and mobile computing (Nambisan et al. 2017), forcing established organizations (so-called incumbents) to transform in order to remain competitive (Yoo et al. 2012; Yoo et al. 2010; Lucas et al. 2013). We refer to the organizational transformation process of using and combining digital technologies in new ways to radically transform an organization as digital transformation (DT).

The success of purely digital organizations such as Netflix, Spotify, or Amazon, as well as the bankruptcy of traditional companies such as Kodak or Blockbusters are typical examples of DT (Lucas/Goh 2009). In other words, digital transformation is “inevitable, irreversible, tremendously fast, and uncertain in the execution” (Krcmar 2014).

Under this heading, scholars from IS, management, or organization science are contributing to a growing body of knowledge concerning this phenomenon (Agarwal et al. 2010; Fitzgerald et al. 2013; Majchrzak et al. 2016; Rowe 2018; Vial 2019; Bharadwaj et al. 2013).

The following chapter seeks to clarify the notion of digital transformation and is organized as follows. First, we provide an overview of the characteristics of DT. Second, we provide and synthesize the multiple and heterogeneous definitions on the phenomenon, and third, connect this chapter to the extensive literature review conducted in Paper 1 “Clarifying the Notion of Digital Transformation: A Transdisciplinary Review” in Part B, where we identified 12 different and heterogeneous schools of thought on DT identified from analyzing 175 journal and conference articles.

2.1.1 Definition

As a first step toward understanding digital transformation, we searched for explicit definitions of the phenomenon. A more comprehensive overview can be found in Paper 1 “Clarifying the Notion of Digital Transformation: A Transdisciplinary Review” in Part B.

The definition of digital transformation used most often is provided by Fitzgerald et al. (2013). According to their interpretation, the main differentiator between digital transformation initiatives and any other organizational transformation initiative that involves the implementation of digital technologies is the notion of novelty associated with the technologies that are implemented. However, the restriction of digital transformation initiatives to those involving new digital technologies is problematic because the perception of novelty is always a matter of perspective.

Nambisan et al. (2017) tried to resolve this by defining a digital innovation as the use of digital technologies during the process of innovating, which is new to the adopting organization but may already be well established in other organizations. A typical example is the use of cloud services in the newspaper industry (Karimi/Walter 2015), even though such services are already well established in the software industry (Leimeister et al. 2010).

Surprisingly, the term digital transformation is only rarely mentioned in digital innovation literature, which has gained momentum in recent years. Research on digital innovation focuses on the enhancement of physical products or a new organizational logic (Yoo et al. 2010) or the orchestration of digital innovations (Nambisan et al. 2017), which are also critical elements of transformations (Fichman et al. 2014). Hence, we reflect on the notion of digital innovation as key enabler of digital transformation later in this background chapter.

Comparing multiple definitions of digital transformation, Vial (2019) made three observations. First, DT is primarily defined on the organizational level. Second, differences across the employed technologies and the nature of the transformation are observable. Third, similarities among the definitions connote to the term "digital technologies", which however remains rather generic. Therefore, we will first discuss the characteristics of digital transformation and then focus on digital innovation, which is based on digital technology, as key enabler of digital transformation.

2.1.2 Characteristics of Digital Transformation

In terms of content, digital transformation refers to a process of holistic organizational change that is driven over time by changes to organizational means for value creation and appropriation (Skog et al. 2018a). Using Service-dominant logic to explain digital transformation in a digitized and interconnected world (Lusch/Nambisan 2015; Vargo/Lusch 2004), services are created in service ecosystems (actor-to-actor networks). In these service ecosystems, value is no longer created by one actor but increasingly created through co-creation on service platforms (Lusch/Nambisan 2015). Exploring co-creation, Sarker et al. (2012) provide three modes of resource alignment in B2B contexts: 1) exchange (resource bartering), 2) addition (resource layering), and 3) synergistic integration (resource amalgamation). Although the resources spent by each organization are the essence of the relationship, more critical for successful co-creation is how these are coordinated (Sarker et al. 2012).

Hence, to foster alignment of resources in digital transformation, change implies the whole service ecosystem. This shift suggests competition is increasingly occurring among service ecosystems, e.g., Apple's App Store versus Google's Play Store. Competition at the ecosystem level implies a fundamental difference to prior notions of organizational change.

While studying service innovation on iOS and Android platforms, Kankanhalli (2015) found an ecosystem of sustainable innovation is enabled through the provision of toolkits for users. This example illustrates that changes in the technology base have a direct effect on the co-creating partners in the ecosystem. These tools can be referred to as boundary resources (Eaton et al. 2015), which are used to govern the co-creation of value in platform ecosystems.

Besides product, service, and business model innovation, digital transformation inherently entails changes to organizational structures and operations Matt et al. (2015). An often mentioned rationale for organizational redesign during digital transformation is to enable ambidexterity (Gregory et al. 2015; Piccinini et al. 2015a). So, organizations can utilize existing resources to foster efficient processes (exploitation), e.g., by optimization, or create novel potentials (exploration), e.g., through research or experimentation (March 1991). Ambidexterity means "organization's ability to pursue two disparate things at the same time" (Gibson/Birkinshaw 2004). Gregory et al. (2015) use ambidexterity to explain that organizations can resolve the paradox in balancing IT investments to meet short term efficiency goals (exploit) and long-term innovation simultaneously (explore).

Further, organizations in digital transformation should encourage “employees to develop a digital mindset in order to increase the acceptance and use of digital technologies in everyday work and processes” (Piccinini et al. 2015a, p. 10). Supporting this view, Chatfield (2015, p. 16) argues that for successfully implementing big data solutions in the public sector a culture which “encourages and rewards smart, motivated employees with the entrepreneurial problem-solving capability and their experimental use of disruptive technologies” is required. This highlights the necessity of establishing an organizational culture that encourages employees to take responsibility and explore various options in transformations. The changes in responsibility, accountability, and experimentation connote a significant shift in corporate culture. In previous organizational change projects, employees were empowered to experiment on the process level, while digital transformation fosters employees combining technological and entrepreneurial thinking in order to change the organization’s business model and the respective value network. This part of DT presents an important step to enhance the diffusion of innovations towards a learning organization (Chatfield et al. 2015; Hildebrandt et al. 2015).

Nevertheless, major transformations may provoke employees’ resistance, especially as digital transformation has an impact on the whole organization and beyond. Therefore, transactional leadership is not sufficient for carrying out a digital transformation. Instead, transformative leadership is essential to communicate the vision and get active involvement of the different stakeholders that are affected by the transformation (Matt et al. 2015). The essence is to observe the limitations of the organizational culture and transform it adequately if some of the central assumptions are invalid, e.g., through environmental changes or the diffusion of technologies that fundamentally alter the organization (Chatfield et al. 2015).

Accounting for empowerment, we observe digital transformation often dovetails with the creation of a new executive role, i.e., the introduction of a Chief Digital Officer (CDO) (Matt et al. 2015), which shows that a fulltime role with decision power in the executive board is important to deal with the speed of digital innovations. That companies are eager to react accordingly, is shown by the number of active CDOs, which doubled every year from 2003 to over 2000 CDOs in 2015, according to the CDO Club (CDO Club 2016).

For the comparison of the role of IT, we again include S-D Logic, which differs between operand and operant resources. Operand resources are defined as resources which actors (e.g., organizations) use to get support (Lusch/Nambisan 2015). Thus, operand resources facilitate changes. For an organizational change, we understand the introduction of a new workflow system as operand resource, e.g., to facilitate changes in business processes. In contrast, operant resources “are resources that act on other resources to produce effects” (Lusch/Nambisan 2015). There, we see a move of understanding resources like IT from an object towards a subject. The introduction of a multi-sided platform ecosystem to co-create new services can be such a trigger for change. Hence, the role of IT in digital transformation can be regarded as an operant resource. For example, the Berliner Philharmonie used a scalable cloud infrastructure to develop their digital concert hall to stream their concerts to customers worldwide, which created the possibility to enjoy them remotely (Uhl et al. 2013). The shift in the role of IT directly affects the role of the IT department, towards actively engaging in the creation of new business models that are transforming the ecosystem (Chanias/Hess 2016; Piccinini et al. 2015a; Lucas et al. 2013).

However, organizations need to find a way to incorporate innovative technology in the organization. The case of Kodak illustrates the downsides if organizations fail to do so (Lucas/Goh 2009). Using IT as an operant resource is of the key shifts that influence the content of organizational change. Therefore, some scholars, the notion of digital innovation requires a new organizational logic (Yoo et al. 2012; Yoo et al. 2010), which is discussed subsequently.

2.1.3 Digital Innovation as Driving Force of Digital Transformation

The literature on digital innovation focuses on the enhancement of physical products or a new organizational logic (Yoo et al. 2010) or the orchestration of digital innovations (Nambisan et al. 2017), which are also critical elements of transformations (Fichman et al. 2014). Digital innovation further requires a firm to revisit its organizing logic and its use of corporate IT infrastructures (Yoo et al. 2010).

Yoo et al. (2010) define digital innovation as “the carrying out of new combinations of digital and physical components to produce novel products”. Following this understanding, a necessary but insufficient condition of digital innovation is that the new combination relies on digitization, which makes physical products programmable, addressable, sensible, communicable, memorable, traceable, and associable (Yoo et al. 2010). Reflecting an expansion of its scope, Nambisan et al. (2017) have more recently defined digital innovation as “the creation of (and the consequent change in) market offerings, business processes, or models that result from the use of digital technology”. Thus, extending digital innovation to the use of digital technology for the design, development, delivery, and operations of market-facing artifacts. However, Skog et al. (2018a) find the definition limiting in the sense that it directs attention to the initial creation of an innovation and, therefore, contextualize it within digital transformation as “the process of combining digital and physical components to create novel devices, services or business models, bundling them to constitute and enable market offerings, and embedding them in the wider sociotechnical environments to enable their diffusion, operation and use.

Following Yoo et al. (2010), digital innovations build on key characteristics that differ from earlier technologies, e.g., reprogrammability, the homogenization of data, the self-referential nature of digital technology, and its layered modular architecture. The ability to be reprogrammed over time through a separation of form from function (Yoo et al. 2012; Yoo et al. 2010), for example, enables a smartphone to be changed at any time by installing new software applications on it (Skog et al. 2018a). The ability to be self-referential is an essential stimulant of more of its kind (Yoo et al. 2010). This enables a virtuous cycle where an increase in the performance, diversity, and accessibility of digital resources leads to the creation of additional resources (Skog et al. 2018a). Layered modular architecture extends the notion of modular architectures, where functions and components are mapped on a one-to-one basis (sources), through four loosely coupled layered (Yoo et al. 2010; Skog et al. 2018a; Henfridsson et al. 2018). These are a layer of devices with associated hardware and software, a network layer providing means for data transfer, a service layer providing particular application functionalities, and a content layer containing digital text, images, audio and video (Yoo et al. 2010).

Therefore, new organizational logic is necessary to cope with digital innovations (Yoo et al. 2012; Yoo et al. 2010). The case of Kodak shows that such new organizational logic is complicated to achieve, mainly when an organization's business model has been successful for more than one century (Lucas/Goh 2009).

Moreover, digital innovation also presents a new perspective in the ongoing discussion between organization and technology, driven by management and organization science scholars (Orlikowski 2000).

2.2 Digital Platform Ecosystems

The purpose of this chapter is to introduce the main phenomenon of investigation, digital platform ecosystems, consisting of an overview of its origin and definitions, perspectives on and characteristics of digital platform ecosystems, and related concepts.

2.2.1 Origin and Definitions

Borrowed from biology, the term ecosystem generally refers to interaction firms that depend on each other's activities recently found momentum in IS, management, and organization science literature (Jacobides et al. 2018). However, research on ecosystems is scattered among various disciplines, including IS, management, and organization science (Jacobides et al. 2018; Staykova/Damsgaard 2018). Three terminologies are most commonly used, which are also dividing the field into three broad streams: "business ecosystems", "innovation ecosystems" and "platform ecosystems" (Jacobides et al. 2018). The streams differ in their focus but share the common understanding of ecosystems as a "set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled" (Jacobides et al. 2018). In a hierarchical sense, the term "business ecosystem" can be seen as the root, being explored first, with "innovation" and "platform ecosystems" derived after that (Jacobides et al. 2018). An overview of the definitions from relevant selected papers is given in Table 2.

Concept	Definitions	References
Ecosystem	"An ecosystem is a set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled"	Jacobides et al. (2018)
Business Ecosystem	"In a business ecosystem, companies co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations"	Moore (1993)
	"The community of organizations, institutions, and individuals that impact the enterprise and the enterprise's customers and supplies"	Teece (2007)
Innovation Ecosystem	The collaborative arrangements through which firms combine their offerings into a coherent, customer-facing solution	Adner (2006)
	"Industrial ecosystem, where platform owner orchestrates the innovation efforts of complements"	Gawer/Henderson (2007)

	"The network of innovation to produce complements that make a platform more valuable"	Ceccagnoli et al. (2012)
Platform Ecosystem	"Collection of the platform and the modules specific to that platform"	Tiwana et al. (2010)
	Platform ecosystem encompasses actors coordinated around a platform through boundary resources	Ghazawneh/Henfridsson (2013)
	"Ecosystems organize and leverage external entities, which are frequently complementors and have interdependencies between them"	Altman/Tuschman (2017)
	Platform owner orchestrating a number of external complementors through a governance regime	Huber et al. (2017)
	"Platform firms orchestrate the functioning of ecosystems by providing platforms and setting the rules for participation by complementor firms"	Kapoor/Agarwal (2017)
	"A platform ecosystem model that emphasizes core interactions between platform participants, including customers, producers, and third-party actors"	Constantinides et al. (2018)

Table 2. Overview of Definitions of Ecosystems

"In a business ecosystem, companies co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations" (Moore 1993, p.76). Originating from this article IS, management, and organization science research has picked up the notion of ecosystems, rapidly, but not consistently at all times. Central in the definition of Moore (1993) is that business ecosystems contains of companies with "co-evolv[ing] capabilities around an innovation". Later this definition was refined and extended towards an "economic community supported by a foundation of interacting organizations and individuals (…) that produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders" (Moore 1996). This broader definition has since been widely maintained, with Teece (2007) defining business ecosystems as "the community of organizations, institutions, and individuals that impact the enterprise and the enterprise's customers and supplies."

There is still incertitude as to where exactly the boundary has to be drawn that separates the entities within from that outside of a specific ecosystem (Weber/Hine 2015). However, this definition also entails that a business ecosystem is constituted relative to a particular firm – with different firms that are not operating in an identical ecosystem even when they are offering similar services or products. In the literature stream of business ecosystems, the unit of analysis is, therefore, usually the individual firm (Jacobides et al. 2018).

In contrast, an "innovation ecosystem" is focusing on innovative solutions towards the end customer. A concise definition of innovation ecosystems is the "collaborative arrangements through which firms combine their offerings into a coherent, customer-facing solution" (Adner 2006). Others understand it as an industrial ecosystem with platform owners orchestrating the innovation efforts of complements (Gawer/Henderson 2007), which makes a platform more valuable (Ceccagnoli et al. 2012). Research following this path often studies the value creation of ecosystems (Adner/Kapoor 2010; Dattée et al. 2018; Autio/Thomas 2014). As innovations are relevant in almost all business ecosystems, it is not a delimitative definition, but merely a terminology for the same concept with an additional emphasis on innovation. Thus, it is no surprise that the descriptions are often used interdependently and that literature on innovation ecosystems are based on the same theoretical background (Brusconi/Prencipe 2013).

In some of the definitions of business or innovation ecosystems, the term “platform” is already mentioned (e.g., see Autio/Thomas 2014), which indicates how closely the idea of a platform is related to ecosystems. Ecosystems are the more general concept, of which platforms are typical instantiations: Many business ecosystems, such as the Apple iOS ecosystem, have at their core a platform that structures and orchestrates the complementors and partners (Dattée et al. 2018; Jacobides et al. 2018; Altman/Tuschman 2017).

Platform ecosystems are most conventional in the IS field, for example, by the work of Tiwana on ecosystems around software platforms (Tiwana 2014; Tiwana et al. 2010; Ceccagnoli et al. 2012; Taudes/Feuerstein 2000). The term “platform” originates from the product development or engineering disciplines (Krishnan/Ulrich 2001; Simpson et al. 2001), and has since enjoyed similar popularity as the term “ecosystem”, with further adoption in industrial economics (Evans 2003; Rochet/Tirole 2003). Ghazawneh/Henfridsson (2013) highlight the importance of boundary resources to govern and coordinate the actors in platform ecosystems. This helps platform owners to leverage external entities, which are frequently complementors (Altman/Tuschman 2017). In the management literature, platform ecosystems have also gained significant momentum, especially in examining the mechanisms of two- or multiple-sided markets (Boudreau/Lakhani 2009; Cusumano/Gawer 2002; Hagiu 2014).

2.2.2 Perspectives on Digital Platform Ecosystems

The overview of the different definitions shows that the scholarly field of digital platform ecosystems is broad and diverse. Scholars from various disciplines have different perspectives on how platforms orchestrate an ecosystem of actors in co-creating value (Lusch/Nambisan 2015). These disciplines include economics with a market-based perspective (Parker et al. 2017; McIntyre/Srinivasan 2017), technology management with a technical perspective (Tiwana et al. 2010; Baldwin/Woodward 2009; Tilson et al. 2010), and information systems with a socio-technical perspective (de Reuver et al. 2017; Constantinides et al. 2018). In addition, 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).

The **market-based perspective** of two-sided markets goes back to the work of Rochet/Tirole (2003), who studied market power in the presence of network externalities (Schilling 2002). Network externalities describe that 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 ecosystem of actors presents challenges and offers new opportunities for companies to leverage network effects (McIntyre/Srinivasan 2017). One challenge for emerging digital platforms is the chicken and egg problem, where the platform needs both sides to be present to ensure a valid value proposition (Caillaud/Jullien 2003). Digital platforms with a sufficient installed base can use their dominance to increase their market share further. These strategies include platform envelopment, for example, Amazon using its profits to tap into new markets by subsidizing its cloud computing services or by using the platform's information superiority to out-compete internal complementors (Zhu/Liu 2018). Other examples, such as the antitrust cases of Microsoft and Google, show the relevance and importance of the so-called winner-take-all effects in two-sided markets (Iacobucci/Ducci 2019; Schmalensee 2000).

The **technical perspective** views software-based platforms as an extensible codebase that provides core functionality and can be supplemented by modular services (Tiwana et al. 2010). Each modular service is a software subsystem that can extend the functionality of the platform (Baldwin/Woodward 2009). New modules can be integrated via standardized interfaces – boundary resources – such as APIs (Ghazawneh/Henfridsson 2013). Depending on the openness of those interfaces, new services, such as applications, can be provided by an ecosystem of either loosely coupled external developers or tightly coupled strategic partners, as exhibited in payment functionality. 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 (Katz/Shapiro 1986). The stability of design rules and interfaces ensures that developers can develop and integrate modules without extensive knowledge of the platform architecture, while the modular architecture allows for versatility and scalability of new modules (Tiwana et al. 2010). Hence, the digital platform is a breeding ground for innovations characterized by generativity (Yoo et al. 2012). In this way, a digital platform acts as a digital infrastructure that ensures platform stability while also cultivating a variety of new modules (Tilson et al. 2010; Constantinides et al. 2018).

The **innovation management** perspective on platforms was developed in the work of Cusumano/Gawer (2002) and is based on the concept of platform leadership. Based on the cases of Intel, Microsoft, and Cisco, the authors illustrate how platform leaders federate and coordinate an ecosystem of innovating and competing agents. Platform leaders maintain a central position in the ecosystem and use economies of scope to facilitate interactions among agents in the ecosystem (Gawer/Cusumano 2014). Another characteristic is the role of platform openness. Depending on the openness of interfaces, an ecosystem can be restricted to internal use within a company, such as in ERP systems, or can be open to taking advantage of the innovation capabilities of external complementors that provide value-adding services. The degree of openness also influences competition within and across ecosystems (Thomas et al. 2014).

Finally, the **socio-technical perspective** focuses on how digital platforms integrate and govern an ecosystem of actors (de Reuver et al. 2017). Digital platforms provide boundary resources in the form of interfaces such as APIs and toolkits such as SDKs to integrate and enable an ecosystem of actors to provide complementary products or services (Ghazawneh/Henfridsson 2013). Interfaces represent standardized processes, while toolkits reduce the structural flexibility between actors of the ecosystem and the digital platform (Lusch/Nambisan 2015). In platform governance, the platform needs to balance control rights with the autonomy of ecosystem actors (de Reuver et al. 2017; Ghazawneh/Henfridsson 2013). Mechanisms such as input and output control, decision rights, and ownership status govern the evolutionary dynamics of an ecosystem (Tiwana 2014; Tiwana et al. 2010). Consequently, research on digital platforms emphasizes the need to focus on boundaries between digital platforms and their underlying ecosystem (Foerderer et al. 2019; Eaton et al. 2015).

2.2.3 Characteristics of Digital Platform Ecosystems

Despite the proliferation of studies focusing on digital platform ecosystems, we lack a common conceptualization. Thus identifying key constructs of digital platform ecosystems is vital for crafting an overarching understanding of this phenomenon (Jacobides et al. 2018). Following Staykova (2019), we synthesized three core constructs of digital platform ecosystems: actors, architecture, and governance.

Actors are agents who undertake activities and produce different offers or services. First, complementors provide complementary products or services to contribute to the platform's value proposition (Zhu/Liu 2018). It is important to note that the role of the complementor differs from that in traditional firm-supplier relationships (Zhu/Liu 2018). While the complementor autonomously decides whether to join an ecosystem, in the firm-supplier relationship, the firm exerts decision rights regarding such cooperation (Kapoor/Agarwal 2017). Second, consumers refer to service beneficiaries that, in turn, can contribute to the platform's value proposition by providing insights about how and which complements are used (Lusch/Nambisan 2015).

Actors in ecosystems are mostly organizations – that is, firms, institutions, ventures, etc. A "focal organization" or "focal firm" is one of the ecosystem's organizations that are being analyzed in a study, which on its own does not imply anything about its leadership or network centrality roles (Adner 2017). A common assumption is there is one organization at the center of most ecosystems that has a leading role. Frequently enumerated examples are Apple at the center of their mobile software ecosystem, Amazon exerting control over the ecosystem around their multi-sided market and Microsoft leading the ecosystem around the personal computer (Eaton et al. 2015; Weill/Woerner 2015; Keller/Hüsig 2009). These companies are frequently referred to as "keystones" (Iansiti/Levien 2004), "platform leaders" (Cusumano/Gawer 2002) or "core firms" (Pierce 2009) because of the core platform that they maintain to govern the collaboration in the ecosystem. Studying the strategies and design decisions of these lead firms is a popular sub-stream, with authors comparing "coring" versus "tipping" approaches (Saarikko 2016; Gawer/Cusumano 2008) and describing business strategies in particular industries (Zhang/Liang 2011) and companies as case examples (Li 2009). Failures by the leaders to establish a thriving ecosystem were also studied, for instance, in the telecommunications industry (Tee/Gawer 2009).

However, being in the keystone position is by no means the only desirable strategy for companies wishing to have a sustainable and profitable competitive position. There are numerous cases of highly successful and profitable companies in the niches of ecosystems, such as the semiconductor intellectual property (IP) licensing company ARM (Williamson/De Meyer 2012). Usually, the entities other than keystones or leaders are called "complementors" or "contributors." Complementors are being studied, for example, in the form of the independent application developers in the iOS or Android software ecosystems (Kapoor/Agarwal 2017; Benlian et al. 2015). Some authors tend to differentiate between complementors that contribute complements to the end customer and suppliers who contribute components to the focal firm (Adner/Kapoor 2010). In this logic, an airport is a complementor in the aircraft manufacturer's ecosystem while a supplier is, for example, responsible for delivering the component of an engine. More recent work calls all entities "actors" that can then be differentiated in having "leader" or "follower" roles – highlighting that there can be multiple firms in leading roles in the same ecosystem (Adner 2017). Another approach, which is to reframe the wording and align the theory more with its biological counterpart, is undertaken by Weber/Hine (2015), who define the inhabitants of ecosystems as “techno-species.” In this thesis, the ecosystem members will be called “complementors,” “contributors,” or “partners” interchangeably.

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/Agarwal 2017). Autonomous agents, such as complementors, who contribute complementary products or services, characterize digital platform ecosystems (Tiwana et al. 2010). Depending on the ownership status of platforms, the platform owners establish governance mechanisms that define the ground rules for orchestrating interactions in the ecosystems (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/Agarwal 2017).

In terms of the structure and architecture of an ecosystem, modularity is a particularly defining issue (Jacobides et al. 2018). A modular architecture is a central feature of ecosystems for the coordination between its partners (Baldwin/Woodward 2009; Moore 2006). Openness depends on the property of modularity, but an ecosystem can still be closed and modular. The iOS ecosystem is entirely modular, but some parts like the core operating system are closed and protected, whereas other parts are more open to external complementors, as, for example, the module of apps accessing the smartphone camera. Modularity is the enabler of flexibility and generativity and is a precondition for leveraging complementarities (Woodward/Clemons 2014)

More specifically, Jacobides et al. (2018) argue that “supermodularity” is a driver for network effects, and supermodular and unique complementarities are the constituting attributes of ecosystems. We conclude that digital platforms are built on a modular architecture that consists of a stable core and a flexible periphery and take advantage of economies of scale and substitution (Tiwana 2014; Tiwana et al. 2010). Bottlenecks are a further characteristic of ecosystems. This term stands for components that constrain the growth and development of an ecosystem in some form (Hannah/Eisenhardt 2017).

This constraint can be due to a lack of supply as well as the unsatisfying quality or performance of a component. Bottleneck segments can be targeted and dominated by firms that then are able to capture a large amount of value from within the ecosystem, precisely as Apple was capturing disproportional value in the iPod ecosystem compared to the device manufacturing suppliers (Jacobides/Tae 2015). Hannah/Eisenhardt (2017) thus derive the “bottleneck” as one of three possible ecosystem strategies, the others being a “component” strategy and a “system” strategy. While bottlenecks can be often observed in ecosystems, according to Jacobides et al. (2018), they could also emerge in other arrangements that are not ecosystems.

In combination with **governance mechanisms**, the platform owner facilitates transactions between the supply and demand-side of an ecosystem of autonomous actors (Lusch/Nambisan 2015; de Reuver et al. 2017). On top of the modular infrastructure, the platform owner provides affordances that the supply-side can actualize based on their individual innovation capabilities to increase the generativity of the digital platform (Yoo et al. 2012). Governance mechanisms are dependent on the ownership structure of a digital platform ecosystem (Tiwana et al. 2010; Bazarhanova et al. 2019; Gawer/Henderson 2007). Consequently, we differentiate between three modes of ownership: 1) single owner in centralized digital platform ecosystems, such as Facebook or Apple, 2) consortia, which refers to a group of actors jointly controlling the ecosystem (Bazarhanova et al. 2019), and 3) community-owned peer-to-peer ecosystems, such as Ethereum-based District0x (Riasanow et al. 2018a).

Strategies in ecosystems often require a balance between cooperation and competition to capture value (Hannah/Eisenhardt 2017). This aspect was already theorized by Moore in 1993, who argues that competition takes place on the level of the whole ecosystem. It is assumed that competition on the ecosystem level unfolds into a new kind of rivalry for dominance across the boundaries of traditional industries (Adner et al. 2013). How a particular ecosystem is organized, however, it also has implications on the competitive strategies of firms within it (Kapoor/Lee 2013). This view is extended by the understanding that there is competition within the ecosystem as well as across ecosystems (Adner 2017). An example of "hypercompetitive" dynamics can be found in mobile software ecosystems, where app developers are constantly under threat of being outcompeted (Kapoor/Agarwal 2017). Collaboration within the ecosystems takes place, especially among the complementors and the lead firms and contributes value through innovation and better performance of the products offered through the ecosystem (Kapoor/Lee 2013). Collaborative partners can, however, also turn into competitors for the entire ecosystem or other complementors (Dattée et al. 2018). For example, Google used to contribute its offerings, such as a search engine or a web browser, to the iOS and Mac ecosystems, but soon decided to attack Apple's leading position by initiating the Android mobile software ecosystem as a competitor (Kapoor/Lee 2013). Even when they are not directly competing against each other, ecosystem members will have varying levels of understandings and expectations, leading to significant political dynamics in ecosystems (Moore 2006). Thus, a strategically important topic in every ecosystem is constant work on the alignment of all partners, which is critical to balance cooperation and competition (Adner 2017).

Based on this synthesis and for the purpose of this thesis, we define digital platform ecosystems as a set of actors—namely platform owner and autonomous complementors—that interact on a digital platform to create value through transaction and innovation.

2.2.4 Related Concepts of Ecosystems

There exist several other conceptualizations of business-environment relationships other than ecosystems, which we will briefly discuss here.

Ecosystems are different from the concepts of value networks and clusters (Peltoniemi 2004). **Value networks** are constellations of multiple business relationships to create value (Holm Blankenburg et al. 1999), and similar to ecosystems, they are not restricted to geographic boundaries. Value networks are mostly characterized by co-operative behavior between entities, whereas ecosystems are defined by a mix of competition and co-operation (Moore 1993).

In contrast, **clusters** are always referring to geographical concentrations of companies and institutions, and the dynamics between entities are more competitive than in ecosystems (Porter 1988; Peltoniemi 2004). Still, studies on ecosystems can be somewhat overlapping with the definitions of clusters, such as when analyzing entrepreneurial ecosystems (Pitelis 2012), or when analyzing cities through an ecosystem theory lens (Visnjic et al. 2016). Networks and clusters can also be seen as scholarly predecessors to ecosystems research (Peltoniemi 2004). However, in business research, network theory was established further at around the same time as the initial ecosystem paper by Moore (1993), for example, by Anderson et al. (1994).

Partnerships between firms in the form of inter-organizational information systems were studied even earlier, e.g., in the form of reservation systems among airlines as drivers of competitive advantage (Johnston et al. 1988). Later they were framed as “information partnerships” that allow “joining forces without merging” (Konsynski/McFarlan 1990) and as electronic data interchange networks (Webster 1995). To some extent, the rise of collaborative ecosystems with platforms at their center was already predicted by these early publications, but they were still focusing on smaller scales of networks within industries and in relatively stable structures. Ecosystems, however, are generally much more dynamic and cross industry boundaries.

Other organizational forms, such as business **alliances**, differ from ecosystems because they require formalization between the partners. The relationship between firms in a business alliance exceeds that of customers with their suppliers or that between venture capital investors and their targets, but is less tightly formalized than acquisitions or mergers between firms (Sheth/Parvatiyar 1992). Some alliances have network structures, for example, the alliances of professional service firms across geographies, cash-dispensing networks for ATMs, or sales alliances of airlines (Koza/Lewin 1999). Hence, alliances and similar contract-based relationships may exist within business ecosystems. When analyzing the effect of the specific organizational form of partnerships in ecosystems on investment decisions, Kapoor/Lee (2013) suggested a continuum of relationships among complementors. It integrates alliances at the moderating center between purely market-based relationships and hierarchically integrated relationships (Williamson 1991). The organizational form at the market extreme is the “arm’s length agreement,” where partners trade at market prices without any deeper integration, knowledge sharing, or collaboration (Hoyt/Huq 2000). Alliances, arm’s length relationships, and hierarchical integrations with investments into other firms are all possible realizations of formalized relationships within ecosystems, albeit, the concept of ecosystems extends beyond these organizational forms.

Supply chains or value chains were the traditional concepts to describe the integration of the businesses between the raw materials producer and the end user, originating in the 1980s (Blanchard 2010). From an ecosystem perspective, it is argued that the (service) ecosystems are substituting supply chains through incorporating the Service-Dominant Logic (SDL) (Lusch/Nambisan 2015; Vargo/Lusch 2004). Also, supply chains focus on transforming static inputs, whereas in ecosystems intangible inputs, such as knowledge, skills, and competencies as well as dynamic relationships, are central (Ben Letaifa 2014; Ben Letaifa/Reynoso 2015). Furthermore, ecosystems augment the supply or value chain construct by including not only vertical relationships from suppliers to buyers but also horizontal relationships between partners and complementors (Autio/Thomas 2014). The same authors also suggest that ecosystem research is more concerned with the evolution towards novel, innovative forms than the supply chain that is optimized towards more output out of a steadier configuration.

To summarize, ecosystems shares common ideas and applications with several other established concepts of value-creating relationships between organizations and institutions. It differs in certain aspects in significant ways, of which an overview is given in Table 3. Other researchers have compared ecosystems to new approaches and theories, such as business models or industry architecture (Adner 2017). The conversation of where the novelty and distinctions of an ecosystem lie in contrast to other concepts is still ongoing and is constantly progressing (Jacobides et al. 2018).

Concept	Differences from the ecosystem concept	References
(Value) Networks	Value networks have co-operative behavior between their entities; ecosystem relationships are both competitive and co-operative	Holm Blankenburg et al. (1999)
Clusters	Clusters are always in geographic proximity; ecosystems can be but are often geographically dispersed Clusters are based on fierce rivalry within it	Porter (1988) Peltoniemi (2004)
Alliances	Alliances are formalized business relationships; ecosystems can include relationships without contractual foundation	Sheth/Parvatiyar (1992) Koza/Lewin (1999)
Supply Chain	Supply chains are product-centric, whereas ecosystems are more service- and knowledge-centric; Service-dominant logic replaces the supply chain with a service ecosystem	Ben Letaifa (2014) Lusch/Nambisan (2015)
Arm's length relationship	Only applicable to buyer-supplier relationships whereas ecosystems include many further types	Hoyt/Huq (2000)

Table 3. Overview of Related Concepts to Ecosystems

2.3 Co-evolution in Digital Platform Ecosystems

Early work discusses solely the ability to evolve by encouraging the introduction of boundary resources enabling the creation of a platform periphery, without actually outlining in details this process, it served as foundation for future studies on digital platform ecosystem evolution.

While recognizing the importance of understanding the IT architecture as underlying part of the digital platform ecosystem, researchers have acknowledged the interdependencies between architecture and governance, leading to the emergence of the co-evolution perspective (Ghazawneh/Henfridsson 2013; Tiwana et al. 2010). In particular, the mutual adjustment of architecture and governance drives the evolution of digital platform ecosystems (Ghazawneh/Henfridsson 2013). Early conceptual research deconstructs the architecture into modularity, design rules, and governance into decision rights, control, and ownership, which all co-evolve together (Tiwana et al. 2010).

Adopting this perspective, scholars further investigate the co-evolution as an attempt to balance between control and generativity, e.g., governance versus architecture (Ghazawneh/Henfridsson 2013; Eaton et al. 2015). To encourage participation from third-party complementors, platform owners need to develop generativity of the architecture by introducing new boundary resources (e.g., APIs, SDKs, etc.) through a process of 'resourcing' (Ghazawneh/Henfridsson 2013). While this improves the overall generativity and facilitates the development of a robust ecosystem around the digital platform, it also leads to increased heterogeneity of actors, which calls for a better or tighter control regime, established through a process of 'securing' (Ghazawneh/Henfridsson 2013). The increased level of control over the access and use of boundary resources, however, may face resistance from third-party complementors, who can refuse the new terms imposed by the platform owner (Eaton et al. 2015). Subsequently, the resistance can lead to a process of adjustment, where, under pressure, the platform owner modifies the newly introduced boundary resources (Eaton et al. 2015). Referred to as 'distributed tuning' (Eaton et al. 2015), this process of 'resistance and accommodating', which shapes the evolution of boundary resources, constitutes a particular manifestation of the co-evolution between architecture and governance.

Apart from connecting generativity to governance (in terms of control), researchers also state that the evolution of architecture's generativity through the provision of boundary resources also affects the variety of third-party complementors (Tiwana 2014). In particular, digital platforms enable the emergence of a variety of external complements due to the offering of stable and versatile interfaces (or boundary resources) (Baldwin/Woodward 2009; Tiwana 2014), researchers began to analyze closely the evolutionary patterns exhibited by these external complements. This shift has led to the establishment of co-evolution link between generativity (platform core) and variety (platform periphery) (Staykova/Damsgaard 2015, 2018).

The co-evolution between generativity and variety is a process, which is difficult to predict and guide (Staykova/Damsgaard 2018). While the generativity of the architecture spurs variety of complements, the latter usually evolve on their own with no detailed guidelines from the platform owner (Woodward/Clemons 2014). Furthermore, whilst most researchers assume that an increase in the level of generativity (that is increased number of boundary resources, such as APIs or SDKs) would lead to an increase in the number of third-party complements (Tiwana 2014; Baldwin/Woodward 2009), recent empirical research challenges this assumption (Um/Yoo 2016).

By investigating the evolutionary patterns of various third party complements over time, researchers also found evidence that the presence of more complementors, enabled by generativity, do not always lead to more variety. Boudreau (2012), for example demonstrates that initially present complementors offer more innovative complements in comparison to late comers, who often provide complements similar to already existing ones.

Increased variety of complements, however, is not always advantageous for a platform owner as it can be a source of various tensions between actors within the digital platform ecosystem including the platform owner (Wareham et al. 2014). In particular, third-party complementors often compete with one another (intra-platform competition) to attract demand-side users by upgrading their complements (Tiwana 2015). In some cases, the also compete with the platform owner by imitating some of the main platform functionalities, or even complements, offered by the owner (Gawer/Cusumano 2014; Gawer/Henderson 2007).

Broadening this perspective beyond co-evolution of architecture and governance, recent studies have pointed out that various other aspects also interplay to drive together the evolution of a digital platform ecosystem. Researchers, for example, have accounted for the co-evolution between architecture and actors (West/Wood 2014), IS capabilities and strategies (Tan et al. 2015) and between digital platform ecosystems and its environment (Ojala/Lyytinen 2018; Tan et al. 2016; Tiwana et al. 2010).

While the generativity-variety as a certain manifestation of early co-evolution research implies for co-evolution between architecture and third party complementors as certain type of ecosystem actors, researchers also started to explicitly outline such interdependency by including wider set of ecosystem actors. Kim et al. (2013), for example, investigate the evolutionary path of online social network, which function as digital platform ecosystems, as a configuration of three dimensions (technology, suppliers, and users), thus proposing that architecture and actors co-evolve. Similarly, West/Wood (2014) in their study on the development of the Symbian ecosystem briefly outline the co-evolution between architecture and ecosystem actors. Jha et al. (2016) also found in their research that architecture and a broad range of ecosystem actors (that is, intermediaries, community, institutions, and partners, etc.) co-evolve.

Researchers have also acknowledged the co-evolution between two distinct groups of actors (e.g., users and complementors) as each of these groups adapt to the changes in the other (Song et al. 2018). While such interdependency has been recognized by prior scholars, Song et al. outline the impact of governance on the co-evolution between distinct groups of actors through the presence of asymmetric influence mechanisms.

Various evolutionary stage models, which trace the simultaneous changes across several elements, also adopt a co-evolutionary perspective. Tan et al. (2015), for example, propose a three-stage model tracing the evolution of digital platform ecosystems through the co-evolution of IS capabilities and their corresponding strategies in each evolutionary stage (nascent, formative, and mature). In particular, they state that drivers for evolution can be both opportunities and problems, identified through 'market responsiveness IS capability'. After a driver appears, a platform owner needs to find a suitable response by relying on IS capabilities that translate "detection of the triggers of MSP development in action" (p. 265). In general, the evolution of digital platform ecosystems develops form formation, where various actors are encouraged to participate, to balancing control and generativity in the later stage, and towards encouraging more openness and providing collective identity (Tan et al. 2015).

Apart from observing solely the co-evolution of actors, architecture, and governance, as well as the capabilities and strategies within the digital platform ecosystem, researchers have also pointed out that ecosystems co-evolve together with their environment (Tiwana et al. 2010). Tan et al. (2016), for example, propose a three-stage model to trace the co-evolution of competitive environment, IT affordances, and the platform configuration, which evolve from a closed platform to open platform and later community platform. They show that as the competitive environment in which digital platform ecosystems operate changes, platform owners can actualize various IT affordances in order to attract distinct users (users and third-party competitors alike), thus driving the ecosystem towards more openness. Similarly, Ojala/Lyytinen (2018) argue that the actions in response to changing competitive environment lead to changes in the architecture and the corresponding 'control points' (governance), which regulate the access to the architecture. The introduced changes in the architecture affect the number of affiliated to the platform ecosystem actors and their interactions. Thus, Ojala/Lyytinen (2018) present the evolution of a digital platform ecosystem as influenced by the exchange between its environment, architecture, governance, and actors.

Co-evolution in digital platform ecosystems	**References**
Co-evolution between platform architecture and platform governance	(Tiwana et al. 2010)
Co-evolution between control and generativity	(Eaton et al. 2015; Ghazawneh/Henfridsson 2013)
Co-evolution between generativity and variety	(Boudreau 2012; Tiwana 2015; Um/Yoo 2016)
Co-evolution between architecture and actors	(Kim et al. 2013; Jha et al. 2016; West/Wood 2014)
Co-evolution between actors	(Song et al. 2018)
Co-evolution between IS capabilities and strategies	(Tan et al. 2015)
Co-evolution of digital platform ecosystems and its environment	(Ojala/Lyytinen 2018; Tan et al. 2016; Tiwana et al. 2010)

Table 4. Overview of Co-evolution in Digital Platform Ecosystems

3 Research Design

To study digital transformation from an inter-organizational perspective, and co-evolution in digital platform ecosystems, we take on a pragmatic epistemological stance and rely on a mixed strategy of inquiry. In particular, we use structured qualitative content analysis, expert interviews, and case studies, which are qualitative methods, and rely on clustering based on text mining, a quantitative method.

3.1 Pragmatic, Mixed Method Research Strategy

To improve our understanding of digital transformation from an inter-organizational perspective, and co-evolution in digital platform ecosystems, we follow a **pragmatic epistemological stance**. Pragmatism rejects the preoccupation with the theory of other epistemological positions (e.g., positivist, interpretative, and critical) (Cherryholmes 1992; Creswell 2009). The pragmatic position assumes that there exists a reality independent of the observer (Creswell 2009). However, pragmatists do not mainly focus on questions concerning the nature of reality (Cherryholmes 1992).

Moreover, pragmatists are also skeptical of individuals' ability to grasp reality objectively and, therefore, focus on whether the actions taken based on individuals' conception of reality led to the desired results (Cherryholmes 1992). Regarding the belief about knowledge, pragmatists assume that knowledge relates to the actions that are used to cope with specific situations and the consequences of these actions (Johnson et al. 2007). Consequently, acceptable methods for generating knowledge can be either quantitative or qualitative and depend on the phenomena being investigated (Creswell 2009). With regard to beliefs about the relationship between theory and practice, pragmatisms belief theory and practice are closely connected, and theory is essential for achieving an informed practice (Cherryholmes 1992). A pragmatic approach is suitable to study digital transformation from an inter-organizational perspective, and co-evolution in digital platform ecosystems because these ecosystems capture complex interactions among different stakeholder, such as platform owners and complementors.

Further, we applied a **mixed method strategy of inquiry** for our research, which constitute the combination of qualitative and quantitative research strategies (Creswell 2009; Johnson et al. 2007). Consequently, mixed strategies allow researchers to better address exploratory and confirmatory research at the same time, to provide stronger interferences, and to generate a richer understanding of the phenomenon of interest than either a qualitative or quantitative strategy on its own (Venkatesh et al. 2013). To study digital transformation on an ecosystem level, we rely on qualitative research methods, as they aim to understand and explain rare and complex social or organizational phenomena (Myers 2013). Based on complexity and rarity of the investigated phenomena, qualitative research is often limited to a number of units that are analyzed and does not aim to generalize the results (Corbin/Strauss 2008; Myers 2013). Further, we use case studies to generate an in-depth understanding of co-evolution in digital platform ecosystems and how the actors, i.e., platform owner an complementors, perceive and manage these situations (Myers 2013). However, we use a quantitative, text-mining based approach, to cluster the organizations in our ecosystems.

Concisely, since digital is a complex organizational phenomenon, often with conflicting understandings and few reliable generalizations, a mixed-methods research strategy is suitable to achieve the objectives of this thesis: Namely exploring the inter-organizational co-evolution mechanisms inherent in such digital transformations on the ecosystem level. Throughout this thesis, the importance of practical implications of our research results, which aims to provide platform owners with mechanisms on how to manage the co-evolution of complementary partners, is highlighted.

3.2 Research Methods

Following the pragmatic paradigm and a mixed research strategy of inquiry, this thesis employs both qualitative and quantitative research methods. The next section briefly describes the methods and related characteristics used in this work. The respective papers (in part B1 and B2) describe the employed procedures in detail.

3.2.1 Literature Review

Literature reviews are particularly helpful when inconsistencies, overlapping and contradictory definitions, and different and heterogeneous schools of thought exist (Ahuja et al. 2009). However, this diversity of theories and concepts from different disciplines often encourage the compartmentalization of perspectives that do not enrich each other (Ahuja et al. 2009). So, literature reviews are essential for any successful academic research project (Webster/Watson 2002). Literature reviews represent a systematic approach to analyze extant literature by investigating relevant studies and their results about a particular focus and goal of a literature review (Cooper 1988). Foci of literature reviews may include research outcomes, research methods, theories, or applications while goals may comprise integrating and synthesizing prior work, criticizing it, or identifying central issues, or future research (Cooper 1988). The results of literature should list the identified literature, conceptualize their results, and discuss possible avenues for fruitful future research (Webster/Watson 2002; Cooper 1988). The next sections comprise of the essential steps in a literature review.

Literature reviews differ in terms of their exhaustive, representative, or pivotal coverage of literature (Cooper 1988). An exhaustive coverage aims at including all publications relevant to the underlying research questions. A representative coverage chooses a sample that is deemed characteristics for a larger group of publications and makes inferences from the sample to that group. The pivotal coverage focuses on publications that are considered central to the topic of interest. With regard to coverage, research should use an exhaustive coverage following a systematic, three-step approach to identify relevant publications (Webster/Watson 2002). First, a key-word based search in leading journals on conference proceedings of the field employing electronic databases is recommended. The key-word search should be complemented by a manual scan of journals' and conference proceedings' tables of content to make sure that all relevant studies in the leading outlets have been identified. Focusing on leading publication outlets helps to ensure the quality of the obtained results (vom Brocke et al. 2009). Second, a backward search should be conducted to consider prior work that is cited in the identified articles (Webster/Watson 2002). Third, a forward search should be conducted. The forward search assures that the literature review also considers articles that cite the identified articles (Webster/Watson 2002). The search for relevant literature is complete when no new arguments, methodologies, findings, concepts, and authors relevant for the focus and goal of the literature review can be found (Webster/Watson 2002). During the whole process, the authors should rigorously document their search, and then provide inclusion and exclusion criteria for the selection of relevant articles (Okoli/Schabram 2010). Researchers should iteratively refine the respective inclusion and exclusion criteria (Okoli/Schabram 2010).

After identifying the sample population of the literature review, the publications should be structured and analyzed according to the underlying focus and goal of the literature review. Two different approaches exist for structuring and analysis of the review. First, the author-centric approach provides a list of relevant publications without a proper synthesis (Webster/Watson 2002). Second, the concept-centric approach helps to “assemble the literature being reviewed for a given concept into a whole that exceeds the sum of its parts” (Webster/Watson 2002; Levy/Ellis 2006). Notwithstanding, the concept-centric approach should be the preferred one. The transition from an author- to a concept-centric review can be accomplished with the help of a concept matrix. (Webster/Watson 2002). A potential contribution of a structured literature review can be the identification of research gaps and, thus, the derivation of a research agenda (Webster/Watson 2002).

3.2.2 Structured Content Analysis using Inductive Category Formation

The qualitative content analysis aims to analyze texts in a systematic and inter-subjectively comprehensible manner and thereby to meet scientific demands on interpretation. This thesis uses the inductive category formation approach to conduct a structured qualitative content analysis due, as this is particularly helpful when conducting explorative research (Mayring 2010b).

The goal of inductive category formation is to depict the data material as close to the subject as possible without distortions due to presumptions of the researcher (Mayring 2010b). Consequently, the procedure can be called inductive category formation (Mayring 2010b, 2014). In Grounded Theory (Corbin/Strauss 2008; Wiesche et al. 2017), this method corresponds to open coding (Mayring 2010b). The inductive approach aims at a true description without bias owing to the preconceptions of the researcher, an understanding of the material in terms of the material (Mayring 2010b). Inductive category formation is a central process within the approach of grounded theory (Corbin/Strauss 2008; Wiesche et al. 2017), which in this context is called “open coding”.

The goal of the structured content analysis is to give the text a structure using a category system. It is essential to define the structuring dimensions as precisely as possible and to ground them theoretically. These structuring dimensions are finally further differentiated in their individual forms (e.g., 'low,' 'medium,' 'high'). To ensure as precise a coding as possible, rules are formulated that must be met for a category to be assigned. Anchor examples can further support this as they give an idea of what is behind a code (Mayring 2010b).

Figure 2 shows the steps of a structured content analysis using inductive category formation.

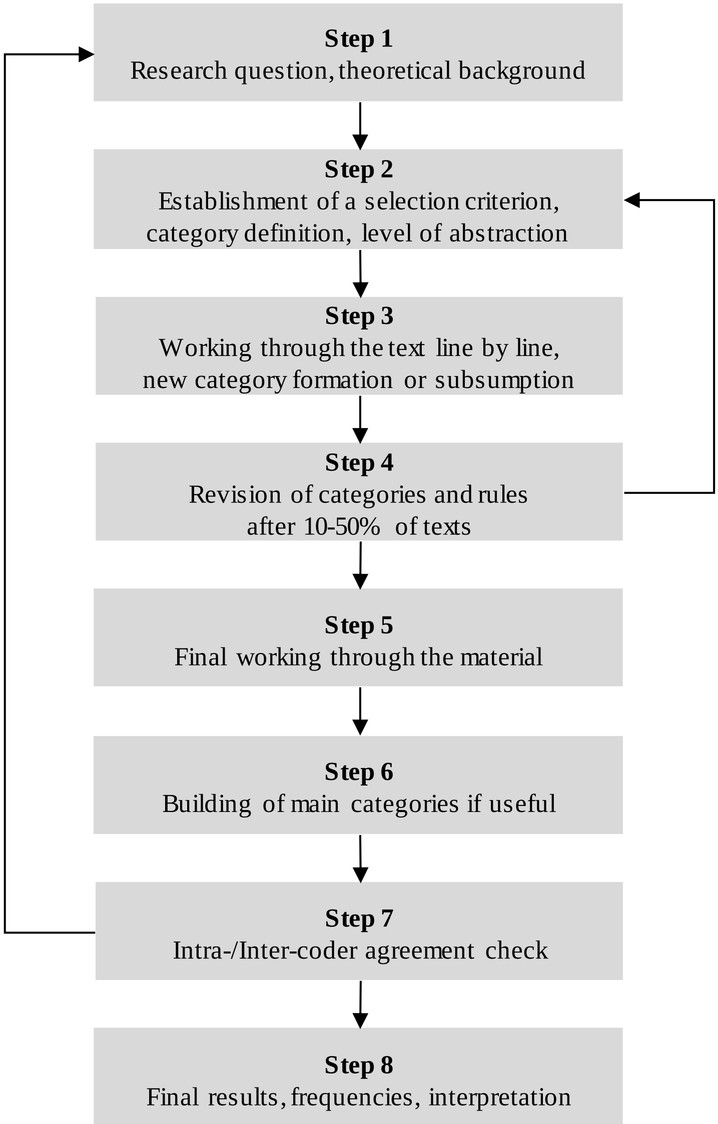

Figure 2. Structured Content Analysis Using Inductive Category Formation

Towards the goal of conducting a structured content analysis using inductive category formation, Mayring (2014) suggests to reflect on the following issues:

Step	**Issues to reflect on**
Step 1: Research question, theoretical background	- Formulate a clear research question (not only a topic) - Describe the theoretical background (theoretical position, previous studies) - The research question must fit an inductive logic, which means it must be explorative or descriptive
Step 2: Establishment of a selection criterion, category definition, level of abstraction	- The category definition serves as a selection criterion to determine the relevant material from the texts; it has to be an explicit definition, theoretical references can be useful - The level of abstraction defines how specific or general categories must be formulated. Both rules (category definition and level of abstraction) are

	central of inductive category formation. They have to be defined in advance and can be altered within the pilot phase.
Step 3: Working through the text line by line, new category formation or subsumption	- Read the material from the beginning, line by line, and check if material occurs that is related to the category definition. All other material is ignored within this procedure - Formulate a category near to the text at the level of abstraction - If the text passage fits the category definition, check if it can be subsumed to the first category or if a new category has to be formulated, and so on
Step 4: Revision of categories after 10-50% of the text	- A revision in the sense of a pilot loop is necessary when the category system seems to become stable (only a few new categories) - Check if the category system fits the research question. If not, a revision of the category definition is necessary - Check if the degree of generalization is sufficient. If you have formulated only a few categories, maybe the level of abstraction is too general. If you have formulated a huge amount of categories maybe the level of abstraction is too specific - If you have changed the category definition and/or the level of abstraction, you have to start the analysis from the beginning of the material
Step 5: Final working through the material	- The whole material has to be worked through with the same rules (category definition and level of abstraction)
Step 6: Building of main categories	- At the end of this process you have a list of categories. You can group them and build main categories, if useful for answering the research question - Follow the rules of summarizing qualitative content analysis for this step
Step 7: Intra-/Intercoder agreement check	- Start the coding from the beginning of the material and compare the results (intra-coder agreement) - Give the material (or parts of it) to a second coder and compare the results. If the explorative character of the study is predominant, give him or her only the text. If the frequency distribution of the categories should be tested, give him or her your categories as well - You should discuss the results and decide which coding is adequate (follow the rules). Only if the second coding is held as better coding, this is counted a disagreement - If you change the better coding for analysis you can enhance the reliability (not always possible)
Step 8: Final results, frequencies, interpretation	- The result (of course after checking quality criteria like intercoder agreement) is at first the list of categories and maybe main categories - If categories had been found in respect to several text passages (many subsumations) a frequency analysis of the category occurrences could be useful - The category system and eventually the frequencies have to be interpreted in the direction of the research question

Table 5. Issues to Reflect on in a Qualitative Content Analysis using an Inductive Category Formation

3.2.3 E^3 value Modeling

In this thesis, we use the e³-value method to visualize ecosystems based on the generic roles of actors and the value streams between them. For the identification of the generic roles of the actors, a qualitative content analysis of CrunchBase data using inductive category formation, as presented in the previous subchapter, is conducted.

The e³-value modeling technique is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective (Gordijn/Akkermans 2003). It is used to evaluate the economic sustainability of value networks by modeling the exchange of things of economic value between actors (Gordijn/Akkermans 2003). The e³-value approach is based on the analysis of value creation, distribution, and consumption in a multi-actor ecosystem (Gordijn et al. 2001). It relies on requirements of engineering and a conceptual modeling technique, which are both based on the information systems community (Gordijn et al. 2001; Gordijn/Akkermans 2003).

Initially, the e³-value method was used to provide an ontology of the electronic business model. The e³-value ontology consists of actors, value objects, value ports, value exchanges, market segments, composite actors and value activities, which are described as follows (Gordijn et al. 2001; Gordijn 2002; Borst et al. 1997; Kotler 1988), e.g., Table 6 shows the essential components of the e^3 value modeling method.

Component	Description
Actor	An actor is an independent economic entity, which carries out value activities. An actor makes a profit or can increase its utility
Value Object	Value objects can be services, products, money, consumer experiences, or data, which are being exchanged between actors. One value object can be valuable to one or several actors.
Value Port	An actor uses a value port in order to provider or request value objects. This concept abstracts the internal business processes and focuses only on how external actors in the value network can be plugged in
Value Exchange	Two value ports can be connected via value exchanges. Value exchanges are one or more potential trades of value objects between value ports
Market Segment	A concept that breaks a market, a set of actors, into segments that share common properties. The value objects for a market segment and its set of actors are equally. According to Kotler (1988), a market segment breaks actors into segments which share common properties. It is crucial to show that actors assign value equally. Market segments are often used to model a large group of consumers
Composite Actor	A composite actor is a partnership of actors who are working together and offer value objects together. They do so by using one value interface to their environment

Table 6. Components of the e^3-value Method

Figure 3 shows an exemplary e^3 value network of the newspaper industry, where newspaper readers, which are paying to read titles, potentially with advertising included, which is serviced by publishers, who earn the money of the readers and advertisers (Gordijn et al. 2006).

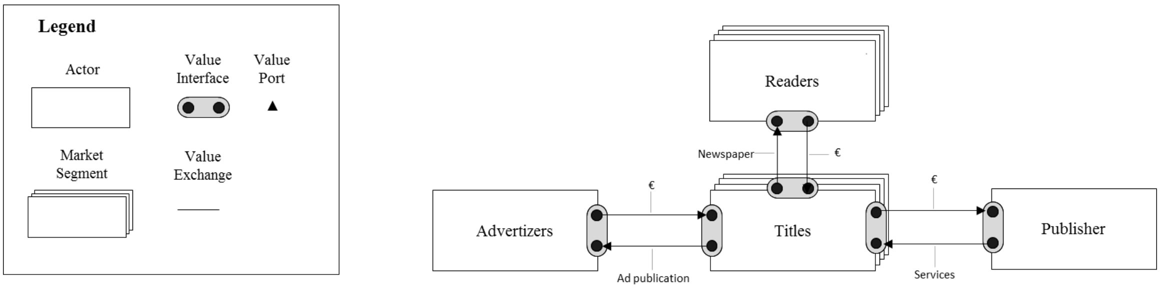

Figure 3. Exemplary e³-Value Network according to Gordijn et al. (2006)

The e³-value method is a useful method to visualize and evaluate value chains, as well as directly show and implement new or potential actors (Gordijn/Akkermans 2003). Actors are market players, are companies that offer different services on different levels. All actors within a value network depend highly on each other and deliver value through co-creation (Gordijn 2002; Gordijn et al. 2001). Therefore, a value network depends strongly on other actors operating in the system (Gordijn 2002). An action by an actor can influence other actors, or an action can require subsequent action by other actors in order to be effective (Gordijn/Akkermans 2003). This implies that every company is a part of the value network and accountable for its transformation (Gordijn/Akkermans 2003). It covers the number of sides it connects and the relationship to other actors within the ecosystem (Gordijn 2002). The e³-value approach allows modeling actors, who select the service and products. Modeling actors is important because it increases market transparency (Böhm et al. 2010).

Market players or actors can be referred to as a role. A company is offering different services to other market players and can, therefore, act in different roles (Böhm et al. 2010). A role is a set of similar services, which are being offered by market players to similar consumers. According to Sawhney/Nambisan (2007), roles define capabilities that actors need to contribute to the ecosystem. Defining roles is one of the most important factors of designing an ecosystem because it covers among other things the number of sides it connects, the relationship to other actors and stakeholder of the platform ecosystem, the ownership regime as well as the power distribution (Gordijn et al. 2001). To analyze an entire ecosystem, all actors of a value network must be included: the consumer, suppliers, competitors, and all other actors operating in the ecosystem which create value (Peppard/Rylander 2006).

For designing value networks, it is essential to show the exchange of value objects between specific actors because new actors can be easily added or removed from the buyer-seller chain (Gordijn et al. 2006). Such a process of intermediation and disintermediation presents particular risks for traditional sellers. For instance, in e-business, marketplaces can quickly appear and disappear. Showing who is doing what and with whom is becoming more critical in the automotive industry due to the interaction with the fast-moving development of new technologies and the rise of new market players (Gordijn 2002).

3.2.4 Text-mining based Clustering

We use a quantitative approach in order to derive similarities in different ecosystems. In order to convert this data into useful information, besides the presented qualitative content analysis (Mayring 2010b), also text analytic methods can be performed. Therefore, we present the text-mining based clustering of Basole et al. (2018).

We use the previously extracted Crunchbase data of all five ecosystems to perform the text-mining based analysis. The company description field in Crunchbase contains information on its mission and value creation as well as it provides various stakeholders (Basole et al. 2018). For **data curation and preparation**, these descriptions are provided in natural language form.

Text analytics can be used to convert the text into vectors of words. Following convention, stop words should be removed (Basole 2018). Since not all words in a position statement carry the same level of importance, weighting schemes can be applied (Basole et al. 2018). This enriches the text by only keeping words with a real meaning (Basole et al. 2018). Since not all words in a position statement carry the same level of importance, weighting schemes can be applied (Basole et al. 2018).

Since not all words in a text are equally important, more frequently appearing words can be seen as carrying more information about the text. However, if the term appears frequently across all texts, it loses its distinguishing power. Therefore, term frequency-inverse document frequency (TF-IDF) normalizes the frequency of words in a text with the rarity it appears (Ramos 2003). TF-IDF therefore assigns weights to words as a combination of a local measure on description basis and a global measure on all descriptions combined. This ensures that ecosystem-specific words, such as “automotive”, “finance” or “insurance” are assigned lower weights, since these words do not carry information about value propositions of the organization.

After data curation, we identify similarities between the organizational descriptions. To do so, we use similarity measures, which are tools for calculating the degree of similarity between two objects, in our case vectors built using TF-IDF. Following Basole et al. (2018), the **computation of the cosine similarity** serves as basis for calculating the similarity between vectors of organization descriptions. Cosine similarity quantifies similarity by the cosine of the angle between two vectors.

Matrix A can be seen as an adjacency matrix for a graph representing organizations as nodes and similarities as edge weights between them. For **constructing the graph from the similarity matrix**, we take the lower triangular matrix of A and exclude the diagonal as well. This way, edges between organizations are only considered once and similarities between the same organizations are excluded. In addition, following Basole et al. (2018), organizations that are not similar to any other organization and therefore represent nodes in the graph that are not connected, should be removed in this step.

After constructing the graph based on similarity measures, the **modularity-based clusters** in the graph that can be detected. We identify clusters in a graph or network based on the computation of modularity (Blondel et al. 2008). Following Basole et al. (2018), a Louvain’s modularity-based clustering algorithm should be chosen due to its good performance in large graphs with a good quality of clusters.

In order to gain more insight about the clusters, a **latent semantic analysis** (LSA) can be performed (Deerwester et al. 1990) on individual clusters in order to extract keywords and topics from the descriptions or organizations in clusters. LSA is an unsupervised text analytics algorithm using statistical measures in order to find a hidden meaning of word usage. LSA is used in natural language processing for feature extraction and information retrieval.

3.2.4 Expert Interviews

Expert interviews are one of the most important tools for gathering qualitative data (Myers/Newman 2007). Expert interviews are investigations which can reconstruct (social) situations or processes in order to find or evaluate scientific explanations and should give the researcher access to specific knowledge (Gläser/Laudel 2009; Wiesche et al. 2017).

According to Myers/Newman (2007), a qualitative interview can be interpreted and seen as a drama, including a stage, actors, a script, a performance, an audience, and props. The stage is usually an office in business settings, whereas a tape recorder refers to an accessory. The interviewee and the interviewer are the actors on the stage, whereas both have to play like actors (Myers 1997, 2013; Myers/Newman 2007). On the one hand, the researcher has to play as an interested interviewer and on the other side the interviewee as a very knowledgeable person of the company (Bogner et al. 2009b; Myers/Newman 2007). The script refers to the interview guide consisting of questions, which have been prepared before the interview. It serves as an orientation during the interview, whereas the interviewees must improvise (Myers/Newman 2007). Overall, the performance of the interview (or drama) affects the quality of the findings. The validation and gathered information, in turn, affects the quality of the data (Myers/Newman 2007).

Research generally differentiates between three types of qualitative interviews. These are either structured, unstructured or semi-structured interviews or group interviews (Myers 2013; Myers/Klein 2011). The semi-structured interview is one of the most used types in IS research (Myers/Klein 2011).

Semi-structured interviews do not require a complete interview guide. The researcher can prepare some questions in the form of an interview guideline beforehand, but there is room for improvisation (Bogner et al. 2009b; Myers/Newman 2007). Guided interviews provide a topic and questions, which are mandatory to answer. There is no explicit formulation nor a specific order of the questions prescribed (Bogner et al. 2009b). They rather occur during the interview from a natural course of the conversation. By asking ad hoc questions, different facets on the same question can be gathered (Myers/Newman 2007).

The function of the interview guideline is a reminder for the interviewer to fully cover the relevant content. However, the flow of the interview should not be dictated by the interview guideline (Bogner et al. 2009b; Myers 2013). Hence, the interviewer may switch the order of the prepared questions. This provides a more natural conversational situation. Overall the interviewee should not be interrupted and encored by asking further questions (Gläser/Laudel 2009).

The interviews conducted for the matter of this thesis followed a semi-structured interview approach with prepared interview guidelines (Gläser/Laudel 2009).

3.2.5 Case Study Research

Case study research is an empirical exploratory approach to investigate contemporary phenomena (the case) in depth and within their real-world context. In particular, it can be used if the boundaries between the considered phenomenon and its context are not obvious and no control over the object of investigation is possible (Yin 2014; Benbasat et al. 1987). Case study research lends itself to research questions that address the context ("how?") Or reason ("why?") (Yin 2014). Often, this approach is used when describing a phenomenon or developing a theory in a field of research that has barely been researched so far. But it can also be used for testing theories (Eisenhardt 1989). Data collection often combines different approaches. Archival data or documents, expert interviews, questionnaires, and observations are generally used (Yin 2014; Eisenhardt 1989).

Figure 4 shows the typical approach to case study research, as described by Yin (2014). Characteristic of this is the iterative character, in which mainly the study design, the data collection, and analysis are continuously adapted to the gain of knowledge until theoretical saturation is achieved.

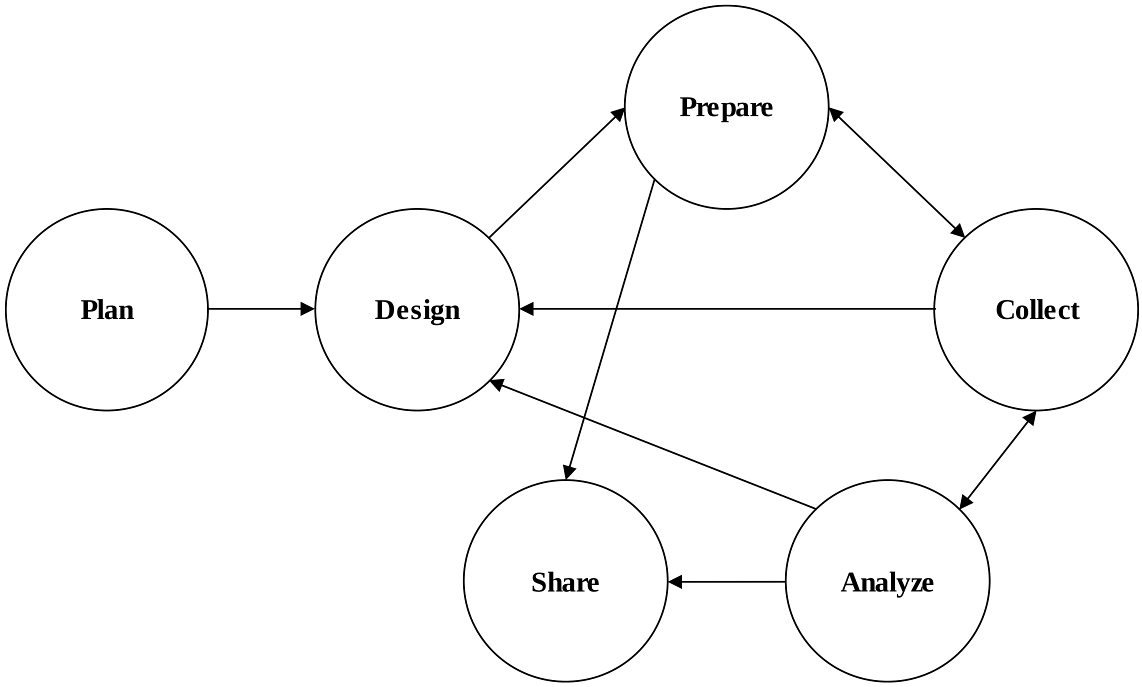

Figure 4. Typical approach to conduct a case study following Yin (2014)

The individual steps are described in more detail below.

At the beginning of the **study planning**, the research questions are outlined and checked whether the case study research is a suitable approach for this (Yin 2014). As already described, the case study research is particularly proper for research questions dealing with the context ("how?") Or the reason ("why?") (Yin 2014). Also, this approach is useful if more variables (considered phenomena) are to be investigated than data points (number of cases) are available. Here, various data sources are used, and their indicators are triangulated (Yin 2014).

The **study design** essentially comprises five aspects (Yin 2014): Research questions, theses (if available), object of observation/analysis unit, relationship between data and theses, and criteria for the interpretation of results. The starting point of the study design are the research questions that should be answered with the investigation. It is essential to ensure that these are suitable for case study research. For the identification and clarification of the research questions, a preliminary literature study is recommended to show the research gaps (Yin 2014). In order to sharpen the focus of the investigation, theses on the context and background should be derived. This facilitates data collection since the theses provide clues about the required information. On the other hand, if one wants to explore a topic without prejudice, one can dispense with the explicit formulation of theses. However, exploration should serve a specific purpose against which the success of the study can be evaluated (Yin 2014). Based on the research questions and the theses, the object of observation is finally narrowed down. The analysis unit results from the phenomenon to be considered and can represent, for example, an industry, a company, a project, or a person. This will set the limits of the case study to limit data collection and not have to collect all available material (Yin 2014). An essential aspect of the study design is the choice of a case study design suitable for the research objective.

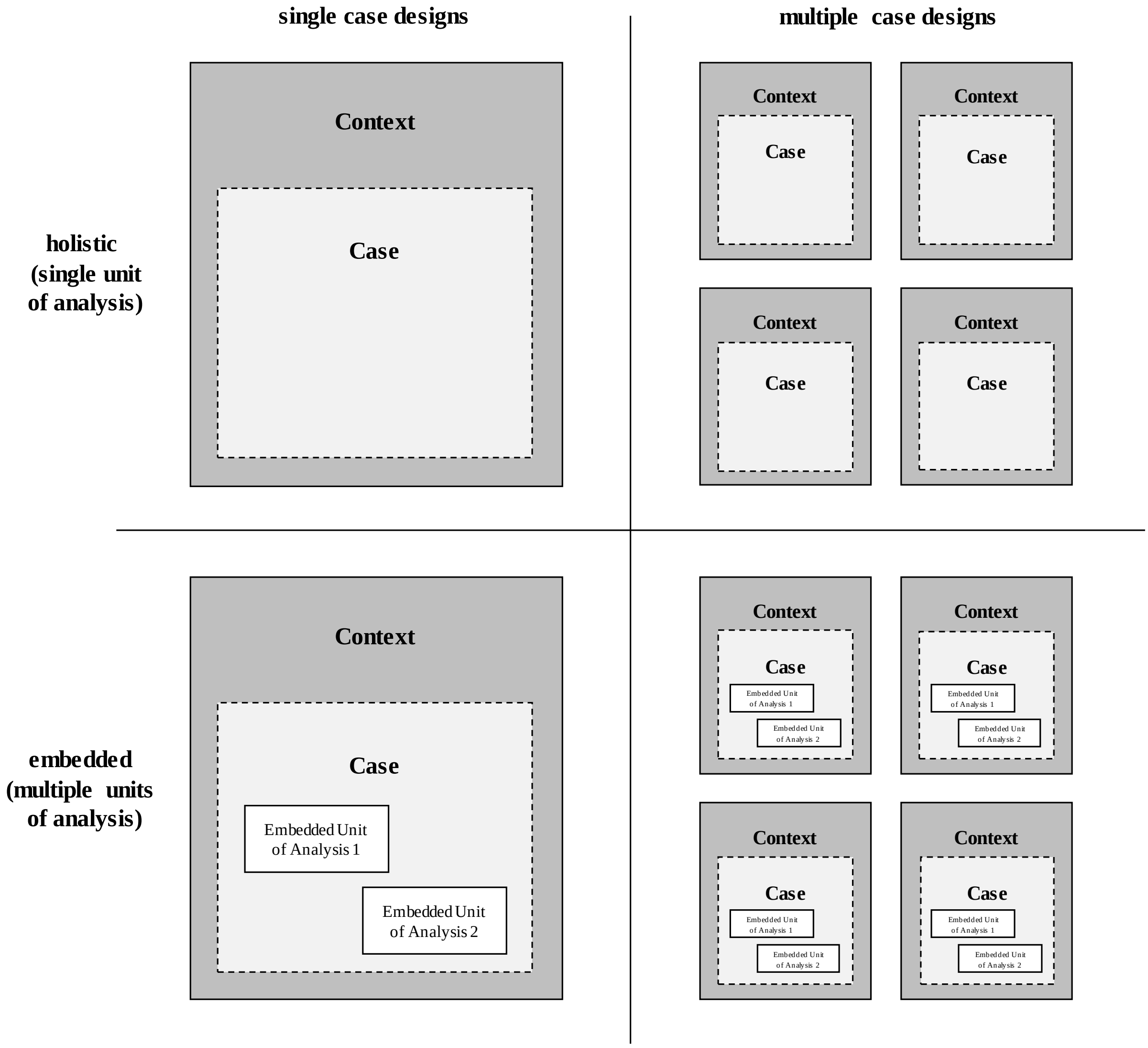

Figure 5. Case Study Design Variants following Yin (2014)

Figure 5 gives an overview of the possible design variants. Case studies are particularly useful for examining critical, special, representative, insightful, or long-term cases (Yin 2014). Multiple case studies follow the repetition logic. They serve in particular the replication of research results as well as the recognition of patterns. They are, therefore, often used to evaluate theories (Yin 2014).

Once a case study design suitable for the research question has been chosen, an interview guide will be developed as part of the **study preparation** to help structure the discussions and ensure that all critical topics are addressed (Yin 2014). Gläser/Laudel (2009) advise on the design of the interview guide. In addition, the experts should be contacted in the study preparation phase. It may also be helpful to have initial discussions or to start a pilot case study to identify the cases relevant to the study (Yin 2014). In addition, the case study protocol will be started at this stage (Yin 2014).

Regarding **data collection**, a case study can benefit come from many sources. The most common are documentation, archive data, interviews, observations, and physical artifacts (Yin 2014). The primary source of data in this work is interviewing people directly involved in disintegration projects, which will be supplemented, as appropriate, with documentation (such as status reports). To ensure high validity of study results, various data sources should be triangulated (Yin 2014).

At the beginning of the **data analysis**, one should consider a procedure that helps to get organized into the data and to draw relevant insights. Yin (2014) recommends starting with data analysis based on the theoretical assumptions made initially. In addition, qualitative and quantitative data can be combined, for example, to find explanations for certain phenomena. Another, mostly complementary approach is the search for alternative explanations within the case study. In order to ensure a high level of internal and external validity of the data analysis, Yin (2014) proposes five analytic techniques:

Analytic technique	**Description**
Pattern Matching	Comparison of case study results with the assumptions made in advance
Explanation Building	Development of an explanatory approach with which the phenomenon shown in the case study can be explained
Time-Series Analysis	Analysis of changes over time
Logic Models	Derivation of cause-and-effect chains of events
Cross-Case Synthesis	Analysis of similarities and differences in different cases

Table 7. Analytic Techniques to Analyze Data in Case Studies

The conclusion of a case study is the dissemination of the knowledge gained. It is important to present these adapted to the respective readership. It is often beneficial to combine the findings with a narrative description of the case study so that the reader can better understand the reasoning and, if necessary, draw their own conclusions (Yin 2014).

Part B1 – Accepted Publications[1]

[1] The original publications have been slightly modified, including the unification of the format and reference styles, and minor grammatical revisions. Furthermore, the tables and the figures were numbered sequentially across all parts of the thesis. Consequently, the numbering of figures, tables, and in-text-references differ from the original publications. The original version of the publications can be found in the appendix.

4 Clarifying the Notion of Digital Transformation: A Transdisciplinary Review of Literature (P1)[2]

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Publication	Journal of Competences, Strategy & Management (JCSM)
Status	Accepted
Contribution of First Author	Problem Definition, Research Design, Literature Analysis, Interpretation, Discussion, Reporting

Table 8. Fact Sheet Publication P1

Abstract

We refer to the organizational transformation process of using digital technologies to radically transform organizations as digital transformation. Yet, within and in-between management, organization science, and information systems literature, there is considerable disagreement on the characteristics of an organization's digital transformation. Hence, we conduct a transdisciplinary review of literature, spanning 175 articles, regarding digital transformation and prior achievements regarding organizational transformation. As result, we identified twelve schools of thought to discuss the phenomenon of digital transformation. We show that digital transformation is building on existing schools of thought, while highlighting new ones, such as digital innovation and ecosystem.

[2] An earlier version of this research was published in the online proceedings of SSRN, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3072318

4.1 Motivation

The market is constantly evolving and giving rise to disruptive digital technologies, such as 3D printing, data analytics, and mobile computing (Nambisan et al. 2017), forcing established organizations to transform in order to remain competitive (Lucas et al. 2013; Yoo et al. 2010). We refer to the organizational transformation (OT) process of using and combining digital technologies in new ways to radically transform an organization as digital transformation (DT). The success of purely digital organizations such as Netflix, Spotify, or Amazon, as well as the bankruptcy of traditional companies such as Kodak or Blockbuster, are examples of DT (Goh et al. 2011). Under this heading, scholars from information systems (IS), management, or organization science are contributing to a growing body of knowledge concerning this phenomenon (e.g., Fitzgerald et al. 2013; Majchrzak et al. 2016; Agarwal et al. 2010; Rowe 2018).

Yet, within and in-between these literature streams, there is considerable disagreement regarding what the characteristics of an organization’s DT are. This is reflected in inconsistencies, overlapping and contradictory definitions, and different and heterogeneous schools of thought. However, the diversity of theories and concepts from different disciplines often encourage compartmentalization of perspectives that do not enrich each other. For example, technology and its relationship with organizational structures, processes, and outcomes have long been of interest to organizational researchers (e.g., Orlikowski 2000). However, digital innovations build on novel characteristics that differ from earlier technologies, e.g., reprogrammability, the homogenization of data, and the self-referential nature of digital technology (Yoo et al. 2010). Recognizing these characteristics, IS scholars have analyzed the influence of digital technology on firm’s strategies, structures, and processes (e.g., Bharadwaj et al. 2013; Oswald et al. 2018; Fichman et al. 2014). Management and organization science focus on the development of a new organizational logic to organize innovation in a digital world (Yoo et al. 2012), including transformational leadership, identity, cognition, and sensemaking (Nag et al. 2007; Rindova et al. 2011).

Because we lack clarity about the exact nature of DT, it is difficult to appropriately compare, analyze, and discuss the phenomenon. Consequently, we conduct a structured literature review, drawing on existing DT articles and prior OT studies, to present the underlying schools of thought of DT and to discuss their differences.

This paper is organized as follows. First, the literature-based research methodology is presented. Second, we present the results of the literature review, which consists of inconsistencies in the understanding of DT in management, organization science, and IS literature, and present 12 different and heterogeneous schools of thought to examine DT. Third, we clarify the notion of DT based on these schools of thought and show how prior achievements in OT inform discussions of DT. Then, we discuss the contributions and limitations of our findings. The paper concludes with avenues for future research.

4.2 Design of the Literature Review

This section describes the design of our literature review-based methodology to clarify the notion of DT and compare it to prior achievements regarding OT in management, organization science, and IS literature. We followed the guidelines of Webster/Watson (2002) to conduct a concept-centric literature review.

Consistent with the title of this paper, we constrained our structured literature review to DT and prior achievements regarding OT in some important dimensions. Most notably, we focused our attention on the management, organization science, and IS literature. This design choice is supported by two considerations. First, the topic of DT and its precursors is simply too huge to be acceptably covered in a single survey paper if prior work is to be recognized in any serious fashion. Second, OT is increasingly enabled by digital technologies, which is one of the key concerns of management, organization science, and IS literature. A second notable distinction with respect to the scope of this article is that it moves beyond OT. Therefore, we explicitly searched for DT articles that were not included in prior excellent literature reviews on OT, such as that of Besson/Rowe (2012). They analyzed the discourse on OT and suggested understanding IS-enabled OT as a process, not as a teleological model of diffusion. Most importantly, they highlighted that most OT theories were developed during the 1980s and should, therefore, be considered as "pre-Internet theories of transformation". This invites us to reassess prior OT literature in the era of DT, particularly because digital technologies fundamentally differ from prior technologies (Yoo et al. 2010). Therefore, the third notable distinction is that we focus on clarifying the notion of DT, which we aim to derive through a comparison to prior research on OT.

We first focused on leading IS outlets, i.e., the AIS Senior Scholars' Basket of Journals (Association for Information Systems 2011). Extending Besson/Rowe (2012), we applied the terms in Table 9 using the Scopus database to the titles, abstracts, and keywords of the publications. Using the described search terms, we identified 107 relevant journal articles. A forward and backward search (Webster/Watson 2002), based on the gathered articles, found 10 additional articles in leading IS journals, resulting in a total of 117 articles. We did not limit the publication year, context, or method of the articles. Following Okoli/Schabram (2010), we reviewed the articles manually and filtered them according to an iterative set of exclusion criteria. Therefore, articles that did not address DT, or focused on aspects of OT, such as Otim et al. (2012), who examined the effect of IT investments on the downside risk of firms, were excluded. Using this set of exclusion variables, we eliminated 32 articles. In the end, we selected 85 relevant IS journal articles.

<table>
<tr><th colspan="2">Outlet</th><th>Search terms</th><th>Hits</th><th>Selected</th></tr>
<tr><td rowspan="7">IS Journals</td><td>MISQ</td><td rowspan="7">"organizational transformation" OR "transformation of the firm" OR "business transformation" OR "radical change" OR "revolutionary change" OR "radical transformation" OR "revolutionary transformation" OR "disruptive transformation" OR "strategic transformation" OR "technochange" OR "strategic change" OR "transformational" OR "digital transformation"</td><td>30</td><td>22</td></tr>
<tr><td>EJIS</td><td>26</td><td>20</td></tr>
<tr><td>JSIS</td><td>16</td><td>13</td></tr>
<tr><td>ISR</td><td>14</td><td>9</td></tr>
<tr><td>JIT</td><td>13</td><td>8</td></tr>
<tr><td>JMIS</td><td>9</td><td>7</td></tr>
<tr><td>ISJ</td><td>7</td><td>4</td></tr>
</table>

	JAIS		3	2
Management/OS Journals	**SMJ**	Search terms as mentioned AND > 2003	25	22
	Org. Sci.		22	14
	AMJ		28	10
	ASQ		6	2
	AMR		5	2
	MS		3	1
IS Conferences	**ICIS**	"digital transformation" AND > 2015		16
	AMCIS			11
	ECIS			9
	PACIS			3
			Grand Total	**175**

Table 9. Literature Search Results in Selected Outlets

Second, to examine management and organization science literature, we applied the same search terms to the titles, abstracts, and keywords of articles published in six selected high-ranked management and organization science journals according to the FT50 ranking. We limited the publication year to 2003 but did not limit the context or the employed research method and found 89 articles. We again used the same set of exclusion variables (Okoli/Schabram 2010) and excluded 38 articles that did not focus on OT, such as Pathak et al. (2014), who studied the impact of divestiture intensity and contextual factors on CEO compensation, leading to a selection of 51 relevant articles.

As a third step, we extended our search to leading IS conferences using the search term "digital transformation", see Table 9. We limited our search to contributions since 2015, as we assume that older high-quality conference papers should have already been published in leading journals. Again, the articles that resulted from the search were selected according to the exclusion criteria defined above. This step yielded an additional 39 articles, resulting in a grand total of 175 articles. The full list of selected articles and the respective coding can be found in the Appendix A of the thesis.

4.3 Findings from the Literature Review to Clarify Digital Transformation

To structure the findings of the literature review, we first analyze the inconsistencies in the understanding of digital transformation within and between management, organization science, and IS. Second, we present 12 different and heterogeneous schools of thought that we identified in DT and prior OT literature. Third, we discuss DT according to the identified schools of thought.

4.3.1 Inconsistencies in the Understanding of Digital Transformation

As a first step toward clarifying DT, and to provide an overview of the existing understandings of DT, we searched for explicit definitions of the phenomenon. In the selected publications, we found 51 articles explicitly using the term DT: 12 in IS journals, 39 in IS conferences, and 0 in management and organization science journals. Reading the selected articles, we identified six different definitions, which are presented in Table 10 ranked by their number of citations in Scopus (as of September 2018).

Source	**Definition of Digital Transformation**	**Citations**
Fitzgerald et al. (2013)	DT is "the use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements (such as enhancing customer experience, streamlining operations or creating new business models)"	231
Matt et al. (2015)	DT affects large parts of companies and even goes beyond their borders, by impacting products, business processes, sales channels, and supply chains	178
Bley et al. (2016)	DT leads to an increasing interconnectedness of classical horizontal value chains in a complex value network	23
Haffke et al. (2016)	DT "highlights the transformational nature of digital technologies for businesses, especially in large corporations with a long non-digital history. Specifically, DT encompasses the digitization of sales and communication channels, which provide novel ways to interact and engage with customers, and the digitization of a firm's offerings (products and services), which replace or augment physical offerings."	9
Nwankpa/Roumani (2016)	"DT is defined as an organizational shift to big data, analytics, cloud, mobile and social media platforms (…) fueled by digital innovations."	9
Horlacher et al. (2016)	"DT goes beyond merely digitizing resources and involves the transformation of key business operations, products, and processes, culminating in revised or entirely new business models."	6

Table 10. Definitions of Digital Transformation

The definition of DT used most often is provided by Fitzgerald et al. (2013). According to their definition, the main differentiator between DT initiatives and any other OT initiative that involves the implementation of digital technologies is the notion of novelty associated with the technologies that are implemented. However, the restriction of DT initiatives to those involving new digital technologies is problematic because the perception of novelty is always a matter of perspective.

Nambisan et al. (2017) try to resolve this by defining a digital innovation as the use of digital technologies during the process of innovating, which is new to the adopting organization but may already be well established in other organizations. A typical example is the use of cloud services in the newspaper industry (Karimi/Walter 2015), even though such services are already well established in the software industry (Leimeister et al. 2010). Surprisingly, the term DT is only rarely mentioned in digital innovation literature, which has gained momentum in recent years. Literature on digital innovation focuses on the enhancement of physical products or a new organizational logic (Yoo et al. 2010) or the orchestration of digital innovations (Nambisan et al. 2017), which are also critical elements of transformations (Fichman et al. 2014). This school of thought has its origin in marketing theory and was later adopted in IS and organization science (e.g., Vargo/Lusch 2004; Lusch/Nambisan 2015).

In some cases, mostly driven by IS scholars, DT is connected to specific digital technologies. For example, Nwankpa/Roumani (2016) identified DT with specific technologies such as cloud computing, big data, and mobile and social media platforms. However, the drastic speed of technological advancements, suggests that DT should not be defined by the use of very specific technologies that could be outdated in just a few years.

Particularly often studied in the IS discipline is the development of technology-enabled business models inherent to DT and their implications for an organization's governance and operation (e.g., Horlacher et al. 2016; Nwankpa/Roumani 2016; Piccinini et al. 2015a). This school of thought regards business model innovation as a constitutive element of DT. However, it also concerns the development of digital business strategies (Bharadwaj et al. 2013), new management roles, e.g., Chief Digital Officers (CDOs) (Tumbas et al. 2017), new organizational cultures (Piccinini et al. 2015a), and IS capabilities, e.g., for the development of a digital platform ecosystem (Tan et al. 2015), to achieve business model innovation.

Up to this point, the debate is contingent on an intra-organizational point of view in which OT processes are examined independently from their effects on organizations' external environments. However, transforming business models means changing the way value is delivered to customers. In particular, Haffke et al. (2016: 2) emphasized the effects on "sales and communication channels, which provide novel ways to interact and engage with customers" and a "firm's offerings (products and services), which replace or augment physical offerings". To be successful, the evolution of a company's business model needs to be complemented by a co-evolution on the customer and partner side (Rai/Tang 2014). For example, Apple's App Store shows that DT does not just affect the organization with its internal value creation processes. Apple heavily invested in resources (e.g., the software development kit for iOS) that helped the organization establish an ecosystem of connected developers and customers (Eaton et al. 2015). Today, the majority of applications is created by external software development companies or independent developers (Sarker et al. 2012). Recognizing this interdependence, researchers have extended the intra-organizational perspective with an inter-organizational perspective (e.g., Riasanow et al. 2018b).

One of the key challenges researchers face when following the debate about DT is related to the level of abstraction applied to the phenomenon. Some researchers treat DT as an industry-level phenomenon (e.g., Bley et al. 2016), which changes the way organizations within and across industries compete. Others regard it as an organizational-level phenomenon with DT representing a change process that pervades major parts of an organization (e.g., Horlacher et al. 2016; Fitzgerald et al. 2013). Still, others interpret DT as a change program consisting of several separate transformation initiatives (Matt et al. 2015). The debate is further complicated by the fact that, in the current debate, the terms DT and digitalization are often used interchangeably (Haffke et al. 2016). Particularly in healthcare settings, DT is often simply understood as the process of digitization, i.e., transforming analogue to digital (e.g., Agarwal et al. 2010). Haffke et al. (2016) highlight that digitalization can be used interchangeably with DT, which is particularly relevant for large corporations with a non-digital history. This proliferation of terms and classifications makes it difficult for researchers to obtain an overview of the existing body of knowledge regarding DT.

For this reason, we aim to clarify the notion of the relevant terms and illustrate the relationships of the underlying schools of thought.

4.3.2 Different and Heterogeneous Schools of Thought

We aim to achieve the proposed clarification of DT by examining the different and heterogeneous schools of thought of the underlying theories and concepts. Based on an analysis of the definitions, we have already identified schools of thought such as digital innovation.

To provide a full overview of the selected articles, we followed the guidelines of Webster/Watson (2002) and coded the theories of the selected articles in management, organization science, and IS literature. Second, we identified 12 schools of thought based on our coding, see Table 11.

Schools of Thought	∑	**Mgmt/ OS JNS**	**IS JNs**	**IS CONFs**	**Example(s) from the selected articles**
Dynamic capabilities/RBV	**32**	7	17	8	(Agarwal/Helfat 2009; Ash/Burn 2003)
IS-enabled OT	**25**	-	22	3	(Orlikowski 2000; Besson/Rowe 2012)
Transformational leadership	**21**	19	2	-	(Barrick et al. 2014; Rindova et al. 2011; Hill et al. 2012)
Digital innovation	**21**	1	9	11	(Nambisan et al. 2017; Yoo et al. 2012; Lucas/Goh 2009)
Revolutionary/ radical change	**16**	2	14	-	(Romanelli/Tushman 1994; Amis et al. 2004)
Identity, cognition, sensemaking	**15**	13	1	1	(Nag et al. 2007; Balogun et al. 2015)
Ecosystem	**13**	3	2	8	(Jacobides et al. 2018; Eaton et al. 2015)
Emergence, institutionalism, and contingency	**11**	4	6	1	(Aguilera et al. 2008; Oehmichen et al. 2017)
Business model	**8**	2	1	5	(Amit/Zott 2012; Feller et al. 2011)
Evolutionary/ incremental change	**4**	-	4	-	(Cunningham/Finnegan 2004; Harkness et al. 1996)
Ambidexterity	**2**	-	1	1	(Gregory et al. 2015)

Service-dominant Logic	**1**	-	1	-	(Barret et al. 2015)
n/a	**6**	-	5	1	Research Commentaries, e.g. (Loebbecke/Picot 2015)
Total	**175**	51	85	39	
IS: Information Systems, Mgmt: Management, OS: Organization Science JNL: Journal, CON: Conference					

Table 11. Schools of Thought Coded in the Selected Articles

Each of the subsequent sections about the different and heterogeneous schools of thought is organized as follows. First, a brief description and information about the coding is provided. Second, we analyze articles on prior OT within and in between management, organization science, and IS literature. As third, we discuss the school of thought regarding DT. We could not code seven studies to a school of thought, as they did not mention a theoretical background (e.g., Loebbecke/Picot 2015).

4.3.2.1 Dynamic capabilities/RBV

Based on a resource-based view (RBV) of a firm, organizations achieve superior performance via resources and capabilities that are firm specific. Organizational capabilities are an organization's ability to organize its resources effectively to achieve strategic goals, such as OT (Grant 1991). In changing environments, the dynamic capability perspective can help to explain how and why organizations change (Teece et al. 1997). Building on the definition of Grant, dynamic capabilities are defined as an "organization's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997: 516), which reflects the majority of the coded articles in this school of thought. We also included articles concerning organizational resources or work routines in this school of thought.

In management and organization science, e.g., entrepreneurial dynamic capabilities of top management (Agarwal/Helfat 2009) are found to be relevant in prior OT. To analyze dynamic capabilities in more detail, its microfoundations were added in tripartite form, i.e., sensing, seizing, and reconfiguring components (Teece 2007). For example, the managerial cognitive capability "language and communication" can have a positive impact on the dynamic capability "reconfiguring", which may in turn help overcome resistance to change (Teece 2007).

In IS literature, OT is often conducted to develop new dynamic capabilities, e.g., for the development of a new IT architecture (Gregory et al. 2015), the integration of IT across business processes (Ash/Burn 2003), or the implementation of a new business model based on IT (Singh et al. 2011). However, most of the dynamic capabilities in IS literature are connected to the development of technological artifacts or business models, whereas management and organization literature also identified dynamic capabilities related to the cognitive and social aspects of OT, e.g., to overcome resistance to change.

In summary, the development of dynamic capabilities plays a major role in OT in management, organization science, and IS literature. Therefore, its importance in DT is not surprising because dynamic capabilities are considered to be essential factors to react to disruptive innovations (Karimi/Walter 2015). Compared to prior OT, some argue that DT requires new capabilities that differ from prior dynamic capabilities, e.g., digital platform capabilities for the DT in the newspaper industry (e.g., Karimi/Walter 2015).

4.3.2.2 IS-enabled OT

Technology and its relationship with organizational structures, processes, and outcomes have long been of interest to organizational researchers (e.g., Orlikowski 2000; Yoo et al. 2012). In this ongoing discussion, different perspectives on technologies parallel to different research objectives in organizations exist (Orlikowski 2000). When technology is used for change, i.e., where people use new technology to alter their existing method of operating, this may lead to redefined work distributions, shifts in the types of collaboration, and changes in learning methods (Orlikowski 2000).

This organizational research-based discussion of the impact of OT on organizations has also informed IS research, as Markus (2004) states "using IT in ways that can trigger major organizational changes creates high-risk, potentially high-reward situations". In this light, Besson/Rowe (2012) highlight the potential deep structure transformation of an organization through IT, which they call IS-enabled OT. IS-enabled OT focuses on "the nature of IT capabilities and organization designs that will enable firms to exploit the business potential of IT" (Sambamurthy/Zmud 1999: 262).

Consequently, though using different names, management, and organization science and IS eventually discuss the same phenomenon from the same perspective, namely, the impact of technology on organizing and vice versa.

IS-enabled OT was not coded in the DT articles. Following Yoo et al. (2010), we consider this school of thought as a precursor of DT because it does not reflect the unique characteristics of digital technologies, e.g., reprogrammability, the homogenization of data, and the self-referential nature of digital technology.

4.3.2.3 Transformational Leadership

OT achieved via transformational leadership includes articulating and presenting a clear vision, displaying charisma, motivating employees through inspiration and intellectual stimulation derived from exposing them to new and complex ways of thinking, and being considerate of their individual needs and desires (Hill et al. 2012).

Management and organization science literature in this school of thought recognizes organizational identity redefinition as a key mechanism for OT (Rindova et al. 2011). The outcome of the transformation process may be influenced by a CEO's charisma, board gender diversity and the power of women directors, frontline employees, middle managers' emotional investment, or managerial cognitive capacity (e.g., Helfat/Peteraf 2015). Another critical aspect is a CEO's transformational leadership because of the impact of the leadership styles of the CEO and top management affect organizational learning (e.g., Vera/Crossan 2004).

Articles in IS discuss specific elements of transformational leadership, e.g., the alignment of IT human resources with the business vision (Roepke et al. 2000) or the challenges of managing self-organized global development teams in transformations (Eseryel/Eseryel 2013).

Nevertheless, major transformations may provoke employee resistance, especially because DT has an impact on the entire organization and beyond. Therefore, transactional leadership is not sufficient to carry out a DT project. Instead, transformational leadership is essential to communicate the vision and to obtain active involvement from the different stakeholders that are affected by the transformation (Matt et al. 2015). The essence is to observe the limitations of the organizational culture and transform it adequately if some of the central assumptions are invalid, e.g., via environmental changes or the diffusion of technologies that fundamentally alter the organization (Chatfield et al. 2015). Accounting for empowerment, we observe that DT often dovetails with the creation of a new executive role, i.e., the introduction of a Chief Digital Officer (CDO) (Matt et al. 2015), which shows that a role with decision power in the executive board is important to deal with the speed of digital innovations. The fact that companies are eager to react accordingly is shown by the number of active CDOs, which has doubled every year since 2003 to over 2,000 CDOs in 2015 (Horlacher et al. 2016).

4.3.2.4 Digital Innovation

Building on prior innovation literature, digital innovation is the use of digital technology during the process of innovating (Nambisan et al. 2017; Yoo et al. 2012). Digital innovation further requires a firm to revisit its organizing logic and its use of corporate IT infrastructures (Yoo et al. 2010).

Many DT articles build on transformations due to digital innovations (e.g., Fichman et al. 2014). Following Yoo et al. (2010), digital innovations build on novel characteristics that differ from earlier technologies, e.g., reprogrammability, the homogenization of data, and the self-referential nature of digital technology. Therefore, new organizational logic is necessary to cope with digital innovations (Yoo et al. 2012; Yoo et al. 2010). The case of Kodak shows that such new organizational logic is very difficult to achieve, particularly when an organization’s business model has been successful for more than one century (Lucas/Goh 2009). As a result, Kodak filed for bankruptcy, even though they initially invented digital cameras, the disruptive technology that destroyed their traditional core business (Lucas/Goh 2009).

Moreover, digital innovation also presents a new perspective in the ongoing discussion between organization and technology, driven by management and organization science scholars (Orlikowski 2000). Therefore, the notion of OT due to digital innovations may provide a bridge between management and IS literature for discussions concerning the DT phenomenon.

4.3.2.5 Revolutionary/radical Change

Revolutionary or radical change asserts that change is discontinuous, fast, and systemic (Besson/Rowe 2012). Revolutionary or radical changes may occur at several levels in OT.

In prior OT literature, we found that radical change may have a significant impact on the organizational structure by “adding, splitting, transferring, merging or deleting organizational units” (Girod/Whittington 2015; Schwarzer/Krcmar 1995). This could lead to greater integration and control at the organizational level (Berente et al. 2016). Many of the articles coded to this school of thought draw on the punctuated equilibrium model, which understand OT as radical process (Gersick 1991; Romanelli/Tushman 1994). In some OT projects, activities are coordinated by a new position in the organizational hierarchy (Rindova et al. 2011), which often implies a shift in the organizational hierarchy and the locus of decision-making (Amis et al. 2004). Amis et al. (2004) recognized the decentralization of decision-making authority as controversial and far-reaching.

This concept is also found in IS literature, e.g., in the failure of radical changes at TELECO (Sarker/Lee 1999). Stoddard/Jarvenpaa (1995) notice tactics for radical change, often motivated by prior crises and failures, are to make use of outsiders, and to qualify employees for change who fit with new the new culture and organizational structure.

The concept of revolutionary change fits many DT articles, especially when it is intended to enable faster decision-making, to ensure necessary resources are available, or to eliminate administrative barriers to increase the information flow, as shown in the case of the digital transformation of LEGO (Andersen/Ross 2016). Therefore, organizations may create a separate DT department, establish a Chief Digital Officer (CDO) as a responsible change agent on the management board (Haffke et al. 2016), or establish cross-functional, self-organized agile teams around the products or services offered (Ross et al. 2016).

4.3.2.6 Identity, Cognition, and Sensemaking

This school of thought is grounded in behavioral theories of a firm. In prior articles, we found that organizational identity is connected to OT because, during transformation attempts, the organizational identity is often destabilized and is susceptible to change (Nag et al. 2007). Organizational identity includes those features of an organization that its members deem to be the most central, distinctive, and enduring (Albert/Whetten 1985). Taking a social constructionist view, organizational identity entails members' consensual understanding of who they are as an organization, which appears to be critical to organizational survival and growth (Nag et al. 2007). Further, a strong organizational identity and an organization's members' efforts to preserve the collective practices that characterized their work may also hinder OT (Nag et al. 2007).

Management studies advice, if the decision to change the organizational identity is made in an OT, a shift in the interpretative schemes of the organization's members follows (Balogun et al. 2015). This requires sensemaking and sensegiving on the part of senior managers, e.g., to direct lower-level employees toward a new desired organizational reality (Balogun et al. 2015).

Besides the mentioned management articles, we only found one article in IS literature connected to this school of thought, which examined the role of IT in the process of developing sustainable business processes. In this process, four functional affordances originating in information systems (reflective disclosure, information democratization, output management, delocalization) were developed that create a context in which organizations can engage in a sensemaking process to understand emerging environmental requirements (Seidel et al. 2013).

Not explicitly, but implicitly mentioned in several articles, DT also requires a sensemaking process. In DT projects, senior managers should encourage "employees to develop a digital mindset in order to increase the acceptance and use of digital technologies" (Piccinini et al. 2015a: 10). Supporting this view, Chatfield (2015: 16) argued that a culture that "encourages and rewards smart motivated employees with entrepreneurial problem-solving capability and their experimental use of disruptive technologies" is required. Yet, a transformation of the organizational identity and the sensemaking process during a DT and its differences to prior OT remain unexplored.

4.3.2.7 Ecosystem

This school of thought analyzes when and why ecosystems emerge and what makes them distinct from other governance forms (Jacobides et al. 2018).

On the ecosystem level, prior OT studies in organization science and management have considered repositioning costs, which are important if OT involves shifts in the firm's activity system (Menon/Yao 2017). Other studies have examined environmental effects on OT, such as negative media coverage (Bednar et al. 2013). Based on these findings, Jacobides et al. (2018) developed a theory of ecosystems to explore when and why ecosystems emerge.

Using digital technologies, potential co-creation has become easier via the supply of boundary resources (Grover/Kohli 2012). As an example, Apple provided a digital platform to distribute iOS applications. Because most of these applications were developed by third parties, these developers had to learn a specific programming language and align their development process with the Apple platform (Eaton et al. 2015). Apple supported third-party developers heavily via the supply of boundary resources (Eaton et al. 2015). Apple relies heavily on co-creation with complementary partners, which played a major role in the successful DT (Sarker et al. 2012). However, while Apple's partners gained access to a huge customer base, they were critically affected by the DT project, e.g., changes in the boundary resources or the payment process for applications. Therefore, if DT means the introduction of a digital platform, the organizational change goes beyond IS-enabled OT because the business models of co-creating partners are affected. Riasanow et al. (2017) demonstrated that emerging players that build mobility service platforms have brought about a substantial transformation in the automotive ecosystem. These examples show that competition takes place via ecosystems of co-creating partners in DT, which implies a fundamental difference compared to prior notions of OT.

4.3.2.8 Emergence, Institutionalism, and Contingency

We grouped three theoretical lenses in this school of thought. In prior articles, we first found that OT can also be an emerging phenomenon, which may not be actively triggered by decision makers, which is contrary to the viewpoint that considers OT to be a process of planned change (Markus/Robey 1988). Second, following an emerging change phenomenon, institutionalism views OT as imported from the outside; it resembles a process of diffusion of a standard, which may be fast or slow, systemic or patchy (Besson/Rowe 2012). Third, contingency theory states there is no best way to organize, lead, or transform an organization (Aguilera et al. 2008). Instead, the optimal course of action is contingent upon the internal or external (e.g., emerging) situation (Aguilera et al. 2008). Comparing companies listed in broad stock indices (i.e., S&P 500), contingent on the situation of an organization, different drivers of strategic change could be observed (Oehmichen et al. 2017). First, organizations can leverage broad industry knowledge if they possess experienced directors. Second, managers lacking access to such information on potential change can use external experienced directors for strategic advice (Oehmichen et al. 2017).

Again, similar to "identity, cognition, and sensemaking", most DT articles do not cover the same terms and vocabulary as management and organization science literature. However, there are some cases, such as the bankruptcy of Kodak due to not innovating the organization as mentioned before (Lucas/Goh 2009), which can be interpreted as emerging change. This leads to the conclusion that DT may not always be actively triggered or organized, e.g., as in the case of co-creating partners being affected by the emerging digital transformation of Apple (e.g., see Eaton et al. 2015). Ultimately, the process of institutionalizing in DT remains unexplored.

4.3.2.9 Business Model

Many articles on business models consider its innovation (Amit/Zott 2012), e.g., with the goal of substantially transforming value creation, innovation, or firm performance (Amit/Zott 2001).

In prior OT literature in management, organizations have used business model innovation to trigger changes in product development, production, and distribution (e.g., Rindova et al. 2011). As such, the Italian luxury housewares and kitchen utensil provider Alessi successfully transformed its existing products for hotels and restaurants by combining concepts from the industry register (products as functional tools) with distinctive formal properties (value of form) (Rindova et al. 2011). Particularly radical projects involve a major change in products and value creation activities, often leading to a new product category and representing a break with the past (Jones 2003).

IS literature focused on increasing possibilities for business model innovations via new technologies and systems, such as e-commerce (e.g., Barua et al. 2004). New technologies require a change in core competencies and resources, such as the introduction of RFID to create a more efficient supply network (Wamba/Chatfield 2009). By means of these technologies, organizations have become aware that value is increasingly generated through networks with business partners that combine their complementary capabilities, e.g., partnerships with distributors (Barua et al. 2004). One means toward business model innovation is to generate new distribution channels, such as the acquisition of new customers online for retailers, manufacturers, distributors, or wholesalers (Barua et al. 2004), or the provision of home health care enabled by telemedicine (Singh et al. 2011).

Prior OT studies in organization science have also noted that competitive pressure induces agents (managers or firms) to focus their attention on nearby competitors (Johnson/Hoopes 2003). In addition to rival companies, competition may also take place via the marketplace, and increasing firm performance is central to prior OT (e.g., Agarwal/Helfat 2009).

In some cases, organizations conduct DT to react to high perceived pressure on their business models (Kaltenecker et al. 2015). One reason for high pressure is that digital innovations reduce entrance barriers and allow emerging players to enter new markets at high speeds (Fitzgerald et al. 2013), such as Uber and Airbnb, which seriously threaten established organizations operating in the same industry. Building on these prior achievements, DT particularly focuses on business model innovation (Loebbecke/Picot 2015). This materializes in the high degree of digital technologies contributing to the value creation of an organization (Lucas et al. 2013). As examples for business model innovations in DT, we identified the transformation from on-premise service provision to a cloud provision (Kaltenecker et al. 2015) and the development of data-driven business models in the context of big data (Loebbecke/Picot 2015), automotive (Piccinini et al. 2015a; Riasanow et al. 2017), or financial (Puschmann 2017) industries. Moreover, the business model of partners is affected in DT, e.g., due to co-creation mechanisms (Puschmann 2017).

4.3.2.10 Evolutionary/incremental Change

Analyzing prior studies, we found evolutionary change states where OT is continuous, slow, and patchy, a type of organizational Darwinism (Besson/Rowe 2012), e.g., business process change (BPC) (Jurisch et al. 2012; Jurisch 2014).

Often referred to in IS literature, BPC is defined as an OT initiative "to improve and (re)design business processes to achieve competitive advantage in performance through changes in the relationships between management, information, technology, organizational structure, and people" (Kettinger/Grover 1995: 12). Contrary to a revolutionary or radical type of change, evolutionary change in the context of BPC focuses on incremental changes in business processes (Teo et al. 1997; Ertl et al. 2018).

However, we did not find any articles connecting DT to evolutionary change. One reason for this may be the disruptive impact of digital innovation that triggers DT (Puschmann 2017; Fitzgerald et al. 2013).

4.3.2.11 Ambidexterity

Organizations can use existing resources to foster efficient processes (exploitation), e.g., via optimization, or to create novel potentials (exploration), e.g., via research or experimentation (March 1991). Ambidexterity means to pursue two disparate things at the same time, such as to focus on exploration and exploitation simultaneously (March 1991). The notion of ambidexterity is often connected to the use of technology, particularly in IS literature (e.g., Gregory et al. 2015).

In some management and organization science studies, organizations focus on exploitative uses of technology to increase efficiency, standardization, and reduce costs in processes or routines (Berente et al. 2016), e.g., via a new information system for material planning can be used to create process efficiencies (e.g., Dey 2001). Particularly IS studies focus on the exploration of new technologies, such as the implementation of a remote patient monitoring system to create the option of home care services (Singh et al. 2011) or the use of RFID to orchestrate a supply chain network (Wamba/Chatfield 2009).

However, we only found one DT study connected to ambidexterity. Gregory et al. (2015) studied the transformation program of a large commercial bank and identified ambidexterity in six areas: portfolio decisions, platform design, architecture change, program planning, governance, and delivery. They found that a continuous balancing of explorative and exploitative behavior, e.g., in the case of platform design: standardization versus differentiation, is necessary (Gregory et al. 2015).

4.3.2.12 Service-dominant Logic

Service-dominant (S-D) logic views what a firm does not primarily as the production and offering of tangible goods or, for that matter, any output (tangible or intangible) but rather as the exchange of services that occurs when one actor uses its skills and capabilities for the benefit of another actor (Lusch/Nambisan 2015; Vargo/Lusch 2004). Rarely used in our sample of selected articles, S-D logic can be a suitable lens to understand (digital) innovations (Barret et al. 2015) and to contribute to the ongoing discussion between organization and technology. In a resource integrating, service-exchange activity, coordinated through institutional arrangements for mutual value creation, service ecosystems are established (Lusch/Nambisan 2015). IT plays a crucial role in service ecosystems and therefore in service innovation because resources are combined and exchanged in new ways that co-create value for actors engaged in the service ecosystem (Barret et al. 2015). Therefore, S-D logic provides a helpful lens to understand DT from an organizational or ecosystem perspective.

4.4 Discussion

Based on this study, four theoretical contributions have come to light. First, the findings of the 12 identified schools of thought show that DT significantly builds on prior OT in management, organization science, and IS literature. Therefore, this study enlarges the excellent literature review of Besson/Rowe (2012). However, our findings show that DT is not only old wine in new bottles by highlighting the unique aspects of DT, particularly via the ecosystem, business model innovation, and digital innovation schools of thought. Therefore, we expand on the study of Fitzgerald et al. (2013), who understand DT primarily as an inter-organizational transformation. Further, we expand on the study of Nambisan et al. (2017) because we understand DT as OT based on the transformative impact of leveraging digital innovations. We also account for the fact that organizations are interconnected in complex ecosystems (Lusch/Nambisan 2015).

Second, we note that organization and management science articles begin to account for the specifics of digital innovation and the required new organization logic (Yoo et al. 2012). Drawing on IS articles on IS-enabled OT based on specific technologies (e.g., sensor networks, big data, cloud computing) could inform this discussion. Further, we refer to management and organization science studies, which address in particular transformational leadership, identity, cognition, and sensemaking. These schools of thought are central drivers of DT that are not yet reflected in IS literature.

However, some schools of thought, such as dynamic capabilities, are relevant to both disciplines. Further, we note that this requires an organizational setup that empowers DT, such as the ambidextrous use of digital technology.

Third, we also highlight conflicts and heterogeneous views, derived from prior OT studies, which remain salient for DT. Because prior OT is viewed as either radical or evolutionary, both schools of thought may be suitable lenses for DT, depending on the particular case. However, we only found DT articles connected to radical change. This may be due to the disruptive nature of digital innovations that drive DT. Furthermore, decision makers may not always actively trigger DT because DT can be also the result of institutionalizing change based on an emerging phenomenon. Moreover, DT is a new stream in the ongoing discussion of the relationship between organizing and technology, having its roots in the new organizational logic due to digital innovations. In this context, we identified relatively disparate discussions in management, organization science, and IS literature. Therefore, our review helps compare prior OT studies to DT and enriches the discussion between different schools of thought in and between the mentioned disciplines.

Fourth, we reject the idea that DT is connected to a specific technology such as cloud computing (Nwankpa/Roumani 2016) and understand it as being driven by any digital innovation, e.g., blockchain or artificial intelligence. Drawing on this understanding, we also reject the idea that DT can be used interchangeably with digitization, which is the mere process of turning analogue into digital and does not necessarily have to be connected with an OT.

Further, this study provides three practical contributions. First, we invite practitioners and scholars to apply the identified schools of thought when talking about DT or comparing it to prior OT. In particular, we provide 12 schools of thought to enlighten discussions about DT.

Second, managers can obtain insights about what is new for DT compared to prior OT. For example, DT does not exclusively influence an organization but also the ecosystem, including the co-creation of partners, and is often connected to a substantial business model innovation.

Third, this discussion of DT helps decision makers to understand and analyze the different aspects of the current discussion on technology and organization, particularly due to digital innovations.

4.5 Limitations and Future Research

Our study is subject to some limitations. First, the identified articles are limited to our search terms and selected databases. However, we also drew on Besson/Rowe (2012), who conducted an excellent review of IS-enabled OT, and complemented their search terms with keywords on DT.

Second, this study is limited by the coding of the articles to the respective schools of thought. Therefore, we also compared our results to Besson/Rowe (2012). Accordingly, all the articles they reviewed are also included in this work. Further, we ensured that a broad amount of DT articles was included by opening the search to recent conference publications.

Our findings suggest five avenues for future research. First, because DT also affects partners in the ecosystem, we suggest that the transformation of complementary partners should be considered in DT. Therefore, we suggest using co-evolution theory (Lewin/Volberda 1999) to examine the simultaneous and reciprocal transformation of an organization and its partners in an ecosystem.

Second, a holistic analysis of current and ongoing transformation activities in different industries is still lacking. For such an analysis, it would be important to view DT from a macro-perspective, such as an ecosystem (Puschmann 2017). In this context, more case studies that cover failed DT initiatives are necessary to learn about DT from a micro-perspective. However, the success factors generated from single case studies are highly context-specific with limited generalizability.

Therefore, as a third avenue, we suggest the use of configurational methods to examine the interplay of environmental and organizational factors via the method of fuzzy-set Qualitative Comparative Analysis (fsQCA) (Ragin 2008), e.g., to derive patterns for successful DT strategies. This configurative research method is particularly useful to examine DT strategies, as it allows for equifinality, e.g., multiple ways can lead to a successful DT, compared to unifinal methods like regressions.

Fourth, we suggest incorporating the phenomenon of DT in the development of an ecosystem theory (Jacobides et al. 2018), particularly because digital innovations can lead to the emergence of new ecosystems (e.g., blockchain) or the transformation of established ecosystems (e.g., the transformation of the financial industry via Fintechs).

Fifth, particular IS studies may learn from prior management and organization science literature by accounting more for the identity, cognition, and sensemaking, and the transformational leadership school of thought of DT. In contrast, management and organization science could learn from IS literature to account for the specifics of digital technologies in OT, as the technological foundations may significantly influence the possibilities of organizational identity, operation, governance, and learning. This is particularly important when designing an organizational setup that empowers DT.

4.6 Conclusions

By discussing the 12 different and heterogeneous schools of thought underlying DT and related prior OT, our study contributes to management, organization science, and IS by clarifying the notion of DT. First, we demonstrated that DT is a novel phenomenon compared to prior OT, particularly by incorporating the notion of digital innovation. Second, we provided 12 schools of thought to discuss the phenomenon of DT adequately and among different literature streams. These schools of thought help synthesize articles on DT and allow comparisons to prior OT. Therefore, this study helps compare articles about DT and shows that not all articles that claim to investigate DT are actually studying this particular phenomenon. Finally, we hope that our work contributes to a consistent terminology and that our proposed avenues for future research will be embraced and will help consolidate this research area as well as move it forward.

5 Co-evolution in Business Ecosystems: Findings from Literature (P2)

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Publication	40th Gesellschaft für Informatik Enterprise Modeling and Information Systems Architectures (GI EMISA)
Status	Accepted
Contribution of First Author	Problem Definition, Research Design, Literature Analysis, Interpretation, Discussion, Reporting

Table 12. Fact Sheet Publication P2

Abstract

The innovative use of digital technologies led to a disruption of well-established business models in many industries. To prevent from being disrupted, organizations are required to transform. Yet, studies about digital transformation primarily focus on intra-organizational perspectives, including process, structures, and business models. However, digital transformation substantially changes inter-organizational behavior, including the ecosystem. In order to examine this phenomenon, we draw on co-evolution theory that states change occurs in all interacting organizations, permitting change to be driven by both direct interactions and feedback from the ecosystem. Hence, goal of this paper is to provide a structured overview of literature on co-evolution in ecosystems in management, organization science, and IS literatures. Following the six properties of co-evolution, we develop a framework for co-evolution in ecosystems consisting of 23 configurations for these properties, based on the analysis of 44 articles. Ultimately, we suggest avenues for future research on co-evolution in business ecosystems.

5.1 Motivation

Digital platforms that have the capacity to combine and deploy innovative technologies in new ways create the potential to radically change the way organizations are doing business in their respective ecosystems, which led to a disruption of many well-established business models (Lucas/Goh 2009; Rai/Tang 2014). We refer to the organizational transformation to prevent a disruption through the innovative use of digital technologies as digital transformation (Weill/Woerner 2015).

Yet, studies about digital transformation are primarily concerned with an intra-organizational perspective, including processes, products, and services, organizational structures, or the business model (see, e.g., Karimi/Walter 2015; Kaltenecker et al. 2015). However, digital transformations substantially influence inter-organizational partnerships, particularly in business ecosystems, where value is co-created among multiple stakeholders (Sarker et al. 2012; Ceccagnoli et al. 2014). Hence, partnerships are increasingly important, as the market for information technology is constantly evolving and giving rise to a variety of innovations, e.g., cloud computing, in-memory databases, or blockchain and distributed ledgers (Piccinini et al. 2015a), which are often provided in platform ecosystems. Platform ecosystems consist of digital platforms and applications specific to it as well as the stakeholders of the platform, platform owners, and complementors (Tiwana 2014). In such ecosystems, we understand platform owners as individual or organization representing the legal entity that owns the platform (Tiwana 2014). Complementors contribute additional value to the platform, e.g., in the form of applications (Tiwana 2014). Further, platform owners also rely on partners to gain access to customers, or complementary resources and capabilities (Sarker et al. 2012; Lusch/Nambisan 2015).

To study the ongoing digital transformation from an ecosystem perspective, we use the lens of co-evolution theory. Co-evolution theory assumes change may occur in all interacting organizations, permitting change to be driven by both direct interactions and positive feedback (Lewin/Volberda 1999; Montealegre et al. 2014). Hence, we analyze extant literature on co-evolution in IS, management, and organization science literature to build a comprehensive understanding of co-evolution in ecosystems. Second, based on the six propositions of Montealegre et al. (2014), we suggest a framework for the co-evolution in ecosystems, including 23 configurations for these propositions. Ultimately, we suggest avenues for future research.

This paper is structured as follows. First, we present our conceptual background and research method. Second, we provide an overview of co-evolution theory in literature, particularly in ecosystems. Third, based on the review of literature, we propose a framework for co-evolution in ecosystems and suggest avenues for future research. After discussing our results, we conclude with limitations and implications.

5.2 Digital Transformation in Business Ecosystems

Many digital transformation articles build on transformations due to digital technologies (e.g., Fichman et al. 2014). Following Yoo et al. (2010), a new organizational logic is necessary to cope with digital innovations. The case of Kodak shows that such new organizational logic is very difficult to achieve, particularly when an organization’s business model has been successful for more than one century (Lucas/Goh 2009).

Using digital technologies, potential co-creation in ecosystems has become easier via the supply of boundary resources (Grover/Kohli 2012). As an example, Apple provided a digital platform to distribute iOS applications. Because most of these applications were developed by third parties, these developers had to learn a specific programming language and co-evolve their development process with Apple (Eaton et al. 2015). Apple supported third-party developers heavily via the supply of boundary resources (Eaton et al. 2015). Apple relies heavily on co-creation in its ecosystem with complementary partners, which played a major role in the successful digital transformation (Sarker et al. 2012). However, while Apple's partners gained access to a huge customer base, they were critically affected by the digital transformation. Therefore, if digital transformation means the introduction of a digital platform, the business models of co-creating partners are affected. Riasanow et al. (2017) demonstrated that emerging players that build mobility service platforms had induced a substantial transformation of the automotive ecosystem.

For ecosystems, three terminologies are most commonly used in research, which is also dividing the field into three broad streams, as found by Jacobides et al. (2018): business ecosystems, innovation ecosystems, and platform ecosystems. The three streams differ in their focus of the research but share the common understanding of ecosystems as a group of interdependent firms. In a hierarchical sense, the term business ecosystem can be seen as the root, being explored first, with "innovation" and "platform ecosystems" derived after that. According to Moore (1993), business ecosystems consist of entities with "co-evolving capabilities around a new innovation" in a cooperative and at the same time, competitive way. These entities represent an "economic community supported by a foundation of interacting organizations and individuals that produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders" (Moore 1993). An innovation ecosystem is a business ecosystem focused on the innovative solution towards the end customer. A concise definition of innovation ecosystems is the "collaborative arrangements through which firms combine their offerings into a coherent, customer-facing solution" (Adner 2006). In some articles on business ecosystems, the term "platform" is already mentioned, as for example in the conceptualization of Autio/Thomas (2014). Business ecosystems are the more generic concept, of which platforms are one common instantiation: Many business ecosystems, such as the Apple iOS ecosystem, have at their core a platform that structures and orchestrates the complementors and partners (Eaton et al. 2015). In this work, we generally use the term business ecosystem and understand platform or innovation ecosystems as specific instantiations of business ecosystems. Following Jacobides et al. (2018), there is broad knowledge on what ecosystems are, however, we still have limited knowledge about the digital transformation of business ecosystems.

Co-evolution, first recognized in the field of biology, occurs when two or more species reciprocally affect each other's evolution (Chaloner et al. 1991; Vessey/Ward 2013). When a system transforms to ensure its best fit, its environment also changes, and those changes in the environment are likely to result in further system changes, resulting in continuous system changes (Vessey/Ward 2013). Therefore, we draw on the theoretical lens of co-evolution to examine this phenomenon.

5.3 Research Approach

Our work follows a four-step research approach. To identify existing literature contributing to co-evolution in business ecosystems, we conduct a structured literature review following Webster/Watson (2002).

In the first step, we focused on leading outlets of IS, management, and organization science, i.e., the AIS Senior Scholars' Basket of Journals, and FT50 journals. Using the EBSCOhost and Scopus databases, we applied the following search terms to the titles, abstracts, and keywords of the publications: 'co-evolution' OR 'co-evolution' AND 'ecosystem' OR 'network'. The search was conducted between May and August 2018. Following Okoli/Schabram (2010), we reviewed the articles manually and filtered them according to an iterative set of exclusion criteria. Thus, articles that did not address co-evolution in ecosystems, such as Helfat/Raubitschek (2000), leading to 26 selected articles.

As the second step, we extended our search to leading conferences to include recent contributions since 2000. This step yielded another 17 articles, resulting in a grand total of 44 articles, see Table 13.

Outlet		Hits	Selected articles
IS Journals	Information Systems Research	6	(Goh et al. 2011; Rai/Tang 2014; Tanriverdi et al. 2010; Tiwana et al. 2010; Vidgen/Wang 2009; El Sawy et al. 2010b)
	Journal of the Association for Information Systems	3	(Montealegre et al. 2014; Vessey/Ward 2013; Putzke et al. 2010)
	Journal of Management Information Systems	1	(Fang/Neufeld 2009)
Management and Organization Science Journals	Research Policy	6	(Amesse/Cohendet 2001; Chaminade/Vang 2008; Höyssä et al. 2004; Kuhlmann 2001; Murray 2002; Manning 2013; Mina et al. 2007)
	Organization Science	6	(Anderson 1999; Djelic/Ainamo 1999; Koza/Lewin 1999; McKelvey 1999; Pacheco et al. 2018; Schulte et al. 2010)
	Long Range Planning	3	(Ambos et al. 2009; Holgersson et al. 2018; Lin et al. 2010)
	Organization Studies	1	(van den Ende et al. 2012)
	Technological Forecasting and Social Change	1	(Kraemer-Mbula et al. 2013)
Top Conferences	International Conference on Information Systems (ICIS)	9	(Ahuja/Chan 2016; Amarilli et al. 2017; Chan/Ahuja 2015; Hua et al. 2017; Hukal 2017; Um/Yoo 2016; Bhattacharya et al. 2015; Ng et al. 2017; Tanriverdi/Lim 2017)

	Hawaii International Conference on Services Sciences (HICSS)	3	(Sakurai/Thapa 2017; Skog et al. 2018b; Anderson et al. 2017)
	European Conference on Information Systems (ECIS)	3	(Dehbokry/Chew 2015; Weeger/Ulrich 2016; Bhattacharya et al. 2015)
	Americas Conference on Information Systems (AMCIS)	2	(Janze 2017; Han et al. 2016)
Grand Total		**44**	

Table 13. Selected Articles on Co-evolution in Ecosystems

In the third step, we draw on the six properties framework for co-evolution identified by Montealegre et al. (2014). Three experienced raters independently coded the selected articles. Before the raters started coding the articles, they coded several articles to become familiar with the coding scheme and then compared their coding for calibration purposes. All authors confirmed the final coding of each article and discussed the coding discrepancies until consensus was reached; this helped to eliminate disparities (Bullock/Tubbs 1990).

5.4 Literature on Co-evolution in Business Ecosystems

Montealegre et al. (2014) identified six properties of co-evolution theory, which we use to structure our findings.

5.4.1 Multi-level Effects

Co-evolutionary effects vary across a range of multiple levels of analysis (Koza/Lewin 1999; Lewin/Long 1999). Each level offers a different perspective on co-evolution. We found nine different levels in the articles. Five are intra-organizational levels, including business process, structure, leadership, culture, and the business model. Four are inter-organizational levels, including partners, customers, the regulatory environment, and other industries.

Vidgen/Wang (2006) found co-evolution in agile software development between the business process, and structure level is successful if organizations match the co-evolutionary change rate, maximize self-organizing, and balance between exploration and exploitation. Lin et al. (2010) characterize the co-evolution in ecosystems based on exchanges of technology on institutional ties. In a single longitudinal case study of a professional service network in the public accounting industry, a network was intentionally created and formally organized to pursue co-evolving effects for the member organization (Koza/Lewin 1999). Co-evolution is also successful on another level, as Höyssä et al. (2004) show in the level of interaction between the city and its national and international region, focusing on the city’s industrial policy as the mediator industry.

5.4.2 Multidirectional Causalities

Montealegre et al. (2014) understand co-evolutionary effects, not as a simple cause-effect logic of linear relations between independent and dependent variables. In general, a co-evolutionary process can have many causes (Durand/Vaara 2009). A co-evolutionary effect can, in turn, be a cause of, or causal factor for, many other co-evolutionary effects (Lin et al. 2010). We refer to multidirectional causality between two configurations, notably cooperation and competition.

In the identified articles, cooperation is understood as a voluntary arrangement in which two or more entities co-evolve in a mutually beneficial exchange instead of competing. Cooperation in the context of co-evolution can happen where resources adequately exist for both parties or are created by their interaction (Murray 2002; Rai/Tang 2014; Jacob/Duysters 2017).

Based on the findings of our literature review, competition is observed as rivalry about, for example, competencies, resources, profit, and market share, quality, service, as well as the right use of knowledge, partnerships and IT (Ahuja/Chan 2016; Koza/Lewin 1999; McKelvey 1999; Amarilli et al. 2017). Some scholars also argue that co-evolutionary processes can combine the configurations competition and cooperation (Holgersson et al. 2018; Lin et al. 2010; Pacheco et al. 2018).

5.4.3 Nonlinearity

Cause and effect of change in co-evolutionary relationships are often not following simple and linear logic. Rather, dependent variables are influenced by complex interactions of influencing variables. A small change of the initial variables can lead to very significant changes in the outputs and even to chaotic consequences (Van De Ven/Poole 1995). We suggest the configurations of 'diffusion nonlinearity', 'hierarchical nonlinearity', and 'network nonlinearity' in the co-evolution of business ecosystems and networks in a context characterized by uncertainty following Rogers (1995).

Hierarchical nonlinearity occurs when the co-evolutionary dynamics follows a vertical direction through the organization or ecosystem. Volberda/Lewin (2003) establish "hierarchical renewal" as one engine of co-evolution in multi-unit organizations, where the change cascades downwards from the top management. In the opposite direction, McKelvey (1999) argues that change can be hierarchically propagated from the bottom in the form of chain competences to top in the sense of the entire organization. Lin et al. (2010) found bottom-up technology ties and top-down institutional ties drive collaboration between organizations, which leads to an inter-network co-evolution. Co-evolution of the complex adaptive system occurs through nested hierarchies containing further sub-systems, which then are subject to evolutionary dynamics (Anderson 1999). Top-down dynamics are observable originating from governmental organizations in a work on disaster relief ecosystems (Sakurai/Thapa 2017) and in the sphere of healthcare in the hierarchical structure of hospitals (Goh et al. 2011).

We refer to network nonlinearity for nonlinear but orchestrated developments among entities of an ecosystem. Co-evolutionary dynamics in inter-organizational networks can act in nonlinear ways such as jolts, step functions, or oscillations (Meyer et al. 2005). Even though network structures between organizations may emerge in the absence of an authoritative entity, their creation and development are generally influenced by the actions of an orchestrating entity (Paquin/Howard-Grenville 2013). In the context of a professional services organization network, co-evolution is orchestrated through a headquarters entity that coordinates and facilitates the exchange in the network (Koza/Lewin 1999), or in the context of innovation policy designing making an orchestration role is less required (Kuhlmann 2001).

In the context of ecosystems, nonlinear diffusion is observed in the form of the diffusion process of technology standards among network members (van den Ende et al. 2012). In a similar manner, innovations are diffusing in ecosystems among suppliers, end users, and new entrants (Holgersson et al. 2018) and are sparked by spillover effects (Murray 2002). Similarly, Bhattacharya et al. (2015) describe diffusion processes of content postings in social media networks. However, diffusion is mentioned in a different sense there, as formalized process for technology transfer out of the organization (Amesse/Cohendet 2001), or as an institution for that specific purpose (Chaminade/Vang 2008).

Some argue nonlinear dynamics go beyond the three identified configurations. A spiral process of co-evolution is detected by van den Ende et al. (2012), and Kuhlmann (2001) uncovers a shockwave of revolution in the context of innovation. Further, nonlinearity is also used to explain why organizations are unable to renew their offerings in radical, big bang approach, e.g., in the context of digital ecosystems of SMEs (Chan/Ahuja 2015).

5.4.4 Mechanisms for Positive Feedback

Positive feedback is described by Lewin/Volberda (1999), as actions and interactions between entities undergoing co-evolution that are recursive and lead to recursive interdependencies (Moore 1993). A rich variety of positive feedback mechanisms was identified in the selected articles, we organized into three configurations “capabilities”, “architectural decisions”, and “managerial actions”.

Organizational capabilities may enable co-evolution, including capabilities for customization and standardization of IT to create and appropriate value in co-evolutionary processes (Ahuja/Chan 2016). In the context of cross-border organizational integration, mechanisms for the co-evolution of capabilities with the organizational structure are depicted by Ambos et al. (2009), including an integration action plan, the introduction of routines for alignment and standardization, and the development of a knowledge broker for bidirectional knowledge transfer.

Positive feedback is also operationalized by architectural decisions on the platforms in ecosystems (Koza/Lewin 1999). In software platforms, the decisions on platform openness, architectural decomposition, and modularity are the central levers alongside governance and decision rights mechanisms, which shape their co-evolutionary growth dynamics (Tiwana et al. 2010). For the co-evolution of SMEs and their respective ecosystems and environments, Dehbokry and Chew (2015) suggest a reference architecture that incorporates different views covering strategy, capabilities, and knowledge alongside contingencies with other institutions and the macro environment.

Another mechanism to strengthen the co-evolution are managerial actions, including exclusive agreements for the members in the ecosystem, which are legally governing the collaboration and co-evolution of the organizations (Amarilli et al. 2017). Holgersson et al. (2018) find that in the context of an intellectual property strategy, mechanisms for supporting co-evolution are among others the coordination of networks through working groups, cross-licensing agreements for technology accessibility across organizational boundaries and technical standardization as a governance tool (Vidgen/Wang 2009).

5.4.5 Path and History Dependencies

The circumstances and conditions in which co-evolutionary processes occur are determined by unexpected events with uncertain outcomes (van den Ende et al. 2012). Addressing these conditions in a co-evolutionary environment need to follow path and history dependencies (Montealegre et al. 2014). Circumstances that causes or helps to cause co-evolution conditions can be both exogenous and endogenous to the industry, the individual organizations, and the ecosystem (Koza/Lewin 1999). Following this, decisions regarding a path dependent course will influence future actions, strategies, and objectives (Ambos et al. 2009) to comply with changes in the ecosystem (Grant 2012).

The changes in circumstances over time create a history dependency, which is shaped by the changing conditions along the evolutionary path and the actions and decisions to address them (Vessey/Ward 2013), i.e., ‘legacy’. Because of individual history and path dependencies between the co-evolving organizations, they develop own individual capabilities to differentiate along historical evolution paths (Tanriverdi et al. 2010). Lin et al. (2010) postulates, that the co-evolution between two networks include general environmental shifts and endogenous communications to build inter-dependencies and mutual transformation. These path dependencies can also be influenced through an already existing community, with inter-organization collaborations influenced by organization’s previous capabilities (Rai/Tang 2014), or networks that shape the choice and path (Murray 2002). Specific path dependencies can develop over time a beneficial outcome the organization, and ecosystem (Ambos et al. 2009), supplemented by organizational socio-technical capabilities (Lewin/Long 1999; Dehbokry/Chew 2015). However, organizations with no legacy like start-ups may conduct co-evolution as ‘greenfield’ approach.

5.4.6 Technology

Montealegre et al. (2014) describe technology as an external and internal force, which influences the decision making within the business ecosystem or environment. Extending this notion, we found three configurations for technology in co-evolution: disregarded, support, and enabler.

In some articles, technology is not detectable as a driver for co-evolution and is disregarded in co-evolution processes (e.g., Djelic/Ainamo 1999). As an example of a supportive role of technology, Hukal (2017) argues that the introduction of new technologies can act as a proxy for co-evolution. Technology can also help to mobile the transformation of customers in the ecosystem (Hua et al. 2017). Digital platform technologies can also support to transform end-users to value-co-creators (Skog et al. 2018b).

Um and Yoo (2016) introduce our last property of technology as an "enabler" force, with the characteristic of forming a shift by not restraining the use of existing technologies but to enhance the use over different fields by promoting the construction of novel growth pattern in a focal platform system. As also shown by Janze (2017), blockchain technology enabled the co-evolution of darknet platforms through the usage of cryptocurrencies.

<table>
<tr><th>Property</th><th colspan="20">Configuration</th></tr>
<tr><td rowspan="4">Multilevel effects</td><td colspan="20">Intra-organizational levels</td></tr>
<tr><td colspan="4">Business process</td><td colspan="4">Structure</td><td colspan="4">Leadership</td><td colspan="4">Culture</td><td colspan="4">Business model</td></tr>
<tr><td colspan="20">Inter-organizational levels</td></tr>
<tr><td colspan="5">Partners</td><td colspan="5">Customers</td><td colspan="5">Regulatory environment</td><td colspan="5">other industries</td></tr>
</table>

<table>
<tr><td>Multi-directional causality</td><td colspan="6">Cooperation</td><td colspan="6">Competition</td></tr>
<tr><td>Nonlinearity</td><td colspan="3">Diffusion</td><td colspan="3">Hierarchical</td><td colspan="3">Network</td><td colspan="3">Big bang</td></tr>
<tr><td>Mechanism for positive feedback</td><td colspan="4">Capabilities</td><td colspan="4">Architectural decisions</td><td colspan="4">Managerial activities</td></tr>
<tr><td>Path and history dependency</td><td colspan="6">Greenfield</td><td colspan="6">Legacy</td></tr>
<tr><td>Technology</td><td colspan="4">Disregarded</td><td colspan="4">Support</td><td colspan="4">Enabler</td></tr>
</table>

Table 14. Properties and Configurations of Co-evolution in Business Ecosystems

5.5 Discussion and Future Research

Through the review of IS, management, and organization science literature on co-evolution in ecosystems, our work provides a structured overview of the field in a transdisciplinary manner. Second, we develop a framework for co-evolution in business ecosystems based on the six properties of Montealegre et al. (2014) consisting of the properties: multilevel effects, multidirectional causality, nonlinearity, mechanisms of positive feedback, path, and history dependencies. Further, we extend Montealegre et al. (2014) by the property technology, and identified 23 configurations for the properties. Second, based on our discussion of the properties and configurations of co-evolution, we provide avenues for future research.

This study is subject to limitations. First, the identified articles are limited to our search terms and the selected articles. Second, this work is limited by the coding of the articles to the respective co-evolution properties and configuration. To mitigate this limitation, three experienced raters coded the articles independently. We ensured that a broad amount of co-evolution articles is included by opening up the search towards conference articles.

Based on this study, four theoretical contributions have come to light. First, the findings of our structured literature review toward the identified configurations show that co-evolution materializes in different ways in business ecosystems. Therefore, the study enlarges the excellent ligature review on co-evolution of Lewin and Volberda (1999) and Montealegre (2014). Second, we fuse insights from IS, management, and organization science literature and build on the proposition of Jacobides (2018) to contribute toward a theory of understanding how ecosystems transform, by suggesting the notion of co-evolution to examine this phenomenon. Third, our findings show that co-evolution in business ecosystems is dependent on new properties, particularly evident due to the emerging role of technology. Fourth, we show that co-evolution is a suitable lens to examine digital transformation from an inter-organizational perspective.

Further, this study provides two practical contributions. First, we invite practitioners and scholars to apply the identified configurations for the properties of co-evolution when talking about digital transformation in business ecosystems. In particular, we provide 23 configurations for the six properties on co-evolution. Second, managers can obtain insights about what is new for co-evolution in business ecosystems in respect of digital transformations. For example, co-evolution in business ecosystems is driven through enabling digital technologies, which are the core of digital platforms.

Based on our discussion of the findings, we suggest five avenues for future research. First, as we coded existing literature on co-evolution in business ecosystems, we were surprised by the limited occurrence of platforms, particularly as digital platforms lie at the center of the value creation of platform ecosystems. Hence, we suggest to use co-evolution theory to examine platform ecosystems. Second, regarding technologies that enable co-evolution, we suggest to analyze the role of boundary resources, such as APIs (Um/Yoo 2016; Eaton et al. 2015). Um and Yoo (2016) understand APIs as the key role in managing the tension between control and generativity of a platform. We suggest to study the effect of changing APIs over time on the business model of complementors or service offerings in platform ecosystems. Co-evolution may be also helpful to determine the effect of API changes on value capture or value co-creation. Third, regarding multi-directional causality in platform ecosystems, there is a gap in how cooperation or competition in platforms ecosystems can be enabled. In this context, competition via different platform ecosystems, such as Google's Android vs. Apple's iOS could be examined. Fourth, the nonlinearity configurations of diffusion, hierarchy, network, or big bang can be used to design longitudinal studies to examine the actual process of co-evolution. Further, we suggest that to detect co-evolution mechanisms for positive feedback in platform ecosystems. As such, scholars could shed light on co-evolution mechanisms for platform owners to enable the co-evolution of complementary partners. Mechanisms complementors can use to manage the evolution of platforms could be also evaluated.

6 Digital Transformation in the Automotive Industry: Towards a Generic Value Network (P3)

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Publication	25th European Conference on Information Systems (ECIS)
Status	Accepted
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Discussion, Reporting

Table 15. Fact Sheet Publication P3

Abstract

The emergence of digital innovations is accelerating and intervening existing business models by delivering opportunities for new services. Drawing on the automotive industry, leading trends like self-driving cars, connectivity, and car sharing are creating new business models. These are simultaneously giving rise for innovative market entrants, which begin to transform the automotive industry. However, literature does not provide a generic value network of the automotive industry, including new market players. The paper aims to visualize the current automotive ecosystem by evolving a generic value network using the e³-value method. We define different roles, which are operating in the automotive industry by analyzing 650 companies re-ported in the Crunchbase database and present the value streams within the ecosystem. To validate the proposed generic value network, we conducted five preliminary interviews with experts from the automotive industry. Our results show the central role of mobility service platforms, emerging disruptive technology providers, and the dissemination of industries, e.g., as OEMs collaborate with mobile payment providers. Scholars in this field can apply the developed generic value network for further research, while car manufacturers may apply the model to position themselves in their market and to identify possible disruptive actors or potential business opportunities.

6.1 Motivation

New technologies accelerate digital innovations, which fundamentally transform the daily lives of consumers, companies, and the structure of entire ecosystems (Fichman et al. 2014). Today, the digital transformation is even changing the value creation of industries where value is generated exclusively through physical materiality (Yoo et al. 2010), most visible in the automotive industry. Recent digital innovations like self-driving cars, connectivity, big data, and social networks are fundamentally revolutionizing the automotive industry (Simonji-Elias et al. 2014; Gao et al. 2016; Wijnen 2013; Hanelt et al. 2015b). Companies need to be aware of these technologies' disruptive character and adjust their business models to deal with new actors in the ecosystem (Möller et al. 2011; Letiche et al. 2008; Perrott 2008).

With the emergence of these technologies, platforms and innovative digital services are offered by a plethora of new market entrants, like Tesla, Uber, or ZipCar which threaten the established ecosystem of the automotive industry (Gao et al. 2016). Uber, for instance, which represents the most popular P2P ride-sharing platform and was already in 2015 valuated higher than 80 % of the S&P 500 organizations, including General Motors and Ford Motor Company (Verhage 2015). Due to the rising number of new market entrants, original equipment manufacturers (OEMs) are no more alone in the market and have to align their strategies to compete with these new market entrants, which provide customer-centric mobility for their customers and substantially intervene the current value network (Berman/Bell 2011; Gao et al. 2016; Matt et al. 2015). Digital transformation strategies are important, because they "reflect the pervasiveness of changes induced by digital technologies throughout an organization" (Chanias/Hess 2016). Hence, organizations have to change traditional business models, which have been robust for many decades and transform their organizations to adapt these trends, e.g., car sharing platforms, or new telematics services (Fitzgerald et al. 2013; Lucas et al. 2013).

Currently, OEMs are heavily investing in adapting to these trends. Hence, a business model disruption in the automotive industry is somewhat likely within the next five years (Simonji-Elias et al. 2014). However, it remains unclear which technologies will prevail, leading to tensions in the automotive industry, as OEMs do not want to give up their leadership in product and technology (Simonji-Elias et al. 2014).

However, the transformative impact on industrial-age physical products, especially of the automotive industry, has remained unnoticed in the Information System literature for years (Yoo et al. 2010). Some research has been conducted in the last two years. For instance, Hanelt et al. (2015b) identified four business model change types: business model extension, revision, termination, and creation, in the automotive industry. Building on these insights, Remané et al. (2016b) detect 27 business model types that were implemented by startups from the mobility sector in the last ten years. However, research is still missing a holistic analysis of the current and ongoing transformation of the automotive industry (Hanelt et al. 2015b), as existing studies solely focus on organizations' business models. Therefore, we analyze the digital transformation of the automotive industry from the holistic perspective of its value network. The central advantage of the representation as a value network compared to a business model canvas is to analyze the value streams between all actors in the network. As a first step towards this goal, and to trigger further research, this paper aims to answer the following research questions: *Which generic roles exist and emerge in the value network of the automotive industry? How does the generic value network of the automotive industry look like?* Therefore, we aim towards a generic e^3-value network model based on 15 generic roles we derived from analyzing 650 companies extracted from Crunchbase, a comprehensive database for existing companies and startups.

The remainder of this paper is structured as follows. First, we analyze the underlying literature of digital innovations in the automotive industry, which have been conducted in this field of research. Second, we describe our methodology. As third, the generic roles and the generic value network is presented. Afterward, we discuss the results and briefly present the implications and outlook.

6.2 Related Work

Service-dominant logic (S-D Logic) suggests servitization is one of the key trends in an increasing digitized and interconnected world (Lusch/Nambisan 2015; Vargo/Lusch 2004). The theory implies that services are generated in service ecosystems (actor-to-actor networks), which represent the central theme of S-D Logic. In service ecosystems, value is no longer created by one actor but increasingly created through co-creation (Lusch/Nambisan 2015). Therefore, it is crucial to understand the underlying value network of ecosystems.

6.2.1 From Value Chains to Value Networks

Service ecosystems have their roots in the literature of value chains. The value chain concept was used for the last decades to understand and analyze industries (Stabell/Fjeldstad 1998). The most established value chain approach is presented by Porter (1985). Traditionally, in the manufacturing industry, value chains are used for visualizing the chained linkage of physical activities (Porter 1985). The value chain method is applied to analyze competitors and new market entrants (Peppard/Rylander 2006; Böhm et al. 2010). On account of that, Porter created an extended value chain, namely a value system, which includes the value chains of the firm, of the suppliers, the customers and the end customer, which create interdependencies between the actors of the value system. Value systems are crucial for firms, as by optimization or coordination of the linkages between the actors a firm can create competitive advantage (Connolly/Matarazzo 2009). But, in a globalized and dynamic world, the explanatory behavior of value chains is limited. Thus, a more complex method is required, which led to value networks (Biem/Caswell 2008). According to Peppard/Rylander (2006), a value network is a “set of relatively autonomous units that can be managed independently, but operate together in a framework of common principles and service level agreements (SLAs)”. Each actor contributes an incremental value to the network (Bovet/Martha 2000) but concentrates only on their core competencies (Stabell/Fjeldstad 1998). Due to the increased connected economy and connected inter-organizational relationships, a value network is an adequate method to visualize inter-organizational exchanges and relationships (Biem/Caswell 2008). The value network presents functions and activities, which are performed simultaneously. The advantage of a value network is an adequate display of cooperation relationships and alliances. Due to the rising complexity of firm relationships, evoked by digitalization, industries can no longer be classified as suppliers, customers and competitors (Böhm et al. 2010; Peppard/Rylander 2006; Biem/Caswell 2008; Pil/Holweg 2006). Today, digitalization is changing value networks and affecting physical products. Therefore, the value network concept is now used for service oriented and non-physical industries (Peppard/Rylander 2006). Due to digitalization, the digital and physical world are merging (Hanelt et al. 2015b). Particularly relevant for this paper, we use the holistic value network approach because the most popular digital innovations and changes can be currently observed in the automotive industry (Berman/Bell 2011; Gao et al. 2016).

6.2.2 Digital Transformation in the Automotive Industry

For the automotive industry, the literature focused on different aspects of the digital transformation, starting from an overview of the different business model changes types (Hanelt et al. 2015b) for specific transformation strategies. Hanelt et al. (2015b) combine the phenomena of the digital and physical world and explore the impact of digital trends on the business model of the automotive industry. Their findings show four different business model change types: extension, revision, termination, and creation. Examples for business model extension are interactive elements with customers, e.g., through social media. Business model revision is required through self-driving cars, which reflects a combination of physical and digital components. Termination of business models may occur through virtualization, e.g., virtual showrooms for sales distribution may terminate the business of car dealers. Finally, business model creation can be achieved through new driver services and new data services. Investigating the strategy for digital transformation, Chanias/Hess (2016) examined existing challenges of the digital transformation in the automotive industry. Therefore, they conducted a case study for the formation of strategies due to digital transformation according to the activity-based process model (Chanias/Hess 2016). Their findings show, digital transformation primarily begins through a multitude of organizational activities from a bottom-up perspective, even before top management initiated a holistic strategy. (Hildebrandt et al. 2015) found that digital technology-related merger and acquisitions (M&As) have a positive impact on digital business model innovations. OEMs have to acquire external knowledge by M&As to capture the potential of digital innovations (Henfridsson/Lind 2014). The emerging digital ecosystem, an OEM is surrounded by, is a "key success factor of IT-enabled business models" (Hildebrandt et al. 2015). Their results show, that openness towards external market players and knowledge will support the digital innovations (Hildebrandt et al. 2015). According to the theory of disruptive innovations, digital innovations increase business performance and result in better user experience (Keller/Hüsig 2009). As external knowledge plays therefore an important role, it is crucial to analyze the entire ecosystem of the automotive industry. Piccinini et al. (2015a) conducted a Delphi study with industry experts to grasp the emerging challenges which come in line with the digital transformation of the physical automotive industry. For digital ecosystems, among these are: competing with an expanding range of new rivals and non-industry rivals and entrants; building complementary partnerships among different ecosystem players (business and IT) to design new business models; bridging gaps between previously separated business units and ecosystem players to create new digital value; improving information flows and exchange between business ecosystem partners to enable a seamless customer experience (Piccinini et al. 2015a). Drawing on organizational ambidexterity, they show organizations need to simultaneously exploit current resources while exploring promising capabilities (Gregory et al. 2015). Most recently, Remané et al. (2016b) analyzed the business models of emerging and current startups in the mobility sector. They used Crunchbase data to classify startups by business model types, according to Weill et al. (2005). They identified 27 different business model types and organized them in four clusters: creator, distributor, landlord, and a broker. However, research is missing a detailed actor-to-actor analysis of the current and ongoing transformation of the automotive industry (Hanelt et al. 2015b), as existing studies solely focus on organizations' business models. Thus, we analyze the digital transformation of the automotive industry from the holistic perspective of its value network. To achieve this, we aim to identify generic roles and the value streams between them.

6.3 Research Approach

We conducted a three-step research approach. First, we identified the roles and values streams between them. Second, we visualized the generic value network based on the identified roles and value streams. Third, we validated the model with preliminary semi-structured expert interviews.

For the first step, we decided to use CrunchBase data in order to derive the roles in the value network. Crunchbase possesses a comprehensive database for existing companies and startups (Marra et al. 2015), including a description of organizations' value propositions. Crunchbase contains startups at all funding stages, which enables researchers to capture new business model innovations in emerging markets (Marra et al. 2015; Perotti/Yu 2015). We extracted all organizations listed on October 20, 2016. To collect all organizations of the automotive industry as well as related technologies, we filtered the Crunchbase category list by the search term "automotive", which led to a sample size of 728 funded companies, which includes 77 initial public offerings (IPOs). This led us to capture established and emerging organizations, which are representative of the current automotive industry. We excluded 15 companies, which have been "closed" so far, for example, WhipCar, a London-based car-sharing service.

Furthermore, we had to exclude three organizations from our coding, as the listed website did not exist anymore. Screening the data, we found companies, which had no relationship to the automotive industry, e.g., Eni, an energy company that engages in oil and natural gas exploration. Hence, we shortened the data set by 60 companies. With the remaining 650 organizations, we conducted in a first step a structured content analysis, including an inductive category development based on Mayring (2010b) and Miles/Huberman (1994). With this method, we identified a set of 15 generic roles. We established intercoder reliability to ensure consistent coding. Two experienced raters independently coded the 650 organizations. Before the raters started coding the organizations from Crunchbase, both raters coded several organizations to become familiar with the coding scheme and then compared their coding for calibration purposes. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached a consensus; this helped to eliminate individual disparities (Bullock/Tubbs 1990). For example, we coded Vroom based on its description "Vroom is an online direct car retailer that makes car-buying and -selling fast and easy" as a car dealer. We used the same approach for the identification of the value streams, but combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles, or annual reports. For example, we coded the value streams between OEMs and tier suppliers as exchange of technology (hardware and software) and money based on the quote "Continental's five largest OEM customers (Daimler, Fiat-Chrysler, Ford, General Motors, and VW) generated approximately 43% of the Continental Corporation's sales in 2016" in Continental's recent annual report (Continental AG 2016). After both raters completed the coding, we used Krippendorff's (2004) Alpha to determine intercoder reliability. The results indicated an Alpha of 0.87, reflecting acceptable intercoder reliability (Krippendorff 2004).

In the second step, we use the e³-value method to visualize the value network of the automotive industry based on the identified generic roles and the value streams between the generic roles.

The e³-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective. It is used to evaluate the economic sustainability of value networks by modeling the exchange of things of economic value between actors (Gordijn/Akkermans 2003).

In the third step, we conducted five preliminary interviews with experts from the automotive industry to validate the generic value network. We used a semi-structured technique (Myers/Newman 2007) to interview two CEOs of value-added partners, a CEO of an OEM's technology subgroup, a department manager of another OEM, and a senior consultant with a major in IS applications for the automotive industry. Each of the experts has a minimum of ten years' experience in the automotive industry and new digital technologies. The interviewees are either working in a leading strategic position or information technology related function (Goldberg et al. 2016b), who have privileged access to information and knowledge on the subject (Bogner et al. 2009b). This allowed drawing from a broad knowledge of long-time market experience and different customer insights from various companies. We conducted the interviews between December and March 2017. The interviews were recorded, and transcribed afterward took 41 minutes on average. To validate the generic roles and value streams, we discussed the roles and value streams of the proposed generic value network with the experts.

6.4 Towards a Generic Value Network for the Automotive Industry

Due to digital innovations, the automotive industry is transforming and is giving rise to a set of new market players in the resulting value network. Following the approach of Böhm et al. (2010), we abstract the definition of market players and actors, which offer similar services and products to customers, and define generic roles based on the structured content analysis of the Crunchbase data of 650 organizations, see Table 16.

Role	**Description**	**Example(s)**
OEM	The original equipment manufacturer (OEM) produces cars. We assume an OEM manufactures traditional combustion engines as well as electro vehicles (EV). The value proposition of OEMs can include direct sales, R&D, manufacturing, after sales, and services (Kang et al. 2009).	Ferrari, Tesla, Cadillac, BMW, Daimler, Bolt Motorbikes
Consumer	Consumers request mobility, which can be fulfilled in many forms like driving their own car, lending, or sharing a car as well as using public transportation or a specific mobility service like Uber. Customers may use products or services before, during, or after transportation. In some contexts, a consumer is a *Prosumer*, by simultaneously using and creating a service. An example is sharing personal data via smartphone with Google Maps while using the aggregated real-time traffic information of other users for navigation. Consumers can pay for services with money, data, or a combination of both.	
Tier 1-3 Supplier	The traditional automotive industry is characterized by a one-sided supplier-buyer relation (Turnbull et al. 1992). Vehicle manufacturers rely heavily on *first-tier* suppliers, which approximately supply 85 percent of the parts. First tier supplier may offer product development,	Bosch, Continental, Faurecia, China Automotive

	design and technology, and many depend on subcontractors, namely *second-tier* suppliers. These, in turn, can depend on *third-tier* contractors, which, e.g., supply press, cutting, welding, forging, or casting work.	Systems, Hyundai Mobis, ABC Group
Public Transportation Provider	This role represents the traditional public transportation, including underground station, busses, city bikes, and trains (Hoffmann et al. 2016).	New York MTA, citibike
Car Rental Provider	A car rental provider offers different models for renting a car (Moeller/Wittkowski 2010).	Sixt, Hertz
Car (parts) Dealer	Apart from directly purchasing from OEMs, consumers can purchase from car (or car parts) dealers. Cars and spare parts can also be sold via online platforms of the respective dealers (Applegate 2001).	LUEG, Amazon (Fiat), carparts.com
Disruptive Technology Provider	Disruptive technology providers offer disruptive innovations to OEMs in the form of software and hardware, such as sensors for assisted driving. Following Christensen (1997), disruptive technologies may be inferior to established technologies in the beginning. However, disruptive technologies move up market relentlessly, leading to the elimination or replacement of established technologies (Christensen 1997).	Savari, Intel, Mobileye,
Mobility Service Platform	We distinguish between different mobility service platforms, such as private or commercial car sharing, P2P-Lending, or service platforms from OEMs (Lee et al. 2016). Mobility services can be accessed and distributed via these platforms, e.g., Uber provides the platform that allows drivers to provide their mobility service to registered users.	Uber, VRide, DriveNow, Tesloop, Taxify, Car2Go
Mobility Service Aggregator	This role aggregates different mobility services, including public transport services and car sharing platforms, which may also imply intermodal mobility services (Plummer/Kenney 2009).	Moovel, Flare
Intelligent Infrastructure Provider	This role represents the connection between physical and digital infrastructure. Due to connectivity and new technologies, e.g., sensors and electric vehicles, the infrastructure, e.g., including traffic signs or parking lots, can be connected to cars and consumers. Electric vehicle charging stations is such an intelligent infrastructure. Providers allow accessing if they are currently used or free, for example.	ChargeNow, CarCharging, Chargerlink
Cloud Infrastructure Provider	A cloud infrastructure provider (IaaS), consists of a shared pool of Internet-based configurable computing resources (e.g., servers, storage, applications, and services), which can be rapidly provisioned and released with minimal management effort (Youseff et al. 2008).	Amazon Elastic Compute Cloud (Amazon EC2)

Cloud Platform Provider	The cloud platform provider (PaaS) offers a digital marketplace of various cloud infrastructure services. The key objective is to connect customers and service providers. The former can search for suitable value-added services, telematics service, and in-car apps while the value-added provider can advertise its services. The platform is built on underlying cloud infrastructure (Youseff et al. 2008).	Google Cloud Platform, Microsoft Azure
Value Added Service Provider	Value added services can be accessed before, during, or after transportation. Two types of value-added service providers (SaaS) exist. First are telematics services, or technical information about the vehicle, safety features or intelligent driver assistance software. Second are services, which offer complex digital services to the customer, e.g., entertainment, security, location-based information services, or concierge services. These services can be access via cloud platforms (Youseff et al. 2008).	Spotify, Data Crossover, Autolinked, ParkNow, OnStar, BMW Connected Drive
Car Service Provider	Car services include all traditional services, such as maintenance, insurance, or stationary services like car wash (Remané et al. 2016b).	Washtec
E-Payment Provider	Provision of payments, which also work for mobile devices or cars.	MercedesPay

Table 16. Generic Roles of the Actors in the Value Network of the Automotive Industry

As our roles are on a more abstract level than business models, one role can refer to different business model types. Further, one company can act in different roles by offering different services to other players.

We compared our identified roles with the business model types of Remané et al. (2016b) and found examples for each business model type in our generic roles. For example, we aggregated the business model types ‘digital service provider’ and ‘sensor-enabled service innovator’ in our generic role value-added service provider due to similar value streams in the value network. Second, we used the e3-value method to propose a generic value network of the automotive industry, see Figure 6. It depicts the identified roles and the value streams between them, we validated through five preliminary expert interviews.

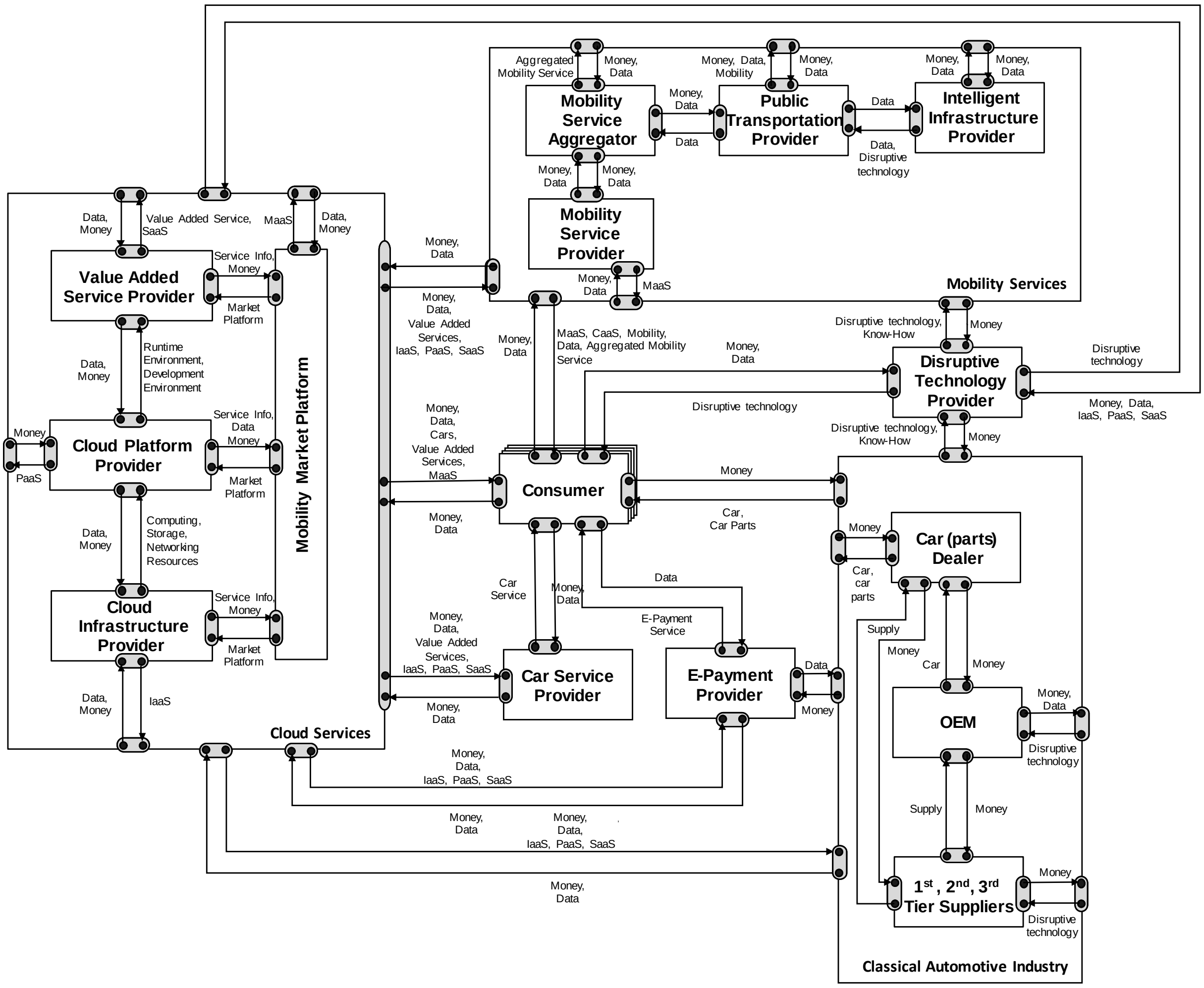

Figure 6. Proposed Generic Value Network for the Automotive Industry

Roles create value within the value network by providing data, services, and physical products (car, rental car, spare parts, and technology). By drawing on publicly accessible information on the companies' websites, we identified the following value streams regarding services: car as a service (CaaS), software as a service (SaaS) and mobility as a service (MaaS).

Further, we integrated the cloud computing perspective of Böhm et al. (2010), by accounting for the platform as a Service (PaaS), infrastructure as a Service (IaaS). Further, the service layer of cloud computing was framed as value-added services here, e.g., BMW Connected Drive. Naturally, products and services are exchanged in favor of money or data. The center of the value network is the consumer, who demands a MaaS, CaaS, SaaS, or buys or rents a physical product (car, rental car, spare parts).

The generic value network shows that the automotive industry transformed into a multi-sided value network, and thus moves away from the traditional one-sided supplier-buyer business model. Thus, we can confirm the conclusion of Remané et al. (2016b) that new roles are emerging, for example, mobility service platforms, or intelligent infrastructure providers. Based on the findings of the proposed model, emerging roles threaten the value creation of OEMs from two sides. On the one hand, the generic value network shows the automotive industry is being intervened through mobility service platforms, like Uber, which directly offer mobility services to the customers. Therefore, OEMs may gradually lose the customer touchpoint. On the other hand, trends like self-driving cars force OEMs to cooperate with emerging players.

This is represented by the central role of disruptive technology providers between OEMs and mobility services, e.g., Mobileye and Intel, in the case of BMW. Therefore, OEMs have to be open to new market entrants and need to gain external knowledge to foster innovation (Hildebrandt et al. 2015). This is particularly helpful in order to enhance the user experience (Keller/Hüsig 2009). The generic value network also highlights the creation of new data-driven roles due to digital innovations, e.g., as intelligent infrastructure providers share real-time traffic information with self-driving cars. Finally, the expert interviews showed the increasing diffusion of mobility services through digital technology as one expert suggested to incorporate the role e-payment providers in the value network. For example, Daimler acquired an electronic payment provider for mobile payments which is now implemented as 'MercedesPay' for mobility services, such as Car2Go or as a virtual wallet for customers' smartphones (Daimler AG 2017).

6.5 Conclusion and Outlook

This paper presents a generic value network for the automotive industry based on 15 generic roles identified by a structured content analysis of the Crunchbase data of 650 automotive organizations. Preliminary findings are that digital transformation creates new roles for value creation in the automotive industry. The value network shows that mobility service platforms and disruptive technology providers penetrate the market and therefor, threaten the value creation of OEMs from two sides simultaneously.

The model is limited by the information provided by the Crunchbase database and our coding of the generic roles. Drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles, or annual reports. Further, we conducted five preliminary semi-structured interviews with experts from the automotive industry to validate the proposed generic value network based on the identified roles and value streams. However, a deeper analysis of the value streams should be conducted, which also relies on quantitative information, such as the Crunchbase database.

Scholars can apply the developed generic value network for further research, particularly for understanding digital transformation. Practitioners, e.g., OEMs, can apply the model to identify potential threats to their current market position and potential opportunities to adapt to trends or shifts in customer needs. As an example, innovative OEMs introduced car-sharing platforms early, like BMW with Drive Now, or more recently, Mercedes acquired a mobile payment provider to enhance their digital portfolio (Daimler AG 2017). Hence, companies can use the generic value network to analyze their position in the automotive industry and their linkages to competitors or partners. However, according to Böhm et al. (2010), it is not necessarily important to know, which generic role might take the largest share within the value network, but to develop a unique value proposition based on core competencies.

Due to its novelty, future research should investigate the intelligent infrastructure provider and monitor roles, reflecting them in practice to potentially extend the generic value network. Moreover, a complete case study of the transformation of an OEM would be particularly helpful to understand the full extent of digital transformation.

7 The Generic Ecosystem and Innovation Patterns of the Digital Transformation in the Financial Industry (P4)

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Table 17. Fact Sheet Publication P4

Abstract

The emergence of financial technology companies (Fintechs) through easy access to digital technologies is transforming the entire financial industry, heralding a new era of business models. With digital technologies like mobile payments, robot advisors, and distributed ledgers or blockchain, Fintechs are challenging the prevailing position of traditional financial institutions. However, literature does not provide a structured overview of the digital transformation in the financial industry, including inter-organizational innovation patterns. By analyzing 792 Fintechs, this paper visualizes the 22 generic roles and value streams within the financial ecosystem using the e3-value method. Moreover, we identify and discuss seven inter-organizational innovation patterns of the digital transformation in the financial industry. We contribute to the literature by examining digital transformation in the financial industry from an inter-organizational perspective. Practitioners may apply the model to position themselves and to identify disruptive actors or potential business opportunities. We also analyze the influence of blockchain technology.

7.1 Introduction

When asked why he launched Alipay in 2004, Jack Ma, the founder and chairperson of Alibaba replied "*at that time, I went to a bank, and the bank said 'we can't do that [online] (...)'. So I decided to do it and threw everything into it*" (Custer 2015). In 2016, Alipay had more than 450 million of the 1 billion internet users registered and already accounted for 52% of the Chinese online payments, which represents more than $ 2,500 billion in transaction volume (Meeker 2017; Statista 2018).

The case of Alipay in the Chinese market shows that pure technology companies are continuously penetrating the business model of traditional financial institutions. One reason is that the market for digital technologies is easily accessible and constantly innovating. Digital technologies, like, e.g., mobile payments, robot-advisors, crowdfunding or -sourcing, or blockchain (Cearley et al. 2017), are some of the main drivers in the financial industry.

Digital platforms that have the capacity to combine and deploy innovative technologies create new business models that fundamentally transform the way business is done (Lucas/Goh 2009; Tiwana 2015). We refer to this organizational transformation as digital transformation following Fitzgerald et al. (2013). Digital transformation is defined as "the use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements (such as enhancing customer experience, streamlining operations or creating new business models)" (Fitzgerald et al. 2013, p. 2). The transformative influence on industrial-age products has remained unnoticed in the Information Systems literature for years (Yoo et al. 2010). However, due to the easy access and the decreasing cost of innovative digital technologies, many startups are challenging the value creation of established organizations.

In the financial industry, these startups are referred to as Fintechs, which is essentially a combination of "finance" and "technology" (Zavolokina et al. 2016). Fintechs use innovative digital technology to create novel financial products or services that either improve existing processes or create new business models, such as robot-advisors or cryptocurrencies (Zavolokina et al. 2016). According to Puschmann (2017), Fintechs reflect the IT-induced transformation of the financial industry. Central advantages of Fintechs are cost efficiency, flexibility, speed, and scalability (Deutsche Bank AG 2014). However, Fintechs either change or improve established processes, products, or services, or create competition or eventually disrupt established business models (Zavolokina et al. 2016; Puschmann 2017).

Due to the rising number of new market entrants, traditional financial institutions such as banks are no more alone in the market. Hence, established organizations have to align their strategies to compete with these new market entrants, which provide customer-centric financial services for their customers (Matt et al. 2015; Puschmann 2017; Riasanow et al. 2018c). Currently, traditional financial institutions invest heavily into Fintechs (Puschmann 2017). Yet, existing studies solely focus on the business model of Fintechs or the transformation of the business model of established financial institutions (Puschmann 2017). However, following Puschmann (2017), literature does not provide an inter-organizational and macro-economic overview of the current and ongoing transformation of the financial industry, particularly through Fintechs. Further, innovation patterns of the digital transformation through Fintechs are particularly missing (Puschmann 2017). Towards this goal, and to trigger further research, this paper aims to answer the following research question: *What is the generic ecosystem of the digital transformation in the financial industry and which inter-organizational innovation patterns can be observed?* Therefore, we first use qualitative content analysis of Mayring (2010b) and

Miles/Huberman (1994) to identify 22 generic roles we derived from analyzing 792 companies. We extracted the company data from the Crunchbase database, a comprehensive, socially curated database for established companies and startups. Further, we use the e^3-value method to develop a generic ecosystem of the digital transformation in the financial industry, including Fintechs based on these 22 roles. Following Puschmann (2017), we discuss seven inter-organizational innovation patterns to structure the digital transformation in the financial industry, such as the elimination of intermediaries.

The paper is organized as follows. First, based on digital transformation literature, we analyze related background on the digital transformation in the financial industry through Fintechs. Second, we describe our methodology. As third, the 22 generic roles and the generic ecosystem are presented. Further, we suggest seven innovation patterns of the digital transformation in the financial industry. Next, we discuss the results, implications, and future research. The final section is the conclusion.

7.2 Digital Transformation in the Financial Industry through Fintechs

Digital transformation is currently one of those topics practitioners and researchers hardly can avoid when talking about IS or business strategy making. Digital transformation is an industry level phenomenon (see, for example da Silva Freitas et al. 2016; Downes/Nunes 2013a) which changes the way organizations within and across industries compete. Therefore, digital transformations “affect large parts of companies and even go beyond their borders, by impacting products, business processes, sales channels, and supply chains” (Matt et al. 2015, p. 339).

Following Horlacher et al. (2016), inherent to digital transformation is the development of technology-enabled business models that are new to the organization that has initiated the transformation. This is particularly relevant for the financial industry, as a magnitude of emerging technology-enabled players penetrate the market (Puschmann 2017). These organizations, so-called Fintechs, use innovative digital technology to create novel financial services or products that either improve existing processes or create new business models, such as robot-advisors (Zavolokina et al. 2016). According to Deutsche Bank AG (2014), central advantages of Fintechs are cost efficiency, flexibility, speed, and scalability. The changing role of IT, changing customer behavior, changing ecosystems, and changing regulation are the main drivers for the success of Fintechs (Puschmann 2017).

Moreover, digital transformation means changing the way value is delivered to customers (Piccinini et al. 2015a), which is also observable in the financial industry. Hence, Fintechs revolutionize the financial industry in several ways. They may improve established processes, products, or services, create competition through innovative products or services, or eventually disrupt established business models (Zavolokina et al. 2016; Puschmann 2017). To be successful, the evolution of a company’s business model needs to be complemented by a co-evolution on the customer side (Riasanow et al. 2017). In particular, Haffke et al. (2016), p. 2) emphasize the effects on “sales and communication channels, which provide novel ways to interact and engage with customers” and a “firm’s offerings (products and services)”, which replace or augment physical offerings. Drawing on the software industry, Apple’s App Store shows DT is not just affecting the organization with its internal value creation processes. Apple heavily invested in resources (e.g., the software development kit for iOS) that helped the organization to establish an ecosystem of connected developers and customers. Today the magnitude of applications is created by external companies or independent developers (Eaton et al. 2015).

Recognizing this interdependence, researchers have analyzed digital transformation with an intra-organizational perspective (see, for example Bley et al. 2016; Haffke et al. 2016; Piccinini et al. 2015a; Matt et al. 2015). However, research is missing a detailed inter-organizational, macroeconomic analysis of the current and ongoing digital transformation in the financial industry (Puschmann 2017) as existing studies solely focus on organizations' business models. Thus, we analyze the digital transformation in the financial industry from the holistic perspective of its ecosystem.

7.3 Research Approach

We conducted a five-step research approach based on Riasanow et al. (2017). To develop the generic ecosystem of the financial industry, we first identified the roles of the actors in the industry and the value streams between them. Second, we presented the generic ecosystem based on the prior identified roles and value streams. Third, we validated the model with four semi-structured expert interviews. Afterward, we identified innovation patterns of the digital transformation in the financial industry using qualitative content analysis.

For the first step, we decided to use CrunchBase data[3] in order to derive the roles in the ecosystem. Crunchbase possesses a comprehensive database for existing companies and startups (Marra et al. 2015), including a description of organizations' value propositions. Crunchbase contains startups at all funding stages, which enables researchers to capture business model innovations in emerging markets (Marra et al. 2015; Perotti/Yu 2015).

We extracted all organizations listed on October 02, 2017. To collect all organizations of the financial industry as well as related technologies, we filtered the Crunchbase category list by the search term "fintech", which led to a sample size of 1000 European funded companies. This led us to capture established and emerging organizations, which are representative of the current financial industry. We excluded eleven companies, which have been "closed" so far, for example, Kiria, a Berlin-based mobile financial assistant. Furthermore, we had to exclude three organizations from our coding, as the listed website did not exist anymore. Screening the data, we found companies, which had no relationship to the financial industry, e.g., DigitalMR, a company that uses artificial intelligence for customer insights. Hence, we shortened the data set by further 247 companies.

With the remaining 742 organizations, we conducted in a first step a structured content analysis, including an inductive category development based on Mayring (2010b) and Miles/Huberman (1994). With this method, we identified a set of 22 generic roles. We established intercoder reliability to ensure consistent coding. Two experienced raters independently coded the 742 organizations. Further, to prevent restriction to the European market, we randomly extracted 50 further non-European organizations from Crunchbase and coded them accordingly, leading to 792 organizations in total. However, we could not derive new roles from this additional data set. This implies our data sample is a comprehensive representation of the international financial industry.

[3] The Crunchbase database is accessible via www.crunchbase.com. We used a premium account for data collection.

Before the raters started coding the organizations from Crunchbase, both raters coded several organizations to become familiar with the coding scheme and then compared their coding for calibration purposes. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached a consensus; this helped to eliminate individual disparities (Bullock/Tubbs 1990). For example, we coded Klarna as "alternative payment solution" based on its description *"Klarna provides e-commerce payment solutions for merchants and shoppers"*. We used the same approach for the identification of the value streams but combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles, or annual reports. For example, we coded the value streams between "loans" and "customers" as exchange of money (payment and fees) and loans or leasing based on the quote "*RateSetter is a P2P lending website allowing users to lend and borrow money directly with each other according to their own interest rates*" (RateSetter 2018). After both raters completed the coding, we used Krippendorff's (2004) Alpha to determine intercoder reliability. The results indicated an Alpha of 0.85, reflecting acceptable intercoder reliability (Krippendorff 2004).

In the second step, we use the e³-value method to visualize the ecosystem of the financial industry based on the identified generic roles and the value streams between the generic roles. The e³-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective. It is used to evaluate the economic sustainability of the ecosystem by modeling the exchange of things of economic value between actors (Gordijn/Akkermans 2003). Further, we compared the prior generic ecosystem to the generic ecosystem, including Fintechs.

In the third step, drawing on qualitative content analysis following Mayring (2010b) and Miles/Huberman (1994), we derive inter-organizational innovation patterns of the digital transformation in the financial industry. Therefore, we analyzed emerging roles that either corporate or compete with existing roles in the ecosystem.

Fourth, we conducted four interviews with experts from the financial industry or the founders of Fintechs to validate the generic ecosystem. We used a semi-structured technique (Myers/Newman 2007) to interview a venture fund representative, a senior analyst at a major German investment bank, and two founders of European Fintechs. Each of the experts has substantial experience in the financial industry and new digital technologies. The interviewees are either working in a leading strategic position or information technology related function (Goldberg et al. 2016b), who have privileged access to information and knowledge on the subject (Bogner et al. 2009b). We conducted the interviews between January and February 2018. The interviews were recorded and transcribed afterward. Each interview took 41 minutes on average. To validate the generic roles, value streams and innovation patterns, we discussed the roles and value streams of the proposed generic ecosystem with the experts.

Fifth, we draw on Puschmann (2017) to identify the inter-organizational innovation patterns. We derive the innovation patterns by comparing the traditional ecosystem with the digitally transformed ecosystem due to Fintechs.

7.4 The Generic Ecosystem of the Financial Industry including Fintechs

Due to the emergence of innovative digital technologies, the financial industry is transforming. This is particularly due to new market entrants like Fintechs. To model the ecosystem of the financial industry, we follow the approach of Riasanow et al. (2017).

Hence, we first derive the roles of the actors in the ecosystem by drawing on data from 792 companies derived from the CrunchBase database. Actors, which offer similar services and products to the customer are abstracted to one role based on a structured content analysis following Mayring (2010b). As our roles are on a more abstract level than business models, one role can refer to different business model types. Further, one company can act in different roles by offering different services to other players. In Table 18, we first present the generic roles of the traditional actors in the financial industry.

Role	**Description**	**Example(s)**
Consumer	The consumer requests, among other applications, financial services for business or private use. In some cases, the consumer is a prosumer through simultaneously using and creating a service. This is particularly the case for crowdsourced services, where users may simultaneously provide and use the service. Consumers pay for services with money, data, or cryptocurrency.	
Savings Accounts	A savings account is a deposit account that pays interest but cannot be used directly as a payment solution in the narrow sense of a medium of exchange. Sometimes customers can compare different plans among several European partner banks. The service is often completely digital and may be activated through a digital identity provider (Ho 2017).	Wells Fargo Saving Accounts
Loans	A loan is a debt provided to another entity at an interest rate and evidenced by a promissory note, which specifies, among other things, the principal amount of money borrowed, the interest rate the lender is charging, and date of repayment. A loan entails the reallocation of the subject asset(s) for a period of time, between the lender and the borrower. Fintechs in this segment, in cooperation with a partner bank, extend credit to customers without recourse to the crowd. They offer innovative factoring solutions, such as selling claims online or offering factoring solutions without a minimum requirement. Companies with this role automate many of their processes, thereby enabling cost-effective, fast, and efficient services (Dorfleitner et al. 2017).	Fannie Mae, Schwäbisch Hall, Monetise, Finanzarel, Capitalise,
Fraud Detection	Fraud detection targets to protect customer and enterprise information, assets, accounts, and transactions through analysis of activities by users and other defined entities. It uses background server-based processes that examine users' and other defined entities' access and behavior patterns and typically compares this information to a profile of what's expected. Fraud detection is not intrusive to a user unless the user's activity is suspect (Phua et al. 2010; Griffin 2012).	Featurespace, Fraugster
Risk Management	Risk Management providers use big data analyses to offer more personalized products and services, e.g., to reduce currency risk in institutional portfolios (Puschmann 2017).	Risklab, Riskopy
Stock Market	A stock market portal offers customers a central access platform to all cash market services concerning listing, trading, and clearing (Hull 2009).	NASDAQ, XETRA

Portfolio Management / Robo-advice	Portfolio management systems and robot-advisors provide algorithm-based and largely automated investment advice (European Supervisory Authorities 2015). These providers are generally based on passive investing and diversification strategies (Sironi 2016). They consider investor's risk tolerance, the preferred duration of the investment, as well as other goals (Fein 2015). We distinguish between "automated investment advice" in which a one-off investment recommendation is given, and "automated financial portfolio management," which is characterized by ongoing recommendations (BaFin 2018). Since these two services often overlap, they are conflated in this paper.	Blackrock iShares ETFs, Easyfolio, Scalable Capital
Personal Financial Management	Personal financial management (PFM) includes Fintechs that offer private financial planning, administration, and presentation of financial data, using digital services. PFMs are typically connected to other financial institutions, using APIs. In many PFM systems, manual entry of the account data is still required (Nienaber 2016; Glushko et al. 1999).	Bean
Money Transfer	Companies that offer e-wallets are money transfer services. An e-wallet is a system in which both digital currencies (not cryptocurrencies) and payment information for various payment systems are stored. The payment information can be used during an online payment process without re-entering it. This enables very fast and user-friendly transactions (Mallat 2007). Other solutions offer peer-to-peer transactions. The money is transferred online and thus faster than via traditional financial institutions (Merritt 2010).	TransferWise, Western Union
Regulatory Authority	Regulatory authorities supervise the solvency of banks, insurers, and financial service providers. Their market supervision facilitates fair and transparent market conditions and protects consumers. The tasks of regulatory authorities include preventing money laundering, terrorist financing (Dewispelaere 2017).	Securities and Exchange Commission (SEC)

Table 18. Generic Roles of the Traditional Actors in the Financial Industry

Second, we propose the generic ecosystem of the traditional financial industry, see Figure 7.

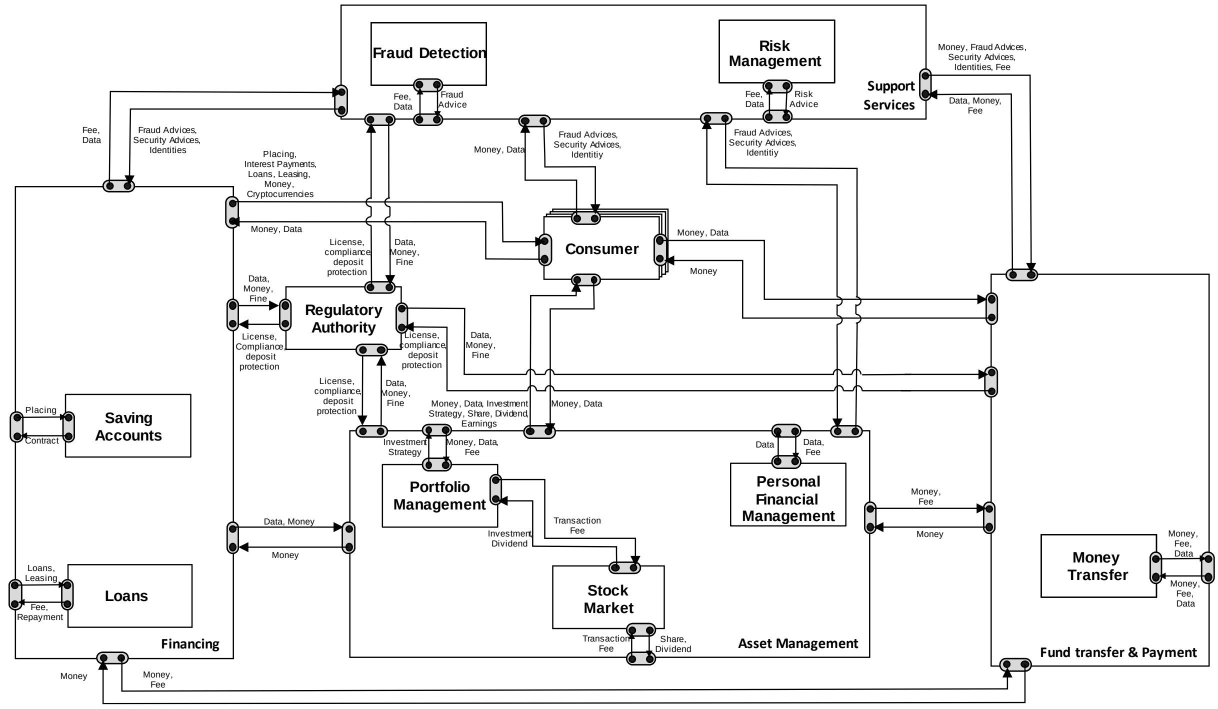

Figure 7. Generic Ecosystem of the traditional Financial Industry

Drawing on the e³-value method, it depicts the identified roles and the value streams between them. As our roles are on a more abstract level than business models, one role can refer to different business model types. Further, one company can act in different roles by offering different services to other players. Following Dorfleitner et al. (2017), products and services in the financial industry can be divided into three categories: financing, asset management, and payment.

Third, we show the generic roles of the actors emerging actors that are exclusively based on Fintechs in Table 19. Further, following the generic ecosystem for cloud computing, we included the four roles of Böhm et al. (2010): cloud infrastructure provider, cloud platform provider, cloud application provider, and cloud market platform.

Role	**Description**	**Example(s)**
Crowd-funding	Crowdfunding involves an open call for the provision of financial resources either in the form of donations or in exchange for the future product or some form of reward to support initiatives for specific purposes and achieve a common goal (Klöhn/Hornuf 2012). Crowdfunding platforms enable the matchmaking between potential complementors (Belleflamme et al. 2014).	Kickstarter, IndieGoGo
Crowd-lending	Crowdlending describes platforms that enable customers to secure loans from the crowd. In return for the provision of the loan, lenders receive a predetermined interest (Bradford 2012).	LendingClub, Auxmoney
Cryptocurrency wallet	Cryptocurrency wallets are platforms, which are accessible from the web or mobile devices and store containers for private keys, usually implemented as structured files or simple databases. Cryptocurrency wallets contain only the keys, not cryptocurrency coins. The coins are	Coyno, MyEther-Wallet

	stored on the blockchain in the form of transaction-outputs. Wallets are key-chains containing pairs of private/public keys. Users sign transactions with the keys, thereby proving they own the coins (Mougayar 2016; EvryLabs 2015).	
Digital Identity Provider	Digital identity providers offer identity on-demand services to verify individuals for financial services digitally. Besides verification, identity and access management are managed, with all identity information collected in one access point, in addition to electronic signatures and certificates. It aims to prove who you are, online and in person (Puschmann 2017).	Yoti, AimBrain, OneVisage
Cryptocurrency exchange	Cryptocurrency exchange provider are digital platforms, which are accessible from the web or mobile devices. The purpose of an exchange platform is to transact cryptocurrency securely, through a clean, intuitive user-interface. Banks are not required to serve as intermediaries for the transaction. Core features are a built-in security center that helps the user to secure his account, backup funds and prevent unauthorized access, as well as the provision of partnerships with trusted exchanges. This facilitates buying and selling cryptocurrencies from the platform. The user pays a transaction fee each time cryptocurrency moves in or out of the wallet. The amount of the fee is based on the size of the transaction and the level of network activity at the time (Schlatt et al. 2016; EvryLabs 2015).	Coinbase, Kraken, Bitfinex
Multi Banking-Aggregator	Aggregators imply the administration and presentation of financial data using digital services. Aggregators enable customers to visualize multiple assets they have deposited with different financial institutions in one user interface. It often requires a one-off or annual fee from users. Examples for multi banking-aggregators are remote deposit capturing apps for mobile phones which allow users to optimize their payment processes by simply photographing a bill instead of typing the data into their online banking system (Nienaber 2016; Glushko et al. 1999).	Feelix, finq, Just Spent
Social Trading	Social trading is a form of investment in which consumer (or follower) observe, discuss, and copy the investment strategies or portfolios of other members of a social network (Liu et al. 2014). Individuals benefit from the collective wisdom of a large number of traders. Consumers can be charged for spreads, order costs, or percentages of the amount invested (Pentland 2013).	Wikifolio, etoro
Alternative Payment Solution	“Alternative payment solutions” is an umbrella role that applies to Fintechs whose applications and services concern payment and mobile payment transactions. The term “mobile payment” generally encompasses various functionalities that are handled via mobile phones (Mallat 2007). The payments often include the use of mobile devices, such as smartphones.	PayPal, ApplePay, AliPay

Cloud Market Platform	This role represents a marketplace where cloud services of different providers are offered. The main objective of the market platform is to bring customers and service providers together. The former can search for suitable cloud computing services, while the latter can advertise its services (Böhm et al. 2010).	Univention AppCenter
Cloud Infrastructure Provider	A cloud infrastructure provider consists of a shared pool of Internet-based configurable computing resources (e.g., servers, storage, applications, and services), which can be rapidly provisioned and released with minimal management effort (Youseff et al. 2008).	Amazon Elastic Compute Cloud (EC2)
Cloud Platform Provider	The cloud platform provider offers an environment to develop, run, and test applications. From a technical perspective, an operating environment, APIs, programming languages are provided. Developers are shielded from technical, infrastructure related details. Programs are executed over datacenters, not concerning developers with matters of resource allocation (Böhm et al. 2010).	SAP Cloud Platform, Microsoft Azure Cloud Platform
Cloud Application Provider	The cloud application provider hosts and operates applications, in contrast to the traditional software model, in an own or outsourced datacenter. Cloud applications are accessible for customers via the internet. The application provider has to ensure a smooth operation of the applications, including monitoring, asset/resource management, and failure/problem management (Böhm et al. 2010).	Salesforce CRM, Dropbox

Table 19. Generic Roles of the Emerging Actors due to Fintechs in the Financial Industry

Third, we used the e^3-value method to develop a generic ecosystem of the digital transformation in the financial industry, including Fintechs. It extends the ecosystem in Figure 8 by the Fintechs, we found by drawing on the identified generic roles for Fintechs.

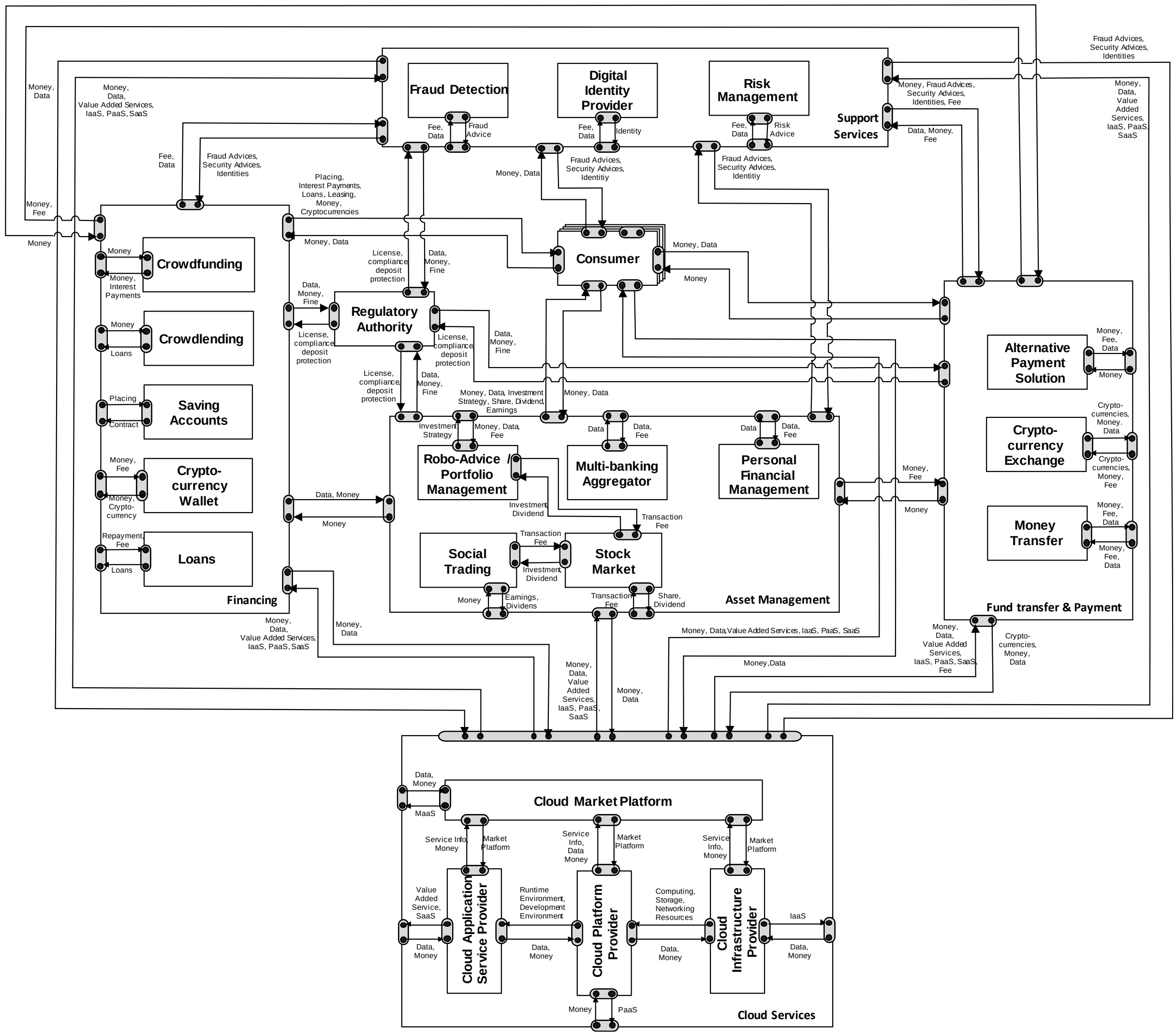

Figure 8. Generic Ecosystem of the Financial Industry including Fintechs

7.5 Innovation Patterns of the Digital Transformation in the Financial Industry

Based on the analysis of the digital transformation in the generic ecosystem, e.g., compare both figures, we identified seven innovation patterns of the digital transformation in the financial industry. These innovation patterns are inter-organizational, as they affect the relationship of at least two roles in the proposed generic ecosystem of the financial industry.

The first innovation pattern is the **elimination of intermediaries**. In this pattern, Fintechs are ruling out products or services of traditional financial institutions. One example is PayPal, where customers send or receive money without the necessity of traditional saving accounts. Another example can be found in the case of crowdlending. In the traditional financial industry, customers only had the chance to get loans from banks if they fulfilled the requirements of the bank. Crowdlending eliminates the necessity of a bank for the distribution of loans. Crowdfunding is the practice of funding a project or venture by raising many small amounts of money from a large number of people, typically online (Belleflamme et al. 2014). Crowdfunding is a form of crowdsourcing and alternative finance. Crowdfunding has been used to fund a wide range of for-profit entrepreneurial ventures such as artistic and creative projects, medical expenses, travel, or community-oriented social entrepreneurship projects (Barnett 2015).

The second innovation pattern, **enhance transparency**, refers primarily to the generic roles in the security segment. There, the generic roles fraud detection, digital identity provider, and risk management are intended to generate transparency in payments, asset management, and financing. The pure online bank Starling Bank built a mobile platform to increase transparency. Their service "gives their customers the ability to instantly check their spending habits, apply overdraft controls directly from their app, and eliminate all fees when traveling abroad" (Biermann 2017).

Most of the emerging roles in the financial ecosystem follow the third innovation pattern **cloud-based services**. These services are built on a modular cloud infrastructure that enables quick scalability and, therefore, eliminates the boundaries of traditional financial products or services that are bound to the capacities of the financial institution. Here, the scalability is bound to the computing power of the cloud infrastructure provider (Youseff et al. 2008). However, Fintechs, like TransferWise, are increasingly building on established cloud infrastructure providers, such as Amazon Web Services (Biermann 2017).

Service aggregation is the fourth innovation pattern in the financial industry. There, the service provider aggregates a plethora of services and makes it accessible in one solution. The Moscow-based Advisa App with its "mobile portfolio management which covers all your banks in one app, it also converts all banking SMS and text notifications into single push inbox" (Advisa.ru 2018) is a typical example for this innovation pattern.

Fifth innovation pattern is **service integration**. This innovation pattern emerges particularly due to the roles of robot advisors or cryptocurrency exchanges. Robo advisors, such as Munich-based Scalable Capital, Germany's leading online asset manager that administers more than € 600 million of customer funds, integrate a multitude of external services. There, customers may invest in various securities, ranging from government or corporate bonds, passively managed exchange-traded funds (ETFs), or commodities to real estate trusts. The different securities are integrated from a multitude of service providers, such as Blackrock's iShares ETFs or services from ING-DiBa (Scalable Capital 2018). Hence, portfolio managers, stock market, or saving accounts provide external services.

As the sixth innovation pattern of the digital transformation in the financial industry, we identified **prosumption**. In some cases, a consumer simultaneously uses and creates a service, we refer to as prosumption. We borrowed this term from the software industry, e.g., when a user is sharing personal data via smartphone with Google Maps while using the aggregated real-time traffic information of other users for navigation (Riasanow et al. 2017). In the financial industry, one may participate in crowdfunding rounds, such as Lending Club. Due to the participation, the network increases, which makes it easier to lend funds in the future. We observe the same innovation pattern in the case of blockchain. In case of minable cryptocurrencies, an increase in the number of nodes in the network simultaneously increases the value of the cryptocurrency, which allows the miner to participate indirectly from the value increase of the mined tokens (Tapscott/Tapscott 2016).

The seventh innovation pattern of the digital transformation in the financial industry is the creation of a **parallel universe**. This is particular the case for blockchain technology. Based on blockchain, more than 1,500 cryptocurrencies like Bitcoin, Ethereum, Ripple, IOTA, Monero, or Litecoin emerged (Coinmarketcap.com 2018). It is therefore hardly surprising that the technology, known above all as the basis of the cryptocurrency Bitcoin (Nakamoto 2008), has the potential to change entire sectors of the economy like the financial industry. Most of the products are services that can be substituted or replaced through automated programmable contracts (smart contracts) are executed without human intervention or any intermediary (Tapscott/Tapscott 2016). Historically, cryptocurrencies as a means of payment were the first application of blockchain technology. It was attributed to the potential to fundamentally transform the financial industry. For example, through the elimination of intermediaries (e.g., clearing houses in securities trading), as well as the speed of transaction, transactions can be carried out more efficiently (EvryLabs 2015). Some startups try to use the potential of the technology to improve the efficiency of existing processes; others propagate a "new economy" without intermediaries in the financial system, such as central banks, e.g., based on the cryptocurrency bitcoin. But, a large number of financial institutions already experiment with blockchain applications for securities trading, lending, or contracts (Schlatt et al. 2016). For example, in the case of securities trading, a limit order could be executed automatically upon reaching the limit, and immediately the securities exchanged for money through the blockchain. Currently, the transfer of securities takes between two and five days (Havard Business Review 2017).

7.6 Discussion

Based on this work, five theoretical contributions arise. First, based on our analysis of 792 companies, we contribute to the literature on Fintechs, as existing studies solely focus on the business model of Fintechs or the transformation of the business model of established financial institutions (Puschmann 2017). Second, by developing the generic, inter-organizational, e^3-value model of the financial industry, including Fintechs, we provide a macro-economic overview of the current and ongoing transformation of the financial industry. We identified 22 generic roles for traditional and emerging players in the financial industry. Third, this study shows that digital transformation is more than an intra-organizational phenomenon as it affects the whole ecosystem. Thus, we extend Fitzgerald et al. (2013), who understand digital transformation primarily as an intra-organizational phenomenon. Fourth, based on the comparison of the traditional actors and the emerging Fintechs, we identified seven inter-organizational innovation patters. These patterns that drive the digital transformation in the financial industry through Fintechs were particularly missing (Puschmann 2017). Fifth, we confirm the generic cloud computing ecosystem of Böhm et al. (2010) by showing that most of the innovation in the financial industry is driven by cloud-based services.

Six practical contributions arise. First, decision-makers, e.g., from traditional financial institutions, can apply the model to identify potential threats to their current market position, potential opportunities to adapt to trends or shifts in customer needs. Second, we show that additional layers of services emerge, such as the recombination of financial services in the service integrator role, or the intelligent combination of existing services to generate a new service in the service aggregator role. The roles show, typical for digital transformation that the way value is delivered to the customer is changing (Piccinini et al. 2015a). Third, inter-organizational innovation patterns differ in magnitude and effect. The innovation pattern *prosumption* shows that this is also true for the financial industry, as consumers are co-creating value with financial service providers. Fourth, blockchain as disruptive technology may be understood as the most threatening digital technology for traditional financial institutions. In all categories of financial products and services – payment, asset management, and financing – we found blockchain-related Fintechs. Fifth, from an ecosystem perspective, blockchain has the potential to substitute many of the existing products and services, e.g., in the case of payments or financing. However, plenty of traditional financial institutions and regulatory authorities are increasingly experimenting with this innovative technology. Sixth, we see that blockchain is not necessarily a *parallel universe* in this context. Nevertheless, many products and services are under strict regulation due to governmental authorities. Therefore, it remains uncertain how large the impact of blockchain on traditional financial institutions is.

7.7 Limitations and Future Research

Our study is subject to limitations. First, the model is limited by the information provided by the Crunchbase database and our coding of the generic roles. Second, drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles, or annual reports. However, we established intercoder reliability among two independent coders with an Alpha of 0.85. Third, we conducted four semi-structured interviews with experts from the financial industry or Fintech founders to validate the proposed generic ecosystem and the identified innovation patterns.

Following Puschmann (2017), we suggest future research to detect intra-organizational, micro-economic innovation patterns. Second, we would be curious to examine if the identified innovation patters are observable in further industries, such as the automotive industry where the digital transformation is less mature. Third, many Fintechs are offering their services on digital platforms (Zavolokina et al. 2016), however, the success factors for digital platforms in the digital transformation process of the financial industry remain uncovered. Fourth, we invite scholars – not only due to the novelty of the technology – to examine the transformational impact of blockchain in qualitative and quantitative nature.

7.8 Conclusion

This paper presents the generic ecosystem for the financial industry based on 22 generic roles of traditional financial institutions and Fintechs, we identified by a structured content analysis of the Crunchbase data of 792 financial organizations. Digital transformation creates new roles for value creation in the financial industry and thus affects the whole ecosystem. The ecosystem shows that robot advisors, cryptocurrencies, or alternative payment providers penetrate the market and therefore, threaten the value creation of traditional financial institutions. To discuss this, we derived seven inter-organizational patterns of the digital transformation in the financial industry, such as the elimination of intermediaries or the creation of a parallel universe. Our work contributes to Fintech literature and the growing body of knowledge on digital transformation. We encourage traditional financial institutions to actively experiment with innovative technologies or to collaborate with emerging players in the market, just as Jack Ma did by introducing Alipay.

8 The Generic Blockchain Ecosystem and its Strategic Implications (P5)

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Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Discussion, Reporting

Table 20. Fact Sheet Publication P6

Abstract

The emergence of blockchain technology, most known due to the hype around Bitcoin, has the potential to transform entire industries, such as banking, insurance, or the Internet of Things (IoT). Yet, parallel ecosystems like cryptocurrencies that substitute products and services of traditional financial institutions emerged. However, literature does not provide a structured overview of the blockchain ecosystem. By analyzing 479 blockchain companies reported in the Crunchbase database, this paper visualizes the current blockchain ecosystem using the e3-value method consisting of eleven generic roles. Moreover, we identify three strategic implications where blockchain is fundamentally different from prior approaches: governance, trust, and openness. Scholars can apply the generic ecosystem for future research, while practitioners can use the model to identify possible disruptive actors or potential business opportunities.

8.1 Introduction

Blockchain, currently at the top of the Gartner hype cycle (Cearley et al. 2017), follows the blueprint process for a technology hype. Blockchain is known above all as the basis of the cryptocurrency Bitcoin (Nakamoto 2008). As of February 2018, more than 1,500 cryptocurrencies have a market capitalization in excess of $ 400 billion, with Bitcoin accounting for more than $ 150 billion with a more than eightfold rise over the last year (Coinmarketcap.com 2018). Some countries already accept cryptocurrencies as a means of payment. Hence, it is hardly surprising that many believe the technology has the potential to disrupt entire branches of the economy (Tapscott/Tapscott 2016).

While some understand it as technological innovation, some argue blockchain to be the technological basis for a new economy (Swan 2015). Drawing on the recent hype, Vitalik Buterin, founder of Ethereum, states, "whereas most technologies tend to automate workers on the periphery doing menial tasks, blockchains automate away the center. Instead of putting the taxi driver out of a job, blockchain puts Uber out of a job and lets the taxi drivers work with the consumer directly" (Tapscott/Tapscott 2016). Traditional banks, insurances, or the interaction of machines through the Internet of Things (IoT) can be replaced or automated through programmable contracts that are executed without human intervention or middleman, so-called smart contracts (Tapscott/Tapscott 2016; Swan 2015).

The case of cryptocurrency shows that innovative technology is continuously penetrating or substituting the business model of established organizations. One reason is that the market for digital technologies, such as blockchain, is easily accessible and constantly innovating. Organizations that have the capacity to combine and deploy digital technologies create new business models that fundamentally transform the way business is done (Lucas et al. 2013). Yet, existing studies solely focus on the business model of organizations or the transformation of the business model of established financial institutions (Puschmann 2017). To visualize the blockchain ecosystem, blockchain landscapes were developed (e.g., Mougayar 2015). However, none of the landscapes presented their coding process. Consequently, literature does not provide a structured inter-organizational overview of the emerging blockchain ecosystem (Puschmann 2017).

Towards this goal, and to trigger further research, this paper aims to answer the following research questions: *Which generic roles and value exchanges exist in the blockchain ecosystem? How does the generic blockchain ecosystem look like?* Therefore, we first use the e^3-value method to model the blockchain ecosystem based on eleven generic roles we derived from analyzing 479 companies. We extracted the company data from the Crunchbase database, a comprehensive, socially curated database for established companies and startups.

The paper is organized as follows. First, we briefly present related work on blockchain. Second, we describe our research methodology. As third, we identify eleven generic roles and present the blockchain ecosystem. Next, we discuss the results, strategic implications, and future research. The final section is the conclusion.

8.2 Related Work

Due to the early stage of development, no general definition of blockchain technology has been established (Swan 2015). Condos et al. (2016) define a blockchain as an electronic ledger for digital records, events, or transactions managed by the participants of a distributed computer network. Previously, most trade repositories, e.g., for example, lending or sale of securities, were not publicly available. The opening of transaction registers for all interested parties is an important innovation of the blockchain technology so that all previous transactions can be viewed in the system (Harvard Business Review 2017). However, this does not necessarily indicate who carried out the transactions, e.g., in the case of Bitcoin, the users remain anonymous or pseudo-anonymous, since only the identification tag of the digital wallets is required for a transaction.

Furthermore, a blockchain is a distributed system without a central control point or authority (Tapscott/Tapscott 2016; Glaser/Bezzenberger 2015). Central control points or authorities are not necessary for a blockchain because the distributed network verifies the transactions being performed. This is considered a key innovation of blockchain technology (Harvard Business Review 2017). If a transaction between two parties is to be made in the network, the nodes in the distributed network compete to solve a mathematical puzzle and also store that transaction in the trade repository (Nakamoto 2008). A transaction can then no longer be deleted from the trade repository or ever returned. The elimination of a central instance in the distributed network implies a radical shift to direct transactions between non-intermediaries or intermediary services (Tapscott/Tapscott 2016). The data structure of a blockchain corresponds to a database that groups entries into blocks that are linked in chronological order via a cryptographic signature (Walport 2015). The blocks contain a copy of the last transactions since the last block was added (Bogart/Rice 2015). The management system of a blockchain corresponds to a distributed consensus system. Since a blockchain has no central authority, there must always be a consensus among the actors in the system about the valid state of the blockchain. For the verification of the blockchain, different consensus mechanisms can be used, which are based on peer-to-peer mechanisms and encryption (Glaser/Bezzenberger 2015). Blockchain was created as an approach to cryptographic-based payment transactions to provide an alternative mechanism of trust between two transaction parties: Bitcoin (Nakamoto 2008). In classical transactions, the parties have to rely on a trusted third party, such as a bank. In the case of Bitcoin, the necessary trust is now completely substituted by the blockchain, as it allows for a collective trade repository operated by many decentralized registers (Nakamoto 2008). A consensus mechanism based on mathematical functions (in the case of bitcoin: hash functions) coordinates the network nodes and can validate and approve or reject the status of a transaction (Nakamoto 2008).

Frederik Voss, Vice President of Nasdaq, states, “Blockchain is a technology that only works at its full potential in a network. You need to have a complete ecosystem on the blockchain for it to offer maximum value to all its participants” (Nasdaq 2016). However, literature does not provide a structured inter-organizational overview of the emerging blockchain ecosystem (Puschmann 2017). To visualize the blockchain ecosystem, some blockchain landscapes were developed for practitioners (e.g., Mougayar 2015). Mougayar (2015) clustered 268 companies that are involved in crypto-tech computing, decentralized services, or cryptocurrencies into four major categories with over 20 sub-categories. However, category development and the coding process is not published. Thus, we target to following a structured approach to identifying the generic roles in the blockchain ecosystem and the value streams between them.

8.3 Research Approach

We conduct a three-step research approach based on Riasanow et al. (2017). To get an inter-organizational overview, we develop the generic ecosystem of the blockchain industry. We first identify the roles of the actors in the industry and the values streams between them. Second, we present the generic ecosystem based on the prior identified roles and value streams. Third, we validate the model with five semi-structured expert interviews.

For the first step, we decided to use CrunchBase data[4] in order to derive the roles in the ecosystem. Crunchbase possesses a comprehensive database for existing companies and startups (Marra et al. 2015), including a description of organizations' value propositions. Crunchbase contains startups at all funding stages, which enables researchers to capture new business model innovations in emerging markets (Marra et al. 2015; Perotti/Yu 2015). The information reported in the database consists of the company size class, its location, its primary role (firms, group, investor), its status (operating, acquired, IPO, or closed), it's a founding date and the dates on which the record was created and updated.

We extracted all organizations listed on December 11, 2017. To collect all organizations of the blockchain industry, we filtered the Crunchbase category list by the search term "blockchain", which led to a sample size of 500 funded companies. This led us to capture established and emerging organizations, which are representative of the current blockchain industry. We excluded six companies, which have been "closed" or "acquired" so far, for example, KapeIQ, a Blockchain-based intelligent fraud detection service. Furthermore, we had to exclude 15 organizations from our coding, as the listed website did not exist anymore, e.g., DigitalMR, a company that uses artificial intelligence for consumer insights. Hence, we shortened the data set by 21 companies. With the remaining 479 organizations, we conducted in a first step a structured content analysis, including an inductive category development based on Mayring (2010b). With this method, we identified a set of nine generic roles.

We established intercoder reliability to ensure consistent coding. Two experienced raters independently coded the 479 organizations. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached a consensus. For example, we coded Axoni as "blockchain infrastructure provider" based on its description "New York-based provider of distributed-ledger technology for financial firms". We used the same approach for the identification of the value streams, but combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles, or annual reports. After both raters completed the coding, we used Krippendorff's (2004) Alpha to determine intercoder reliability. The results indicated an Alpha of 0.87, reflecting acceptable intercoder reliability (Krippendorff 2004).

In the second step, we use the e³-value method to visualize the ecosystem of the blockchain industry based on the identified generic roles and the value streams between the generic roles. The e³-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective. It is used to evaluate the economic sustainability of ecosystem by modeling the exchange of things of economic value between actors (Gordijn/Akkermans 2003; Riasanow et al. 2017).

In the third step, we conducted five interviews with experts from the financial industry to validate the generic ecosystem. We used a semi-structured technique (Myers/Newman 2007) to interview a COO and co-founder of a blockchain startup, a senior developer of a blockchain startup, two senior managers working in the blockchain lab of one of the big four accounting

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[4] The Crunchbase database is accessible via www.crunchbase.com. We used a premium account for data collection.

firms, and an independent blockchain consultant with a major in IS applications. The interviewees are either working in a leading strategic position or information technology related function, who have privileged access to information and knowledge on the subject (Bogner et al. 2009b). This allowed us to draw from a broad knowledge and different insights from various companies. We conducted the interviews between December and March 2018. The interviews were recorded, and transcribed afterward took 48 minutes on average. To validate the generic roles and value streams, we discussed the roles and value streams of the proposed generic ecosystem with the experts. This step yielded another two generic roles: the blockchain community and the token-based community platform provider, ultimately leading to eleven generic roles.

8.4 Development of the Generic Blockchain Ecosystem

To model the generic blockchain ecosystem, we follow the approach of Riasanow et al. (2017). Hence, we first derive the roles of the actors in the ecosystem by drawing on data from 479 companies derived from the CrunchBase database. Actors, which offer similar services and products to the consumer are abstracted to one role based on the structured content analysis following Mayring (2010b). One company can act in different roles by offering different services to other players. In Table 21, we first present the generic roles of the blockchain ecosystem.

Role	Description	Example(s)
Consumer	The consumer requests on- and off-chain and hybrid applications as well as cloud mining services. In some contexts, a consumer is a *Prosumer*, by simultaneously using and creating a service, as it is the case when running an own node or creating an own token on the Ethereum blockchain. When participating in a token-based community platform, the consumer is a *Participant*, contributing knowledge and content with the intention of being rewarded by the auction mechanism. Since in many cases, a consumer participates through investing in a blockchain or blockchain application, he can also be called an *Investor*. Besides that, consumers benefit from the analyses and statistics offered by ancillary service providers and are part of the public dialogue with blockchain alliances. A consumer pays for value-adding activities with money or cryptocurrency.	
Blockchain Infrastructure Provider	Blockchain infrastructure provider supply users and developers with a set of infrastructure capabilities, including the conceptual framework, the underlying decentralized ledger technology (DLT) and cryptocurrencies (Swan 2015; Mougayar 2016). Corresponding information as permission rules, block sizes, etc. are defined here. They provide the foundational elements for any further blockchain service development or delivery utilized by platform or application providers. Further capabilities of blockchains are the P2P network, consensus algorithms, a virtual machine, historical records, and state balances (Mougayar 2016).	Ethereum, Bitcoin, BigChainDB, MultiChain, Corda, Hyperledger

Blockchain Platform Provider	Platform providers offer a technical basis in the form of software and services that are on top of the infrastructure. They build an environment to develop, run, and test applications and extend the functionality of infrastructure elements (Mougayar 2016). This includes smart contract languages and scripts, testing tools, sandbox environments, integrated development environments, and rapid application development frameworks as well as other software capabilities on higher stack levels than blockchain protocols (Tapscott/Tapscott 2016). Through providing smart contracts with implemented token settings, voting systems as well as auction and reward mechanisms, blockchain platform providers offer the technical basis for token-based community platforms. Cloud-based development environments are offered as Blockchain as a Service (BaaS). Blockchain platform providers allocate APIs, including a transaction scripting language, a P2P nodes communication API, and a client API to check transactions on the network (Mougayar 2016). The software offered by the technical platform provider is compatible with one or more types of blockchains.	Elemetric, Monax, Multichain, Setl.io, Etherparty, Smart Contract Solutions, ShapeShift, ChromaWay, RiddleAndCode, Neuroware, io, Tierion, BlockApps, IBM BlueMix
Blockchain Application Provider	Application providers offer applications that are linked to on-chain and off-chain services and technically differ as follows. On-chain services as identity management, voting, tokenization, messaging, assets linkages, and naming registration are provided by decentralized applications, called dapps (Mougayar 2016). The back-end of dapps is executed on blockchain nodes, whereas the front-end either runs on a third-party-server, a user-owned software or a decentralized storage owner such as Inter-Planetary File Systems. On the other hand, services such as reputation, storage, exchange services, and payments gateways belong to off-chain services, where the value is moved outside of the blockchain. The back-end of such traditional applications is not executed on a blockchain but rather on cloud computing services like Amazon Web Services. Besides offering dapps and off-chain applications, application provider also mix up applications with an existing web application and create a so-called hybrid blockchain application. By taking advantages of the decentralized character of blockchain, those providers create P2P marketplaces for users by developing appropriate applications (Mougayar 2016). Areas of application are diverse and can be found in every existing industry. A large proportion of studied application providers are wallet providers. A wallet stores the access to currency by saving the private keys that demonstrate ownership of a public key, which in turn can be used to access currency addresses. Currently, three distinct categories of wallets are available for storing currency: software-, hardware- or paper-based wallets (Dale 2018). The applications are hosted and operated by the application provider and are built on top of technical platforms and the appropriate blockchain infrastructure (Mougayar 2016). Thus, applications	Databroker DAO, BlockScience, Storj.io, Power Ledger, Crowdz, Propy, OwlTing, Binded, FunFair, Scorum, TAO Network

	represent end-user products, which are accessible via the internet. One of the main duties of the application provider is to ensure a smooth operation of the application through constant monitoring as well as resource and problem management. Accordingly, the service provider must be aware of the state of his system at any time (Böhm et al. 2010).	
Token-Based Community Platform Provider	A token-based community platform is built on internal token distribution reward systems for establishing and evaluating content (Steem 2017). It serves a dual purpose of being a digital token processing systems and a platform having a specific purpose, such as Steemit, a social media platform. Actors on such platforms do not compete over raw computing power, as miners do, but over incentives that in turn add value to the network. An example is Numerai, which proposes Numeraire, a cryptographic token executed on the Ethereum blockchain that can be used in an auction mechanism. As it is the purpose of token-systems, data scientists participating in Numerai projects reveal their knowledge of their models' abilities to generalize to new, unseen data to maximize winnings through the auction mechanism (Craib et al. 2017). Such platforms propose tokens appropriate to the blockchain they are executed on. In the case of Steemit, they are generated at a fixed rate of one block every three seconds. These tokens are represented as smart contracts, which in turn dictate the maximum number of coins mined the rules for distributing tokens and the initiation of sending and destroying tokens. In many cases, they are based on Ethereum's ERC-20 tokens, accompanied by certain built-in "Proof-of-Brain" properties, which is the token rewards algorithm that aligns incentives between application owners and community members. The reward pool is a pool of tokens dedicated to incentivizing content creation. It then distributes these tokens to various participants based on the defined rules.	Numerai, Steemit
Miner / Mining Pool	Miners execute the decentralized computational process of confirming transactions trustfully in public blockchains (BitcoinMining 2018). Thus, they are responsible for adding transaction records to the ledger of past transactions. Miners use special soft- and hardware to solve the given mathematical problem and are issued with the appropriate cryptocurrency of the blockchain they did the mining for as a reward. Since in the case of Bitcoin the difficulty for mining increased, miners started to pool their resources together and share their hashing power while splitting the reward equally according to the number of shares they contributed to solving a block (Blockchain.info 2018). This collaboration is called *Mining Pool*. Nevertheless, whether miners are involved in a blockchain or not depends on the type of blockchain that an application or platform	Antpool, Slush Pool, BTC.top, Bitfury

	is executed on and the appropriate trust and permission layer and consensus algorithm.	
Mining Solution and Equipment Provider	Mining solution providers offer hardware and software that is required for executing the process of mining. This includes equipment sales, maintenance, and repair services. Since normal processors or graphics cards do not withstand the required computing power anymore, miners use special hardware, which computes hashes with application-specific integrated circuits and appears to be noticeably faster (Schulz 2017; Swan 2015). Besides distributing mining hardware, they provide cloud-mining solutions for private individuals who are not interested in physically hosting machines. This service is called Mining as a Service. Another service offered by mining solution providers is consulting in setting up and operating mining farms.	Giga Watt, Canaan, MinersGate Technology, Riot Blockchain, Bitmain Technologies Ltd., Genesis Mining
Blockchain Ancillary Service Provider	Provider of ancillary services for blockchain technology undertake a wide variety of tasks. This is, for example, the provision of assistance before, during and after the launch of a crowd sale, including securing funding and providing acceleration services such as connecting with experts to co-develop white papers or to comply with global regulations and legal and business administration. Ancillary service providers offer monitoring services with appropriate statistics and analysis. Moreover, they publish the latest blockchain and cryptocurrency news and developments, inform and educate people interested in blockchain and offer workshops and training for developers and managers (Mougayar 2015).	Sweetbridge, SettleMint Blockchain Academy, Byte Academy, BTC Media
Blockchain Alliances	Blockchain alliances are founded as associations for boosting the public dialogue between the different participants of the blockchain ecosystem. Those alliances can be collaborations between industry experts to explore the potential of DLT within their industry for the benefit of all stakeholders in the value chain. They try to fulfill the need for education and certification of industry professionals, as well as to solve legal issues, set up standards, and establish a regulatory framework. Alliances bridge the gap between blockchain-focused organizations and national and international governmental agencies and regulatory authorities (WallstreetBlockchainAlliance 2017).	WSBA, Enterprise Ethereum Alliance, Hyperledger, R3, B3i, EWF
Blockchain Community	The blockchain community is a strong and crucial force in driving the blockchain technology further. Consisting of individuals with a great affinity with blockchain (e.g., open source developers or blockchain and crypto professionals), the community discusses whether a new currency, application, crowd sale, etc. are accepted or not. This step is crucial for the breakthrough and establishment of the general market.	Reddit, Slack, Blockchain Community IEEE, CryptoFriends, Commonlounge

Blockchain Consulting Services	When a company decides to leverage blockchain technology within their organization, they often request consulting companies for their expertise in blockchain-centric software, customized blockchain development, or prototyping. Additional services might provide a proof of concept, a cost-benefit and risk evaluation to evaluate the business case, as well as the assessment of security issues regarding the implementation of such a technology. Particularly service providers might make use of consulting services. Infrastructure and mining service provider demand consulting services to solve technical and security problems to evaluate service offerings.	DigitalX, BlockGemini Technology, e-BIT Inc., Blockchain Partners, Deloitte Consulting, Datarella GmbH

Table 21. Generic Roles of the Blockchain Ecosystem

Second, we used the e^3-value method to propose a generic blockchain ecosystem, see Figure 9. It depicts the identified roles and the value streams between them. As our roles are on a more abstract level than business models, one role can refer to different business model types. Further, one company can act in different roles by offering different services to other players.

Drawing on the developed generic ecosystem, we identify three strategic implications in which emerging blockchain companies fundamentally differ from established companies: governance, trust, and openness.

Governance can be characterised by the allocation of decision rights, control, and ownership (Tiwana et al. 2010). In contrast, blockchain allows the creation of decentralized marketplaces that can be governed by a community. This empowers users to directly influence the direction of a project. For instance, the project District0x offers a creation platform that allows its users to design and set up new marketplaces, called districts. As users stake tokens to a project, they gain voting rights. These rights can not only be used to participate in the change of the design and the functionality of a district but also to specify how the generated revenue of a marketplace is used or distributed (Lestan et al. 2017).

Trust lays the foundation of the willingness of users to participate in and execute transactions (Riasanow et al. 2015). With blockchain, a single central authority as trust mediator becomes unnecessary (Tapscott/Tapscott 2016; Beck et al. 2016). As an example, Provenance enables companies to track the paths of products within the supply chain, allowing verification of ownership, attributes, and origin. Thereby, blockchain enables product journeys to be more transparent (Provenance 2018). An integration into the marketplace would allow consumers to avoid plagiarism and parallel imports. Through the integration of external reputation platforms, a global web of trust could be built that is founded on immutable and verified data stored on blockchains. Furthermore, participants with no available reputation data can improve their reputation score by staking tokens into their accounts that serve as additional security deposits in the case of a conflict (Liu/Fraser 2018).

Openness is associated with the degree of accessibility, and it can even involve relinquishing control over a platform (Boudreau 2010). In the context of blockchain organizations, openness is of particular importance, as many of these projects are open source. Today, many organizations grant access to their platforms by providing boundary resources in the form of documented APIs (Eaton et al. 2015). Blockchain goes beyond that. For example, Syscoin makes its core and API-server available as open-source (Wasyluk 2018). As a result, an open ecosystem is established that allows developers to create their frontend applications or even participate in core development.

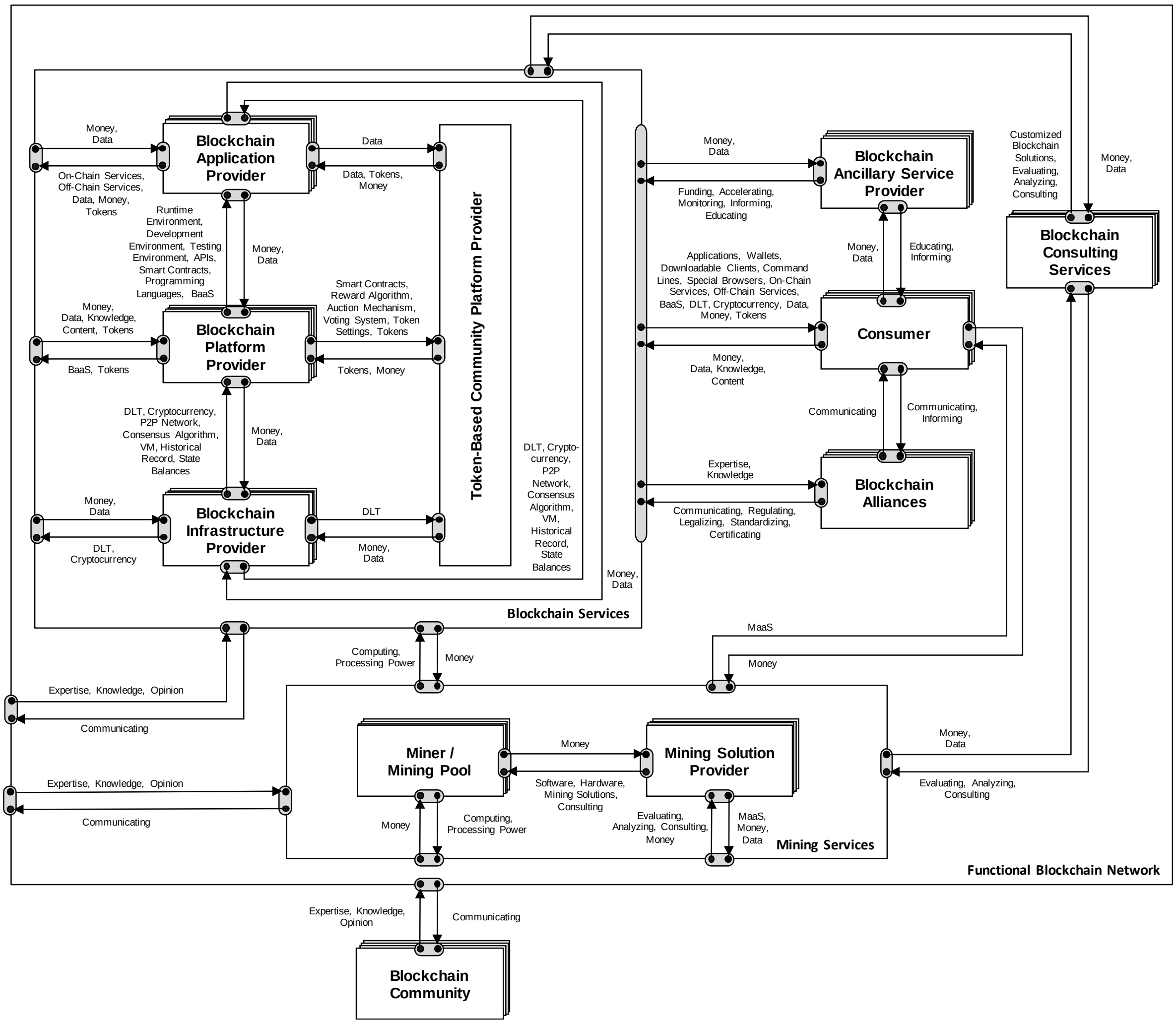

Figure 9. Generic Blockchain Ecosystem

8.6 Discussion

The model is limited by the information provided by the Crunchbase database and our coding of the generic roles. However, we reached an Alpha of 0.87, reflecting acceptable intercoder reliability for the coding of the generic roles. Drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles, or annual reports. Further, we conducted five semi-structured interviews with blockchain experts to validate the proposed generic ecosystem.

Scholars can apply the developed generic ecosystem for further research, particularly for understanding digital transformation in the financial industry. We contribute to literature on blockchain, as existing studies solely focus on the transformation of the business model (Puschmann 2017). By developing the generic, inter-organizational, e^3-value model of the blockchain ecosystem, we provide a macro-economic overview of an ecosystem that seeks to substitute the financial industry. There, we identified eleven generic roles. Based on the ecosystem, we identified three strategic implications in which blockchain fundamentally differs from prior approaches: governance, trust, and openness. On an ecosystem perspective, blockchain has the potential to substitute many of the existing products and services, e.g., in the case of payments or financing. However, plenty of traditional financial institutions and regulatory authorities are increasingly experimenting with this innovative technology.

We suggest future research to determine the impact of blockchain on other ecosystems, such as the IoT. Blockchain could contribute to the interoperability of heterogeneous services and objects, which can be achieved through common standards and a platform (Mattila 2016). The unique identification of things or objects is of central relevance to the IoT. Blockchain-based identity management for items, services, and their transactions could break the concept.

Practitioners, e.g., from financial institutions, can apply the model to identify potential threats to their current market position and potential opportunities to adapt to trends or shifts in consumer needs. According to Böhm et al. (2010), it is not necessarily important to know, which generic role might take the largest share within the ecosystem, but to develop a unique value proposition based on core competencies.

8.7 Conclusion

This paper presents the generic blockchain ecosystem, we identified by a structured content analysis of 479 blockchain organizations. The generic e^3-value model shows the complexity of the blockchain ecosystem, consisting of eleven generic roles. Among them are miners, community roles, and various application providers. However, many of the services are based on the cloud computing ecosystem (Böhm et al. 2010). To discuss three strategic implications in which blockchain differs fundamentally from prior organizations: governance, trust, and openness. Moreover, we encourage organizations to actively experiment with innovative technologies or to collaborate with emerging players in the blockchain ecosystem.

9 The Generic InsurTech Ecosystem and its Strategic Implications for the Digital Transformation of the Insurance Industry (P6)

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Table 22. Fact Sheet Publication P6

Abstract

The emergence of insurance technology companies (InsurTechs) through the easy access to digital technologies is transforming the entire insurance industry and heralding a new era of business models. With digital technologies such as big data analytics, robot advisors, and mobile distribution models or blockchain, InsurTechs are challenging the prevailing position of traditional insurance institutions. However, the literature does not provide a structured overview of digital transformation in the insurance industry, including strategic implications and inter-organizational innovation patterns. By analyzing 956 InsurTechs, this paper visualizes the 34 generic roles and value streams within the insurance ecosystem using the e3-value method. Moreover, through semi-structured interviews with industry experts, we identify and discuss five strategic implications following seven inter-organizational innovation patterns of digital transformation in the insurance industry. We contribute to the literature by examining DT in the insurance industry from an inter-organizational perspective. Practitioners may apply the model to position themselves in a digital insurance ecosystem and to identify disruptive actors or potential business opportunities.

9.1 Motivation

Disruptive technologies are the engine of digital transformation. They transform industries as well as society and government through introducing the digital lifestyle and eliminating well-established business models (Bharadwaj et al. 2013; Fitzgerald et al. 2013). Recent developments and adaptations, like, e.g., mobile payments, robot-advisors, peer-to-peer, or blockchain (Oswald et al. 2018), are some of the most promising drivers in the insurance industry.

The combination of new innovative technologies and the development of new digital platforms fundamentally change the value creation of existing companies and their way how business is executed (Lucas/Goh 2009; Tiwana 2015). The transformative impact on pre-digital products, especially in the insurance industry, has remained unnoticed in the IS literature for years (Yoo et al. 2010). However, companies are forced to overthink and redefine their business models to stay competitive against recently founded startups which act more agile based on their IT-enabled digital business models (Lucas et al. 2013; Venkatraman 1994). In this context, the term InsurTech is often used for start-up companies who deliver innovative or disruptive solutions to the market (Puschmann 2017; Bower/Christensen 1995). Established insurance companies and insurance broker are forced to compete with a rising number of new market entrants, which provide customer-centric solutions for their customers and substantially engage in the current ecosystem (Berman/Bell 2011; Matt et al. 2015; Riasanow et al. 2018b). The industry is facing new trends, e.g., pay on demand insurances, data science for preventive health care or insurance compare platforms, and new market entrants in this changing environment and shaping the DT in the industry (Fitzgerald et al. 2013; Lucas et al. 2013).

However, existing literature does not provide an inter-organizational and strategic overview of the current and ongoing transformation of the industry, particularly through InsurTechs (Puschmann 2017). Further, strategic implications for the industry through InsurTechs are particularly missing (Puschmann 2017). Towards this goal, this paper aims to answer the following overall research question: What is the generic ecosystem of the digital transformation in the insurance industry and which strategic implications can be observed?

Therefore, we follow the research approach of Riasanow et al. (2018b) to identify 34 generic roles we derived from analyzing 956 companies. We extracted the company data from the Crunchbase database, and use the e3-value method to develop a generic ecosystem of the digital transformation in the insurance industry, including InsurTechs based on these 34 roles. Following Riasanow et al. (2018b), we discuss five strategic implications following seven inter-organizational innovation patterns of the digital transformation in the insurance industry, such as the aggregation of intermediaries.

The paper is organized as follows. First, based on digital transformation literature, we analyze related background on the digital transformation in the insurance industry through InsurTechs. Second, we describe our methodology. As third, the 34 generic roles and the generic ecosystem are presented. Further, we provide a framework for five strategic implications following seven innovation patterns of the digital transformation in the insurance industry. Next, we discuss the results, implications, and future research. The final section is the conclusion.

9.2 Digital Transformation in the Insurance Industry and the Role of InsurTechs

DT is currently one of those topics practitioners and researchers hardly can avoid when talking about IS or business strategy making. Digital transformation is an industry level phenomenon (see for example da Silva Freitas et al. 2016; Downes/Nunes 2013a) which changes the way organizations within and across industries compete. Therefore, digital transformation "affect large parts of companies and even go beyond their borders, by impacting products, business processes, sales channels, and supply chains" (Matt et al. 2015).

Following Horlacher et al. (2016), inherent to digital transformation is the development of technology-enabled business models that are new to the organization that has initiated the transformation. This is particularly relevant for the insurance industry, as a magnitude of emerging technology-enabled players penetrate the market (Puschmann 2017; Zavolokina et al. 2016). These organizations, so-called InsurTechs, use innovative digital technology to create novel insurance services or products that either improve existing processes or create new business models, such as robot-advisors (Zavolokina et al. 2016). According to Zeier et al. (2018), the central advantages of InsurTechs are cost efficiency, flexibility, speed, and scalability. The changing role of IT, changing customer behavior, changing ecosystems, and changing regulation are the main drivers for the success of InsurTechs (Puschmann 2017).

Moreover, digital transformation means changing the way value is delivered to customers (Piccinini et al. 2015a), which is also observable in the insurance industry. Hence, InsurTechs revolutionize the insurance industry in several ways. They may improve established processes, products, or services, create competition through innovative products or services, or eventually disrupt established business models (Puschmann 2017). To be successful, the evolution of a company's business model needs to be complemented by a co-evolution on the customer side (Riasanow et al. 2018b). In particular, Haffke et al. (2016) emphasize the effects on "sales and communication channels, which provide novel ways to interact and engage with customers" and a "firm's offerings (products and services)", which replace or augment physical offerings. Recognizing this interdependence, researchers have analyzed DT with an intra-organizational perspective (Bley et al. 2016; Haffke et al. 2016; Matt et al. 2015; Zavolokina et al. 2016). However, research is missing strategic implications for the industry as well as a detailed inter-organizational, macroeconomic analysis of the current and ongoing DT in the insurance industry (Puschmann 2017) as existing studies solely focus on organizations' business models. Thus, we analyze the digital transformation in the insurance industry from the perspective of its ecosystem.

6.3 Research Approach

We conducted a five-step research approach based on Riasanow et al. (2017) and Riasanow et al. (2018b). To develop the generic ecosystem of the insurance industry, we first decided to use CrunchBase data in order to derive the roles in the ecosystem, which possesses a comprehensive database of existing companies and startups (Marra et al. 2015). To collect all organizations of the insurance industry as well as related technologies, we filtered the Crunchbase category list by the search term "InsurTechs" and "FinTechs and Insurance", which led to a sample size of 1424 worldwide funded companies. Screening the data, we found companies, which had no relationship to the insurance industry. Hence, we shortened the data set by further 454 companies. Second, we presented the generic ecosystem based on the prior identified 34 roles and value streams. Third, we validated the model with seven semi-structured expert interviews. Afterward, we identified strategic implications and followed and modified the discovered innovation pattern of Riasanow et al. (2018b) of the digital transformation in the financial industry using qualitative content analysis.

9.4 The Generic Ecosystem of the Financial Industry including InsurTechs

Due to the emergence of innovative digital technologies, the financial industry is transforming. This is particularly due to new market entrants like InsurTechs.

We first derive the roles of the actors in the ecosystem by drawing on data from 956 companies derived from the CrunchBase database. Actors, which offer similar services and products to the customer are abstracted to one role based on a structured content analysis following Mayring (2010b). As our roles are on a more abstract level than business models, one role can refer to different business model types. Further, one company can act in different roles by offering different services to other players. In Table 23, we first present the generic roles of the traditional actors in the financial industry.

Role	**Description**	**Example(s)**
Consumer	The consumer requests, among other applications, insurance services for business or private use. In some cases, the consumer is a prosumer through simultaneously using and creating a service.	Private, business client
Product Development	The product development in insurance companies develops and modifies products for new or changing customer needs. The product development aims to create new products for an optimal customer journey with short development cycles (Gondring 2015).	Allianz, AIG, AXA
Underwriting	Underwriting is the process of a primary insurer or reinsurer to check applications, assess risks, and finalizes them. Underwriting assumes its real significance in business with industrial or general risks and reinsurance (Gondring 2015; Farny 2006).	Allianz, AIG, AXA
Distribution Management	Distribution management translates the strategic goals of the insurance company into sales targets that can be implemented operationally (Gondring 2015).	Allianz, AIG, AXA
Policy Service	The basic function in the insurance administration, which serves only indirectly the actual purpose of the operation, by ensuring the smooth running of operations by looking after client related requests and issues (Gondring 2015).	Allianz, AIG, AXA
Billing & Collection	Insurance companies handling large amounts of money streams and therefore, a large portion of the administration is billing and collection of insurance premiums (Gondring 2015; Farny 2006).	Allianz, AIG, AXA
Claims & Payment	The administration, assessment, and settlement of insurance claims and life insurance refunds are handled by a specified division in every insurance line (Gondring 2015; Farny 2006).	Allianz, AIG, AXA
Asset Management	Asset Management in insurance companies need to assess and predict future cash-flows and adjust the investment strategy accordingly for providing enough Cash-Flow for claim payments and life insurance refunds (Gondring 2015; Romeike/Müller-Reichart 2008).	Allianz Global Investor, AIG-Global Capital, AXA Assets

Global Agent	Global agents coordinate the distribution of multinational clients and provide them with the needed insurance coverages. In the respective markets, these agents have exclusive partnerships with insurance companies, which may differ between the insurance lines and countries (Gondring 2015).	Aeon, Willis Tower Watson
Independent Broker	An insurance broker is anyone who commercially handles the brokerage or conclusion of insurance contracts for the principal without being entrusted by an insurer or an insurance agent.	FondsFinanz, Euroassekuranz
Fraud Detection	Fraud detection targets to protect customer and enterprise information, assets, accounts, and transactions through analysis of activities. Fraud detection is not intrusive to a user unless the user's activity is suspect (Griffin 2012; Phua et al. 2010).	Trulioo, Fraugster
Business Service	Business Services, which are handled by external Service Provider in all aspects of the insurance industry ranging from areas like Consulting, Human Resource Management or Debt Collection Services.	Aeon, Price Waterhouse Cooper (PWC), InkassoDirect
Claims Partner	Policyholders and insurers turn to claims partners as professionals with claims-relevant expertise and on-site capacity to handle claims. Claims partners support the parties in the event of a claim, especially in the process of claims settlement (Gondring 2015).	Cognotekt, MotionsCloud, McLaren
IT-Service Provider	The IT service provider is based on the use of information technology and supports the insurance industry partner's business processes and in digital identity management(Puschmann 2017).	Capgemini, Yoti, AimBrain, OneVisage
Service Insurance	The service insurer relies on personal contact with its customers and a wide branch agent and broker network.	Allianz, AXA, Zurich
Direct Insurance	Direct-Insurance companies offer a comparison and purchase possibility without meeting with agents or brokers. The customer receives advice only via internet chat, e-mail, or telephone hotline.	DirectCar, HUK 24, AllSecur
Reinsurance	Reinsurance is the insurance for insurance corporations. It's the transfer of a part of the risks assumed by a direct insurer to policyholders under insurance contracts or by statutory provisions, or risks to a second insurer, the reinsurer, which is not directly related to the customer (Gondring 2015).	Munich RE, Swiss RE
Regulatory Authority	Regulatory authorities supervise the solvency of insurers and other financial service providers. Their market supervision facilitates fair and transparent market conditions and protects consumers.	SEC, EIOPA, BaFin

Table 23. Generic Roles of the Traditional Insurance Industry

Second, we propose a generic ecosystem of the traditional insurance industry in Figure 10. Drawing on the e3-value method, it depicts the identified roles and the value streams between them.

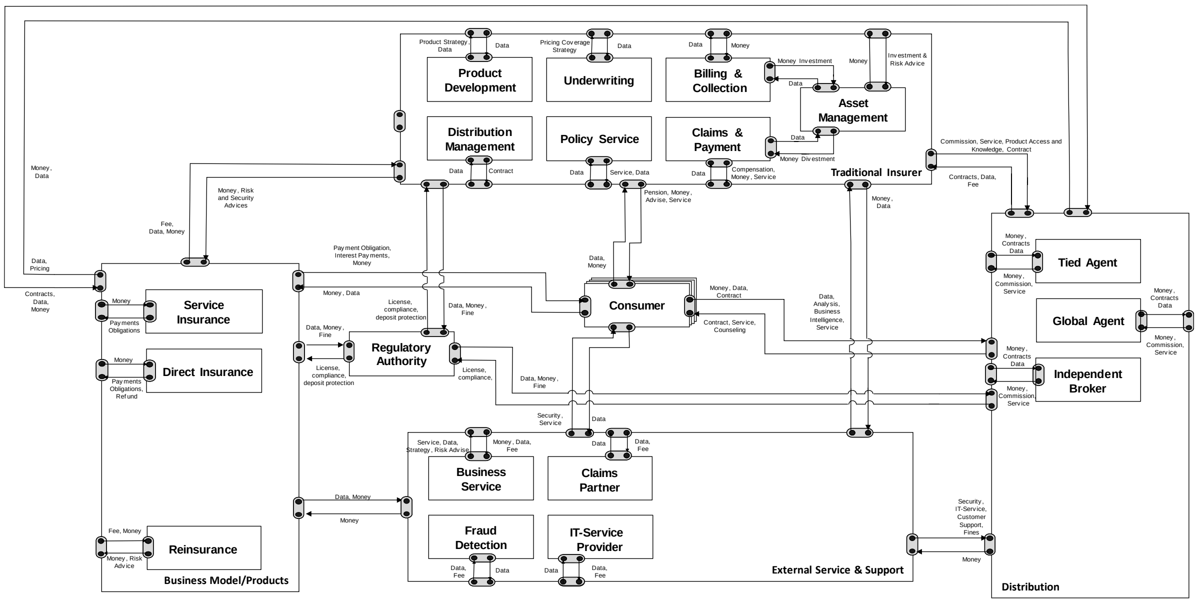

Figure 10. Generic Ecosystem of the Traditional Insurance Industry

Third, we show the generic roles of the actors emerging actors that are exclusively based on InsurTechs in Table 24. Further, following the generic ecosystem for cloud computing, we included the four roles cloud infrastructure provider, cloud platform provider, cloud application provider, and cloud market platform, extracted from Böhm et al. (2010).

Role	Description	Example(s)
Comparison Platform	Comparison Platforms enable customers to form adequate decisions regarding different products and providers.	getinsured, impacthealth, comfortplan.de
Digital Broker/ Robo Adviser	Digital brokers are intermediaries, which are offering insurance brokerage services by incorporating digital technologies like Artificial Intelligence, web-based platforms, or mobile applications.	Knip, Clark
Cross-Seller	Cross-Seller's target the potential of insurances in a digital environment. Focusing on e-commerce solutions for online shops combining the traditional insurance business with the new digital online shopping, with a one-click solution.	Simplesurance, Check24
Big Data Analytics / Predictives	Big Data analytics and Predictives provide services and solutions to risk takers to manage data and take advantage of large data collections for extensive analytics like analyses of target customers, calculate quotes, decrease claims related expenses, fraud detection, frequent risk assessment, and stress-test simulations.	Laptetus, Fraugster, Cognotect
Smart Contract / Blockchain	Blockchain technology is a secure technology is incorporated by InsurTechs in automating processes in claims regulation, payment management, data, and platform handling.	Black, safeshare

Instant Insurance	Instant coverages are products for a selected period, in contrast to conventional insurance products, which provides coverage at any time.	Trōv
Peer-to-Peer Insurance	Peer-to-Peer Insurances supply competitive priced insurance products financed by eliminating moral hazard and profit margins through reinsurance contracts.	Friendsurance, Lemonade
E-Payment Provider	The term "e-payment" generally encompasses various functionalities that are handled via mobile phones (Mallat 2007). Provision of payments, which include the use of mobile devices, such as smartphones.	PayPal, ApplePay, AliPay

Table 24. Generic Roles of InsurTechs

Third, we used the e^3-value method to develop a generic ecosystem of the digital transformation in the insurance industry, including InsurTechs. It extends the ecosystem in Figure 10 by the InsurTechs, we found by drawing on the identified generic roles for InsurTechs, see Figure 11.

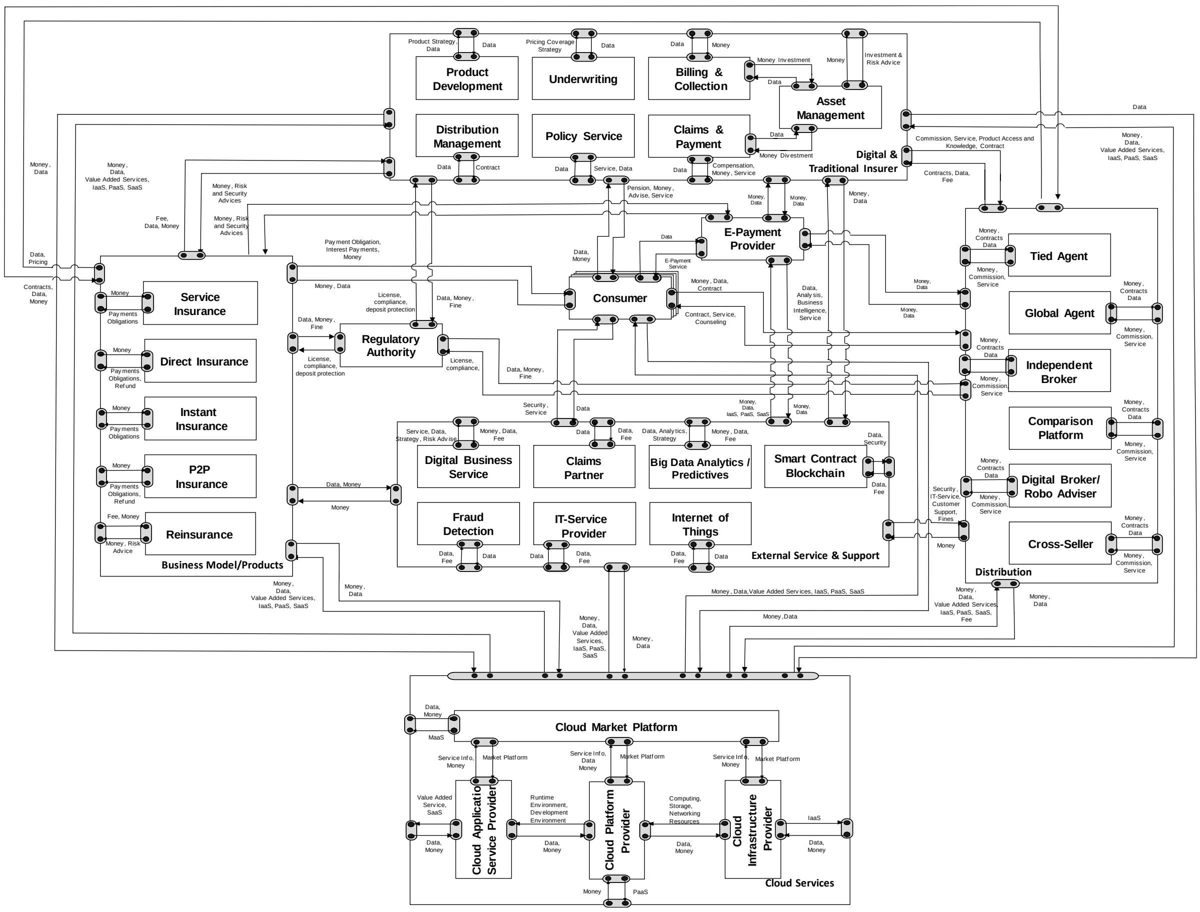

Figure 11. Generic Ecosystem of the Insurance Industry including InsurTechs

9.5 Strategic Implications and Innovation Patterns in the Insurance Industry

Based on the analysis of the digital transformation in the generic ecosystem, e.g., compare Figure 10 with Figure 11, and the conducted interviews with seven industry experts we extend and modify the research of Riasanow et al. (2018b) by strategic impactions and inter-organizational innovation patterns.

<table>
<tr><th>Strategic Implication</th><th>Innovation Pattern</th></tr>
<tr><td>Customer Centricity</td><td>Aggregation of Intermediaries</td></tr>
<tr><td rowspan="3">Create coverage for customer ecosystem</td><td>Enhanced Transparency</td></tr>
<tr><td>Service Aggregation</td></tr>
<tr><td rowspan="2">Presumption</td></tr>
<tr><td rowspan="2">Re-structuring the organization to enable DT</td></tr>
<tr><td rowspan="2">Cloud-based Services</td></tr>
<tr><td>Leverage in-house collaboration</td></tr>
<tr><td rowspan="2">Integrate partners with complementary services in the ecosystem</td><td>Service Integration</td></tr>
<tr><td>Parallel Universe</td></tr>
</table>

Table 25. Strategic Implications and Innovation Patterns

The first strategic implication is to provide *customer centricity*, which is independent of location, time, and a key enabler of digital transformation (Fitzgerald et al. 2013; Haffke et al. 2016). Due to, accelerating media and channel fragmentation and evolving new customer expectations, omni-channel management has become more complicated for the insurer. Moreover, customer-to-customer interactions through simultaneously using and creating service are creating significant challenges and opportunities for the insurer. Customer experiences are more social, and peer customers are influencing experiences as well. The insurer also has much less control, overall, of the customer experience and the customer journey (Lemon/Verhoef 2016). In the reaction of this, insurers need to develop a new base of "digital only" clients and launch and support a new direct-to-customer channel, which is also shown in the *aggregation of intermediaries* by the InsurTechs roles of comparison platforms or robot-advisers. They provide appropriate expertise such as personalized and digital app-based interactions with the customer by also integrating new customer services like robot advisors or smart contract interactions. Such a combination of new technologies and services open a plethora of new communication touchpoints with the customer.

Creating coverage for customer ecosystems is the second strategic implication and is also related to transparency, *enhancing transparency* refers primarily to the generic roles in the areas of distribution, coverage reliability and product design and is the second innovation pattern in the industry. There, the generic roles in distribution channels, fraud detection, asset management, and product development are intended to generate transparency in claims management, fund management, and the overall understanding of insurance products. The development to provide a more customer focus systems view in the industry as a contrast to the traditional focus on insurance services, which only included a single insurance provider and a customer. We define the digital ecosystem as a conglomerate of all interactions an insurer has with its customers, within all the ranges of products and services the insurer provides to them. The need to identify hidden customers' interest in insurance coverages, without an insurance stimulus on the customer side is critical for insurer in this context. *Service aggregation* is, therefore, the third innovation pattern in the insurance industry. There, the service provider aggregates a plethora of services and makes it accessible in one solution, e.g. in the dimensions of customer-ecosystems in Smart Home, Connected Health, Life, and Mobility. These dimensions also introduce the field of our fourth innovation pattern of *presumption*, which will be enabled through cloud-based services (Böhm et al. 2010) and the integration of advanced big data analytics. In which the customer simultaneously uses and creates a service, e.g., when a user is sharing personal data via smartphone with Google Maps while using the aggregated real-time traffic information of other users for navigation (Riasanow et al. 2017; Riasanow et al. 2018b).

This innovation pattern needs to be integrated within the organizational processes and structure, which set the third strategic implications of *re-structuring the organization to enable* digital transformation. Because of the mentioned change of customer demands, new competitors, like InsurTechs, and increasing pressure from digitalization, insurer need to reorganize and close the “digital gap”. Providing a flexible and comprehensive IT infrastructure enables new ways of efficiency. Handling business tasks without human interaction is critical in the insurance industry for increasing efficiency and profitability. The field of application ranges from manually set up workarounds to complex software on a virtual machine. Providing IT services in an appropriate environment of *cloud-based services* is the fifth innovation pattern (Böhm et al. 2010). These services are built on a modular cloud infrastructure that enables quick scalability and, therefore, eliminates the boundaries of the traditional insurance administration, products, or services that are bound to the capacities of the insurance institution. Here, the scalability is bound to the computing power of the cloud infrastructure provider (Youseff et al. 2008). In an environment of constantly increasing demands coupled with enormous cost pressure, cloud-based services, big data analytics, and process automation can deliver high-quality work results on a flexible schedule and offer new business opportunities and therefore strengthening the position in the ecosystem.

Fourth, the insurer should *leverage in-house collaboration* and human resources. Most insurers are functionally and regionally organized with standardized processes. For a company in a changing and agile market environment and due to new digital technologies, the employees of a company must be able to position themselves differently with stronger entrepreneurial focus. New types of collaboration empowered through cloud-based services and the use of new forms of organization and working methods encounter different cultures, visions, goals, and strategies, especially in cross-company collaboration and design are needed. Cultivating the entrepreneurial attitude and promoting it among all managers and employees. It also includes modern ways of working and other ways to consciously take risks and establish the associated culture of error. This also contributes to positive cultural development. Within the organization, engage specific individuals with this role to evaluate action-oriented future opportunities and, as a consultant in a structured approach, to make these opportunities transparent and conduct business development. Insurance companies should establish Smart Circles across functionalities, regions, and silos, a culture of continuous collaboration between different roles like underwriting, product development, asset management, claims, and distribution. The purpose of this is to develop a joint understanding of current business performance and to identify areas of opportunities and actions that are both aligned and understood by all different roles.

The insurance industry belongs to the network economy and is shaped by complementary network effects. Thus, the industry behaves like a massively interconnected network of organizations, technologies, consumers, and products. Hence, our final strategic implication is to *integrate partners with complementary services in the ecosystem*. The insurance industry and its value proposition for the customers was the result of independent developments of standardized products driven by a regulatory background. The execution focus was on developing customer insight, building core competencies, and beating the competition in price and efficiency. Thus, companies devoted less attention to external companies that were neither competitors nor customers. However, in the insurance industry, this centralized and vertical perspective has changed significantly. The management of dependencies to a multitude of external complementary companies is relevant to success in strengthening the position in the ecosystem. For the right position in the ecosystem, suitable partners are an important factor (Riasanow et al. 2018b; Barua et al. 2004), where an insurer and its partners create value for the customer through additional services, which is the seventh innovation pattern of *service integration*. The success of an insurance company depends therefore not only on its quality but also on its ability to manage a landscape of multiple partners to meet the customer's desire for a comprehensive product and service offers. Furthermore, the integration of partnerships for data generation and analysis is critical for business success. Also, the emerging and creation of a *parallel universe*, the sixth innovation pattern, which is particular the case for blockchain technology (Riasanow et al. 2018b) and peer to peer insurance models. The case of Trov shows that insurance products or services can be substituted or totally replaced through the connection of customers through new platform set-ups and incentives.

9.6 Discussion

Based on this work, five theoretical contributions arise. First, based on our analysis of 956 companies, we contribute to the literature on InsurTechs, as existing studies solely focus on the business model of InsurTechs or the transformation of the business model of established financial institutions (Puschmann 2017). Second, by developing the generic, inter-organizational, e3-value model of the insurance industry, including InsurTechs, we provide a macro-economic overview of the current and ongoing transformation of the financial industry. We identified 34 generic roles for traditional and emerging players in the insurance industry. Third, this study shows that digital transformation is more than an intra-organizational phenomenon as it affects the whole ecosystem. Thus, we extend Fitzgerald et al. (2013), who understands digital transformation primarily as an intra-organizational phenomenon. Fourth, based on the comparison of the traditional actors and the emerging InsurTechs and industry insights derived from interviews, we identified five strategic implications following seven inter-organizational innovation patters. These patterns that drive the digital transformation in the insurance industry through InsurTechs were particularly missing (Puschmann 2017; Riasanow et al. 2018b). Fifth, we confirm the generic cloud computing ecosystem of Böhm et al. (2010) by showing that most of the innovation in the insurance industry is driven by cloud-based services.

Six practical contributions arise. First, decision-makers, e.g., from traditional insurance institutions, can apply the model to identify potential threats to their current market position, potential opportunities to adapt to trends or shifts in customer needs. Second, we show that the different layers of innovation pattern influence and drive the strategic implications for the digital transformation of insurance companies. Third, we prove that the innovation pattern of the financial industry discovered by Riasanow et al. (2018b) are also by valid in the insurance industry, such as the recombination of insurance services in the service integrator role, or the intelligent combination of existing services to generate a new service in the service aggregator role. The roles show, typical for digital transformation that the way value is delivered to the customer is changing (Piccinini et al. 2015a). Fourth, inter-organizational innovation patterns differ in magnitude and effect. The innovation pattern prosumption shows that this is also true for the insurance industry, as consumers are co-creating value with insurance service providers. Fifth, blockchain as disruptive technology may be understood as the most promising digital technology for traditional insurance institutions. In all categories of insurance products and services and payment, asset management, and financing, we found insurance related or process-optimizing InsurTechs using blockchain technology. Sixth, from an ecosystem perspective, InsurTechs do not possess a significant market share nor is a crowding out effect or disruption visible. However, plenty of traditional insurance institutions and regulatory authorities are increasingly experimenting with new innovative technology. Seventh, we see that new business models as peer to peer insurance are not necessarily a parallel universe in this context. Nevertheless, many products and services are under strict regulation due to governmental authorities. Therefore, it remains uncertain how large the impact of new technologies like blockchain or new business models on traditional insurance institutions is.

9.7 Limitations and Future Research

Our study is subject to limitations. First, the model is limited by the information provided by the Crunchbase database and our coding of the generic roles. Second, drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles, or annual reports. However, we established intercoder reliability among two independent coders with an Alpha of 0.87. Third, we conducted seven semi-structured interviews with experts from the insurance industry or InsurTech founders to validate the proposed generic ecosystem and the presented strategic implications and innovation patterns (Riasanow et al. 2018b).

Following Puschmann (2017), we suggest future research to detect intra-organizational, micro-economic innovation patterns. Second, we would be curious to further investigate the developed strategic implications. Third, many InsurTechs are offering their services on digital platforms (Zavolokina et al. 2016). However, we invite scholars to investigate the success factors for digital platforms in the digital transformation process of the industry remain uncovered.

9.8 Conclusion

This paper presents the generic ecosystem for the insurance industry based on 34 generic roles of traditional financial institutions and InsurTechs, we identified by a structured content analysis of the Crunchbase data of 956 financial organizations. Digital transformation creates new roles for value creation in the insurance industry and thus affects the whole ecosystem. The ecosystem shows that robot advisors, big data, or short term insurance providers penetrate the market and therefore, threaten the value creation of traditional insurance institutions. To discuss this, we developed five strategic implications following seven inter-organizational patterns of the digital transformation (Riasanow et al. 2018b) in the insurance industry, such as the development of a customer-centric voice by the aggregation of intermediaries or the integration of new services in the creation of customer ecosystems. Our work contributes to InsurTech literature and the growing body of knowledge on digital transformation. We encourage traditional insurance institutions to actively experiment with innovative technologies or to collaborate with emerging new players in the market.

Part B2 – Publications under Review[5]

[5] The original publications have been slightly modified, including the unification of the format and reference styles, and minor grammatical revisions. Furthermore, the tables and the figures were numbered sequentially across all parts of the thesis. Consequently, the numbering of figures, tables, and in-text-references differ from the original publications. The original version of the publications can be found in the appendix.

10 Core, Intertwined, and Ecosystem-Specific Clusters in Platform Ecosystems: Analyzing Similarities in the Digital Transformation of the Automotive, Blockchain, Financial, Insurance, and IIoT Industry (P7)

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Publication	Electronic Markets
Status	Revise & Resubmit
Contribution of First Author	Problem Definition, Research Design, Literature Analysis, Data Analysis, Interpretation, Discussion

Table 26. Fact Sheet Publication P7

Abstract

Digital transformation is continuously changing ecosystems, which also forces established companies to re-evaluate their value proposition. However, only transformations of single ecosystems have been studied. Therefore, this work targets to examine the similarities of digital transformation in five platform ecosystems: automotive, blockchain, financial, insurance, and IIoT. For our analysis, we combine the strengths of conceptual modeling using e3 value with a cluster analysis based on text mining to identify similarities in the respective ecosystems. As a result, we identified 15 clusters. Cluster 01 is the core cluster, containing roles of organizations from all five ecosystems. Cluster 02-05 are intertwined, as they include roles from at least two ecosystems. Clusters 06-15 are ecosystem-specific that only include roles found in one ecosystem. Scholars and practitioners can use these clusters when analyzing, building or a new platform ecosystem, or transforming a traditional ecosystem towards a platform ecosystem.

10.1 Motivation

Digital innovations enabled by new technologies fundamentally transform the way organizations interact with each other (Fichman 2014; Yoo et al. 2012). We refer to the organizational transformation to account for these adaptations in value creation through the innovative use of digital technologies as digital transformation (Vial 2019; Weill/Woerner 2015). Digital transformation also challenges organizations that build only physical products with the need to incorporate digital services as part of their offerings (Vial 2019).

However, most studies regarding digital transformation are primarily concerned with an intra-organizational perspective, such as the transformation of processes, products, and services, organizational structures, or business model (e.g., see Kaltenecker et al. 2015; Hansen/Sia 2015; Agarwal et al. 2010). They should, however, also take an inter-organizational perspective into account (Jacobides et al. 2018; Puschmann 2017), particularly since digital transformation may substantially influence inter-organizational partnerships in ecosystems when value is co-created among multiple stakeholders (Sarker et al. 2012).

Increasingly a structured analysis of ecosystems has gained attraction among scholars in information systems, management, and organization science (Adner 2006; Autio/Thomas 2014; Jacobides et al. 2018; Tiwana 2015). To visualize and analyze ecosystems, cluster analysis (Basole 2009; Basole et al. 2018), ecosystem-as-a-structure (Adner 2017), or conceptual modeling have been used (Riasanow et al. 2017). However, the analyzed ecosystems only concern single industries (see Adner 2017). Therefore, we still lack a structured analysis of the similarities of digital transformation in multiple ecosystems (Jacobides et al. 2018; Vial 2019). Hence, when analyzing, building, or transforming ecosystems, scholars and decision makers often disregard their inherent interconnectivity.

Therefore, this study analyzes five platform ecosystems, which we use to answer the following research question: *What are the similarities in platform ecosystems in a digital transformation*? For our analysis, we suggest a new method to identify and analyze similarities among several platform ecosystems by combining the strengths of conceptual modeling and cluster analysis.

The paper is organized as follows. First, we provide a brief survey of related work on platform ecosystems and existing methods to model and analyze ecosystems. Second, we describe our method for identifying similarities in a two phased process. First, we draw on Crunchbase data to drive roles for organizations in one ecosystem and use the conceptual modeling technique e3 value for visualization (phase 1). Second, we perform a cluster analysis based on the Crunchbase data of all organizations using text mining to identify similarities among the five ecosystems (phase 2). Based on that analysis, we identified 15 clusters. Cluster 01 “Cloud and On-Premise Providers, Cyber Security Providers” is the core cluster, as it contains roles of organizations of all five ecosystems, with some of them (cloud application, cloud platform, and cloud infrastructure provider) found in all ecosystems. Notably, based on the similarity of the organization descriptions, roles like disruptive hardware, IIoT solution, or digital identity providers can be found in the core cluster, too. Cluster 02-05 “Digital Financial Services”, “OEMs and IIoT Solutions”, “Data Prediction and Monitoring”, and “Brokers and Agents” are intertwined clusters, as they include roles from at least two ecosystems. Cluster 06-15 are ecosystem-specific, which, therefore, only contain roles found in one of the five ecosystems. We conclude with a discussion of our results, the limitations of this work, and suggest avenues for future research. Scholars can use these core roles when analyzing platform ecosystems, and practitioners can use them when building or transforming a traditional ecosystem towards a platform ecosystem.

10.2 Related Work

Digital platforms that have the capacity to combine and deploy innovative technologies create new business models that fundamentally transform the way business is done (Lucas/Goh 2009; Tiwana 2015). We refer to the organizational transformation to account for these adaptations in value creation through the innovative use of digital technologies as digital transformation (Vial 2019; Weill/Woerner 2015).

Yet, studies about digital transformation initiatives are primarily concerned with an intra-organizational perspective on transformations, such as processes, products, and services, organizational structures, or the business model (see, e.g., Karimi/Walter 2015; Kaltenecker et al. 2015). However, digital transformation initiatives substantially influence inter-organizational partnerships, particularly in platform ecosystems, where value is co-created among multiple stakeholders (Sarker et al. 2012; Ceccagnoli et al. 2014).

10.2.1 Platform Ecosystems

Three terminologies for ecosystems are most commonly used in IS, management, and organization science research, which also divide the field into three broad streams, as found by Jacobides et al. (2018): “business ecosystems”, “innovation ecosystems” and “platform ecosystems”. The three streams differ in their focus of the research but share the common understanding of ecosystems as a group of interdependent, but loosely coupled firms. In a hierarchical sense, the term “business ecosystem” can be seen as the root, with “innovation ecosystems” and “platform ecosystems” derived thereafter.

Moore (1993) defined business ecosystems as companies with “co-evolv[ing] capabilities around a new innovation” in a cooperative and at the same time competitive way. This broader definition has since been widely maintained, with Teece (2007) defining business ecosystems as “the community of organizations, institutions, and individuals that impact the enterprise and the enterprise’s customers and suppliers”. There is still incertitude as to where exactly the boundary has to be drawn that separates the entities within from that outside of a specific ecosystem (Weber & Hine, 2015). However, this definition also entails that a business ecosystem is constituted relative to a particular firm – with different firms that are not operating in the identical ecosystem even when they are offering similar services or products (Jacobides et al., 2018).

In some of the definitions of business ecosystems, the term “platform” is already mentioned, as in the conceptualization of Autio/Thomas (2014). This already indicates how closely the idea of a platform is related to ecosystems. Ecosystems are the more generic concept, of which platform ecosystems are one typical instantiation: Many ecosystems, such as the Apple iOS ecosystem, have at their core a platform that structures and orchestrates the complementors and partners (Dattée et al. 2018; Altman/Tuschman 2017). The term “platform ecosystem” is likely to be most conventional in IS, shaped, for example, by the work of Tiwana on ecosystems around software platforms (Tiwana 2014; Tiwana et al. 2010). The designation “platform” originates from the product development or engineering disciplines (Simpson et al. 2001; Kirshnan/Ulrich 2001), and has since enjoyed similar popularity as the term “ecosystem”, with further adoption in fields such as (industrial) economics (Evans 2003; Rochet/Tirole 2003).

In management literature, it has also gained significant momentum in the meantime (Hagiu 2014; Boudreau/Lakhani 2009; Cusumano/Gawer 2002), especially in researching the mechanisms of two- or multiple-sided markets. In the review by Thomas et al. (2014), the literature on platforms in management was consolidated, with “platform ecosystems” as one of the major streams.

10.2.2 Approaches to Ecosystem Analysis

Platform ecosystems with actors that have unique, supermodular, or non-generic, complementarities require the creation of a specific structure of relationships to create value (Jacobides et al. 2018). Different methods exist to first visualize and second analyze ecosystems, such as conceptual, heuristic, mathematical, ontological methods, or cluster analysis (Arreola Gonzalez et al. 2019; Basole et al. 2018).

We focus our attention on conceptual modeling using the e3 value methodology (Gordijn/Akkermans 2003), and cluster analysis based on text mining. This design choice is supported by two considerations. First, the topic of value ecosystem modeling and analysis is simply too huge to be acceptably covered in a single survey paper if prior work is to be recognized in any serious fashion. Hence, for an overview of the various methods for ecosystem analysis refer to the literature review conducted by Arreola Gonzalez et al. (2019). Second, we focus on e3 value for conceptual modeling based on its suitability to comprehensively visualize large ecosystems (e.g., Böhm et al. 2010), and cluster analysis using text mining as it allows to objectively analyze large ecosystems based on organizational descriptions (see Basole et al. 2018).

Conceptual Modeling

First, ecosystem-as-a-structure is the easiest conceptual method to visualize and analyze ecosystems. Ecosystem-as-a-structure models every participant relevant for an organization of an ecosystem (Adner 2017). Since its level of abstraction is typically on an individual organization level, this is the easiest way to visualize and analyze the ecosystem around a single organization or digital platform. This approach is also used to identify the value creation of organizations in ecosystems (Urmetzer et al. 2018). However, if an ecosystem is very large, ecosystem-as-a-structure models become very large and would require more abstraction.

The abstraction of similar organizations to roles can be modeled with e3 value, another conceptual modeling technique (Gordijn/Akkermans 2003; Gordijn et al. 2006). Therefore, the e3 value methodology is more suitable to model large ecosystems consisting of a multitude of different actors. For example, the generic cloud computing network consists of infrastructure provider, platform provider, application provider, a market platform, aggregator, integrator, consultant, and consumers (Böhm et al. 2010). For the aggregation to generic roles, Böhm et al. (2010) used a qualitative content coding technique (Mayring 2010a). There, the role application provider contains services such as Dropbox, Microsoft Office 365, or Salesforce CRM, which are all typical instantiations of this role. This reduction of complexity helps to communicate the ecosystem and changes occurring in it more easily. Henceforth, the level of abstraction varies from an organizational level in ecosystem-as-a-structure to a role-based level, which in this method can be the aggregation of different organizations in an ecosystem. However, conceptual modeling is time-consuming and follows a manual process.

Extending the approach of Böhm et al. (2010) to use e3-value method to visualize the ecosystem, Riasanow et al. (2017) validated their generic automotive ecosystem with expert interviews in the respective ecosystem. This step is conducted to verify the robustness of the developed ecosystem, as the experts discuss and verify the identified roles and their relationships in the ecosystems. Riasanow et al. (2017) identified that the traditional automotive ecosystem is blurring due to the impact of cloud-based roles, which allow the development of digital platforms or further value-adding service, which are partially extending or substituting the value creation of OEMs.

Cluster Analysis

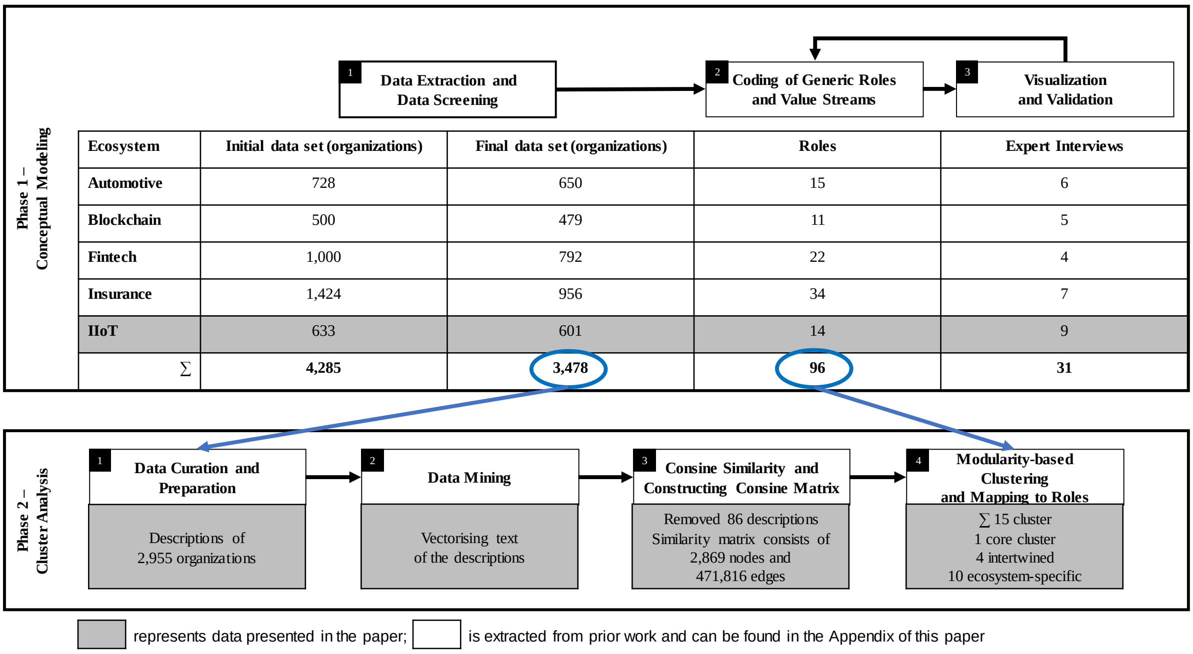
The quantitative analysis of ecosystems relies on text mining to cluster organizations regarding their similarity (Basole/Karla 2011; Basole 2009). Thereby, computation power is used to detect patterns and clusters in a much faster way using graph theory algorithms (Basole/Karla 2011). Since organizational data is mostly available in an unstructured form, text mining techniques are leveraged together with graph theory algorithms to detect ecosystems and structural characteristics among this unstructured data (Basole et al. 2018). This method can be used to cluster organizations based on their similarity in description or value creation (Basole et al. 2018).

One of the central advantages besides relying on computation power for the analysis is the objectivity of this methodology. Whereas conceptual modeling relies on the subjective coding, the clusters are mathematically derived based on the similarity of organizational descriptions, for example. In contrast, this method is limited to the accuracy of the organizational descriptions.

Due to this clustering, Basole et al. (2018) identified a tremendous growth of Fintechs in the last decade, however, the rate of new emerging startups is getting slower, partially due to a maturing of the industry. Second, they identified an increasing global footprint of the Fintech organizations in their analyzed ecosystem. Third, a core set of Fintech ecosystem players could be identified, and a number of peripheral actors (Basole et al. 2018). This may be due to the financial power of large incumbents such as American Express, JP Morgan, or Bank of America, which are acquirers of Fintech companies that occupy differing structural positions in the ecosystem (Basole et al. 2018). Ultimately, the clustering identified six core market segments (Basole et al. 2018).

10.3 Research Approach

Our suggested approach aims at combining conceptual modeling with cluster analysis in order to identify similarities among multiple ecosystems. In the first phase, we follow the approach of Böhm et al. (2010) and use e3 value to model multiple ecosystems, and Riasanow et al. (2017) and use Crunchbase to derive organizational data to code generic roles and value streams between them, which we require to model an ecosystem. Furthermore, expert interviews are conducted to validate the ecosystems (Myers/Newman 2007). In the second phase, we adapted the method of Basole et al. (2018) and use the Crunchbase descriptions of all organizations from five ecosystems to perform a cluster analysis to detect similarities among them. Figure 1 provides an overview of the steps of our research approach.



Ecosystem	Initial data set (organizations)	Final data set (organizations)	Roles	Expert Interviews
Automotive	728	650	15	6
Blockchain	500	479	11	5
Fintech	1,000	792	22	4
Insurance	1,424	956	34	7
IIoT	633	601	14	9
∑	4,285	3,478	96	31

Figure 12. Overview of our Research Approach

We do not choose a pure quantitative approach, because as we compared our results of the manual modeling of every ecosystem with the results of using the below proposed quantitative approach to assign organizations to roles and they strongly differed. The comparison shows that the quantitative approach is on average only able to predict 53% of the organizations correctly, see Appendix F. Hence, we choose the proposed combined approach, to profit from the accuracy of manual coding and the objectivity of an unbiased similarity calculation using text mining. In other words, the manually derived roles add additional information to the calculated clusters, which eases interpretation and increases explanatory power.

For our cluster analysis to detect similarities, we combine the following ecosystems: automotive, blockchain, financial and insurance. Further, we will use data from the Industrial Internet of Things (IIoT) organizations to model a new ecosystem, which we use to introduce our approach for the conceptual modeling using e3 value in the subsequent chapter.

We chose the respective five ecosystems based on a theoretical sampling strategy (Eisenhardt 1989; Eisenhardt/Graebner 2007; Yin 2014). We decided for the automotive, financial, and insurance ecosystem to analyze platform ecosystems that are currently substantially transforming due to innovative digital technologies (Piccinini et al. 2015b; Basole et al. 2018; Puschmann 2017). We chose the three ecosystems due to their varying maturity of the digital transformation, with the financial ecosystem being most mature due the plethora of emerging organizations, which are breaking up and recombining the value creation of incumbent organizations (Basole et al. 2018; Westerman et al. 2011), and the automotive ecosystem being less mature, mainly due to its asset-heavy products (Riasanow et al. 2017; Piccinini et al. 2015b). In the next step, we focused on ecosystems based on innovative technologies with the capabilities to transform or substitute products and services of incumbents in other ecosystems and chose the blockchain and IIoT ecosystem. For example, cryptocurrencies allow payments without trusted intermediaries such as banks (Tapscott/Tapscott 2016), and IIoT is an enabler for location-based or pay-per-use insurances in the car (Desyllas/Sako 2013; Greineder et al.

2019). In other words, both technologies serve as baseline for the digital transformation of the automotive, financial, and insurance ecosystem.

As next, we will briefly explain all of the steps of phase 1, the conceptual modeling, and provide the input, procedure, and results of each step for the IIoT ecosystem. The data of the other ecosystems are based on prior work (Riasanow et al. 2017; Riasanow et al. 2018a; Riasanow et al. 2018b; Greineder et al. 2019). Afterwards, we present the steps of phase 2.

10.4 Inductive Coding and Conceptual Modeling

We use Crunchbase, a socially curated directory of organizations, peoples, and investors, in order to extract organizational data to model our ecosystems. Following Basole et al. (2018), due to a large number of entries, Crunchbase data is suitable to model ecosystems. We use the provided information about these organizations to derive roles and value streams. Crunchbase possesses a comprehensive database of traditional companies, or incumbents, and startups (Marra et al. 2015), including a description of organizations' value propositions. Additionally, start-ups at all funding stages are included in the database, which enables researchers to capture new business model innovations in emerging markets (Marra et al. 2015; Yu/Perotti 2015). The information reported in the database consists of the company size class, company descriptions, its location, its primary role (firms, group, or investor), its status (operating, acquired, IPO, or closed), its founding date, and the dates on which the record was created and updated (Basole et al. 2018). All additions and edits in the Crunchbase data undergo a verification process before they are released online. Crunchbase, therefore, allows the capture of established and emerging organizations related to an ecosystem and related technologies[6].

Additionally, other databases for specific ecosystems can be used as well. As an example, we used the IoT One database[7], which provides a comprehensive overview of existing IIoT platforms and solution providers.

10.4.1 Data Extraction

As input for the extraction of the company data for our IIoT ecosystem, we used the following search terms: "IIoT", "Industrial IoT", "Industrial Internet of Things", and "Industry 4.0" for the IIoT ecosystem. On May 29th, 2018 we extracted the data of 308 organizations from Crunchbase and an additional 200 of organizations from the IoT One database "Top 200 IIoT companies". Since top companies in the field of IoT were still missing according to CB Insights, we added 115 organizations from their "Top 125 IoT Startup" list. As the output of this step, we extracted data from 633 organizations. Appendix 10 shows the data of Alleantia[8], one of the extracted organizations.

10.4.2 Data Screening

Using the extracted data from the 633 organizations, we excluded all organizations that were marked as "closed" or "acquired" in the operating status since our goal is to evaluate the current situation of an ecosystem.

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[6] For data gathering we used a Crunchbase Premium account, since the free account limits the use (and amount of) available company data

[7] https://www.iotone.com

[8] The data can be also found online: https://www.crunchbase.com/organization/alleantia

For example, Lumenetec, an award-winning software, sensor, and analytics innovator providing performance optimization, big data analytics, and risk management, was closed in 2015. Linear AMS, a provider of tooling for injection molds, compression molds, and tooling required for processing of thermoplastic resins, was acquired by Moog in 2015. Additionally, we excluded all organizations that did not include a website or description provided by Crunchbase, which amounted to 11 organizations. Screening the data, we also found companies that had no relationship to the IIoT industry. Hence, we shortened the data set by a further 21 companies. For the IIoT ecosystem, 601 organizations remained in total for further analysis.

10.4.3 Coding of Roles and Value Streams

To identify roles and value streams in an ecosystem, we use structured content analysis, including an inductive category development based on Mayring (2010a) and Miles/Huberman (1994). First, one of the coders used the organizational descriptions derived from Crunchbase to develop codes for the generic roles. For example, the generic role IIoT Solution Provider is connected to the terms: solution, scalable, data collection, from wire to cloud, software, interoperable, connect devices (e.g., sensors), or digital twin, see Table 27.

Organization	**Crunchbase description (extract)**	**Coded role**
Alleantia	(…) Alleantia provides the most <u>scalable</u> and cost-effective <u>Industrial IoT solution</u> in the market for <u>data collection</u>, information <u>standardization</u> and distribution <u>from wire to cloud</u>, to implement pervasive machines data access and comprehensive information sharing within the enterprise and across its extended supply chain. Alleantia <u>software</u> <u>connects</u> in few seconds <u>any device</u> — from complex machinery to simpler sensors — to <u>create a complete and interoperable digital twin</u> (…).	IIoT Solution Provider

Table 27. Coding of the Roles

Next, inspired by the codes and the organizational descriptions from Crunchbase, descriptions for the generic roles were developed, for example see Table 2.

Afterwards, the organizational descriptions and the descriptions of the generic roles were given to a second rater, who coded the organizations to the generic roles independently. Both raters compared and discussed their coding for calibration purposes. To measure the intercoder reliability, we calculated Krippendorff’s (2004) Alpha. The results indicated an Alpha of 0.83, reflecting acceptable intercoder reliability (Krippendorff 2004).

All authors confirmed the final coding of each organization and discussed discrepancies, which helped to eliminate individual disparities (Bullock/Tubbs 1990).

The same approach is used for the identification of the value streams, but we combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles, or annual reports.

Coding the remaining 601 organizations of the IIoT ecosystem, we identified a set of 14 generic roles. Table 28 shows the three of the 14 derived roles with example organizations, the other can be found in Appendix D.

Role and Description	Example(s)
Sensor and Connectivity Providers offer connectivity for entities used by the manufacturer/OEM. This includes sensors to connect machines already in use, or sensors for new machines, or robots that allow connectivity to the manufacturing process. The sensors can be used to collect data, which is an essential prerequisite for IIoT applications, or offer wireless network connectivity for IoT devices, and thus, a connection to the cloud.	Alien Technology, Libelium, Verizon, Acent Systems
The **IIoT Hardware Provider** offers connected hardware, technology, or machines used for the digital factory. Members of this role typically possess proven expertise in the engineering required for the hardware (and often for the complementary software).	Kuka, EOS, Rethink Robotics
The **IIoT Solution Provider** offers complete solutions of hardware and software to manufacturers. Therefore, he/she uses the offerings of other providers like the Industrial IoT Hardware Provider, Sensor & Connectivity Provider, Fog & Edge Intelligence Provider, and the Added Value Service Provider or partly fulfills those roles himself. Compared to the Hardware or Sensor provider, he/she is not only offering the product but rather a complete solution to perform a service.	Alleantia, Konux, Xometry, KAESER

Table 28. Roles and Descriptions of the Actors in the IIoT ecosystem

10.4.4 Visualization and Validation

In the next step, we use the e³-value method to visualize the IIoT ecosystem based on the identified roles and the value streams between these (Böhm et al. 2010; Gordijn/Akkermans 2003). The e³-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective.

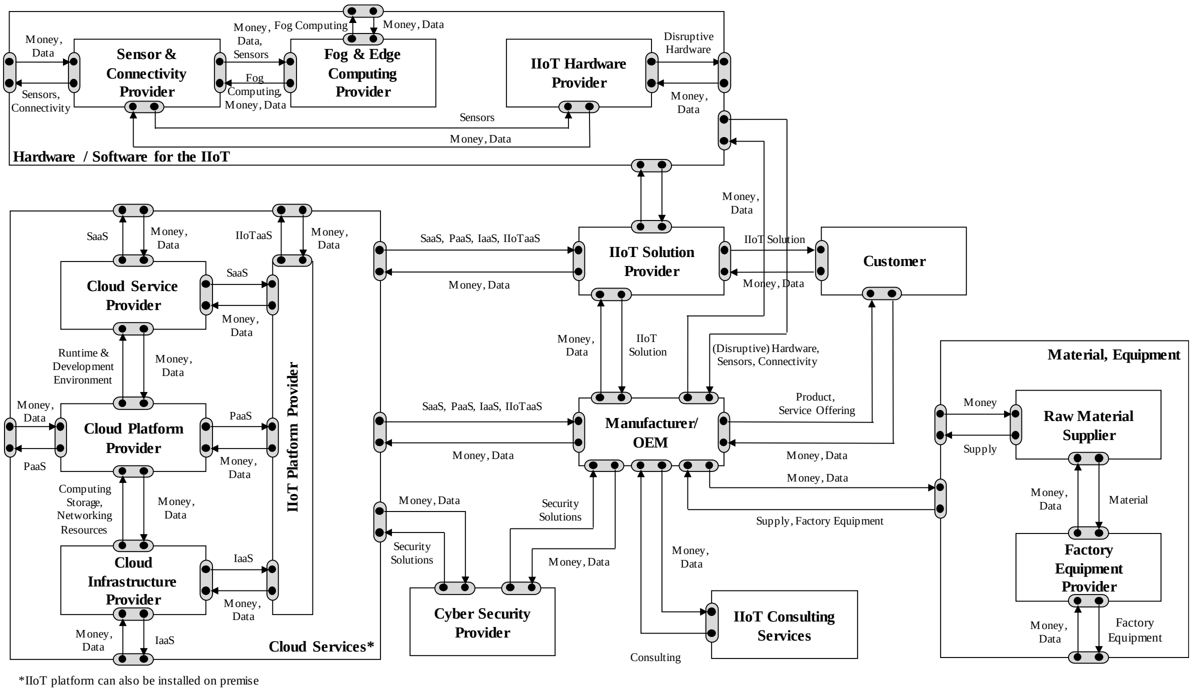

Figure 13. The Generic IIoT Ecosystem

It is used to assess the economic sustainability of an ecosystem by modeling the exchange of economic value between actors (Gordijn/Akkermans 2003). The visualized IIoT ecosystem can be seen in Figure 13.

To validate the ecosystem, interviews with industry experts were conducted. We used a semi-structured technique (Myers/Newman 2007). Each of the chosen experts demonstrates a wealth of experience in the respective ecosystem, as well as with digital technologies. We use experts in a leading strategic position or information technology-related function (Goldberg et al. 2016a) who have privileged access to information and knowledge on the subject (Bogner et al. 2009a). This allows us to draw on different practice-based insights from various companies and long-time market experience from broad knowledge. We recorded all the interviews and transcribed them. During the interviews, we discuss the roles and value streams of the proposed modeled ecosystem with the experts to validate the modeling.

For the IIoT ecosystem, we conducted nine interviews with experts from the manufacturing industry to validate the generic ecosystem. Interviewees were the head of department of "Industry 4.0", a project leader for Industry 4.0, a partner for production, a partner for Industry 4.0, a Head of Industrial Research and Innovation, a Process Manager, a consultant for Industry 4.0 in manufacturing companies, and two partners of leading consulting companies with a long history in the manufacturing business. Each of the experts has substantial experience in the manufacturing industry and IIoT technologies. We conducted the interviews between August and September 2018. Each interview took 38 minutes on average. Our interviewees confirmed the identified roles and did not suggest new roles for the IIoT ecosystem.

The visualization and information regarding the conducted expert interviews for the remaining four ecosystems can be found in prior articles (Riasanow et al. 2017; Riasanow et al. 2018a; Riasanow et al. 2018b; Greineder et al. 2019).

10.5 Clustering based on Similarity Measures using Text Mining

After coding every ecosystem iteratively, we resume by using clustering to detect similarities in the five ecosystems – automotive, blockchain, financial, insurance, and IIoT – and build on Basole et al. (2018).

10.5.1 Data Curation and Preparation

We use the previously extracted Crunchbase data of all five ecosystems to perform the text-mining based cluster analysis. The Crunchbase description field contains textual and unstructured data on organizations. We started with the 3,478 previously coded organizations. We had to drop 522 of the organizations since they were no longer available or were not imported via Crunchbase (e.g. OneIoT Database). After data curation, 2,955 data sets were used for further steps. Data sets for each organization include the organization name, the assigned role, the ecosystem and the organization description extracted from Crunchbase.

10.5.2 Data Mining

In this step, we clustered the remaining 2,955 organizational data sets.

In these data sets, the description of each organization is provided as unstructured text and has to be converted to a computer-readable form. We used text analytics to convert the text into vectors of words. First, we removed all stop words. This enriches the text by only keeping words with a real meaning (Basole et al. 2018).

Next, we used Porter's suffix-stripping algorithm for stemming the words (Porter 1980). Stemming is a normalizing procedure since several variations of words carry the same meaning (Metzler et al. 2007). We follow Basole et al. (2018) and use term frequency-inverse document frequency (TF-IDF) as a well-established weighting method for vectorizing text.

Since not all words in a text are equally important, more frequently appearing words can be seen as carrying more information about the text. However, if the term appears frequently across all texts, it loses its distinguishing power. Therefore, TF-IDF normalizes the frequency of words in a text with the rarity it appears. Described by Ramos (2003), we use TF-IDF, which formally assigns weights to words as a combination of a local measure on description basis and a global measure on all descriptions combined. This ensures that ecosystem-specific words, such as "automotive", "finance" or "insurance" are assigned lower weights, since these words do not carry information about value propositions of the organization. For the implementation, we use the sklearn package of Python[9].

10.5.3 Cosine Similarity and the Similarity Matrix

After data curation, we identify similarities between the organizational descriptions. To do so, we use similarity measures, which are tools for calculating the degree of similarity between two objects, in our case vectors built using TF-IDF.

Following Basole et al. (2018), we use the cosine similarity for calculating the similarity between vectors of organization descriptions. Cosine similarity quantifies similarity by the cosine of the angle between two vectors. The cosine similarity is calculated pairwise between the organizations and represented for all organizations as Matrix A of shape NxN, where N is the number of organizations in the analysis.

The results range from 0 to 1, where 1 represents equality of the texts. We assume that organizations coded in the same role should be treated as identical since we already know the connection between them. We, therefore, change the similarity measure of these organizations to 1. By doing this, we enhance the data with the manual work of the previous step.

Matrix A can be seen as an adjacency matrix for a graph representing organizations as nodes and similarities as edge weights between them. For constructing the graph, we take the lower triangular suggest of A and exclude the diagonal as well. This way, edges between organizations are only considered once and similarities between the same organizations are excluded. In addition, following Basole et al. (2018), we removed 86 organizations that are not similar to any other organization and therefore represent nodes in the graph that are not connected.

We use NetworkX package in python to construct the graph[10]. The resulting graph consists of 2,869 nodes and 472,816 edges.

10.5.4 Modularity-based Clustering

After constructing the graph based on similarity measures, we target to identify clusters.

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[9] https://scikit-learn.org

[10] https://networkx.github.io/

We identify clusters in a graph or network based on the computation of modularity (Blondel et al. 2008). Following Fortunato/Barthelemy (2007), modularity measures the strength of division of a graph into subgroups. Modularity is maximized if densely connected nodes are clustered together and not as frequently linked nodes are split into different clusters (Newman 2006).

Following Basole et al. (2018), we choose Louvain's modularity-based clustering algorithm due to its good performance in large graphs with a good quality of clusters. As a result, we identify 15 clusters containing organizations from different roles from the five input ecosystems (automotive, blockchain, financial, insurance, IIoT). The clusters can be found in Appendix E.

In order to analyze the clusters, we aggregate all organizations included in the clusters to the generic roles as shown in the previous qualitative steps. E.g., BMW and Daimler are aggregated to the generic role OEM.

10.5.5 Cluster Visualization and Latent Semantic Analysis for Topic Detection

We use Gephi[11] to visualize the created graph of organizations and clusters. Visualizations are important for human understanding and enable us to better understand the clusters (Basole et al. 2016).

Since there is no best solution for representing data, the choice should be guided by the nature of the data and the question that needs to be answered (Basole et al. 2018). In our case, a visual representation of the graph showing interconnectivity between organizations and clusters has to be taken into account. We follow Basole et al. (2018) and apply the noverlap algorithm in order to prevent nodes from overlapping. We color the individual nodes according to their ecosystem and mark the clusters with a squared frame in order to improve readability. We also use curved edges in order to make the graph more appealing. We color edges based on the ecosystem of the source node, see Figure 14.

In order to gain more insight about the clusters, we perform latent semantic analysis (LSA) (Deerwester et al. 1990) on individual clusters in order to extract keywords and topics from the descriptions or organizations in clusters. LSA is an unsupervised text analytics algorithm using statistical measures in order to find a hidden meaning of word usage. Also known as Latent Semantic Index (LSI), LSA is used in natural language processing for feature extraction and information retrieval.

In the first step, we remove all ecosystem-specific words and preprocess the data by removing stop words and stemming the words (see above). We only remove the ecosystem-specific words here for the topic detection (we did not remove them in the clustering before), as we seek to identify similarities in the ecosystems. Hence, removing ecosystem-specific terms ensures that the cluster descriptions only include words connected to the value proposition of the organizations.

We then represent the organization descriptions of each cluster as a term-document matrix M. Columns in the term-document matrix represent organizations and rows of all words occurring in these descriptions. The values in the term-document matrix represent the importance of the word; we use the above-mentioned TF-IDF method for quantifying the importance of a word in each description since a weighted matrix has proven to resolve in better results (Dumais

[11] https://gephi.org/

1991). Next singular value decomposition (SVD) is used on the term-document matrix in order to break down the matrix into topics. Through this process, latent meaning, noise reduction, high-order co-occurrence, and sparsity reduction can be achieved (Turney/Pantel 2010). We then use the cosine similarity measure in the reduced term-document matrix vector space for measuring closeness between the words.

For this method, we need to make a choice about how many dimensions should be removed, or in other words how many topics do we want for any given cluster. We use a coherence score in order to identify the optimal number of topics we want to retrieve but set the maximum to 10 since we want an interpretable output. For the calculation, we use the Gensim coherence model implemented in Python based on Röder et al. (2015). The coherence score is commonly used for evaluating topic models in which a higher coherence score indicates a better model. For each cluster and each number of topics between 1 and 10, we build an LSA model using the Gensim package and evaluate the coherence score. We then choose the number of topics for each cluster that maximizes the coherence score. Clusters can, therefore, have a different number of topics assigned to them.

10.6 Cluster Analysis

Following the described steps, we identified 15 clusters for the 2,955 organizations originating from the five ecosystems (blockchain, financial industry, automotive, insurance industry, IIoT). As a result, we mapped the organizations in the 15 clusters to their generic roles assigned in phase 1. Hence, we can use the generic roles to discuss the various value propositions found in the clusters. The LSA topics are guidelines for naming the clusters and give reference for the interpretation. Figure 14 shows the visualization of the clusters.

Towards our search for similarities in the digital transformation of platform ecosystems, we first focus on 5 of the 15 clusters, as they contain organizations from more than one ecosystem. Cluster 01 is the "core" cluster, as it contains roles from all five ecosystems, with some of them found in all ecosystems. Cluster 02-05 are "intertwined", as they include roles from at least two ecosystems, marked black in Figure 14. Cluster 06-15 are "ecosystem-specific" since they contain organizations from only one ecosystem, marked gray in Figure 14.

For each of the clusters, we briefly provide the name, a short description, the extracted topics, the generic roles these organizations were assigned to in phase 1, and their affiliated ecosystems. Finally, we discuss the identified connection between the identified clusters. The assigned roles for each cluster, as well as the calculation results for the coherence value of the keyword extraction, for each of the clusters, can be found in Appendix E. Appendix F shows the result of the sensitivity analysis.

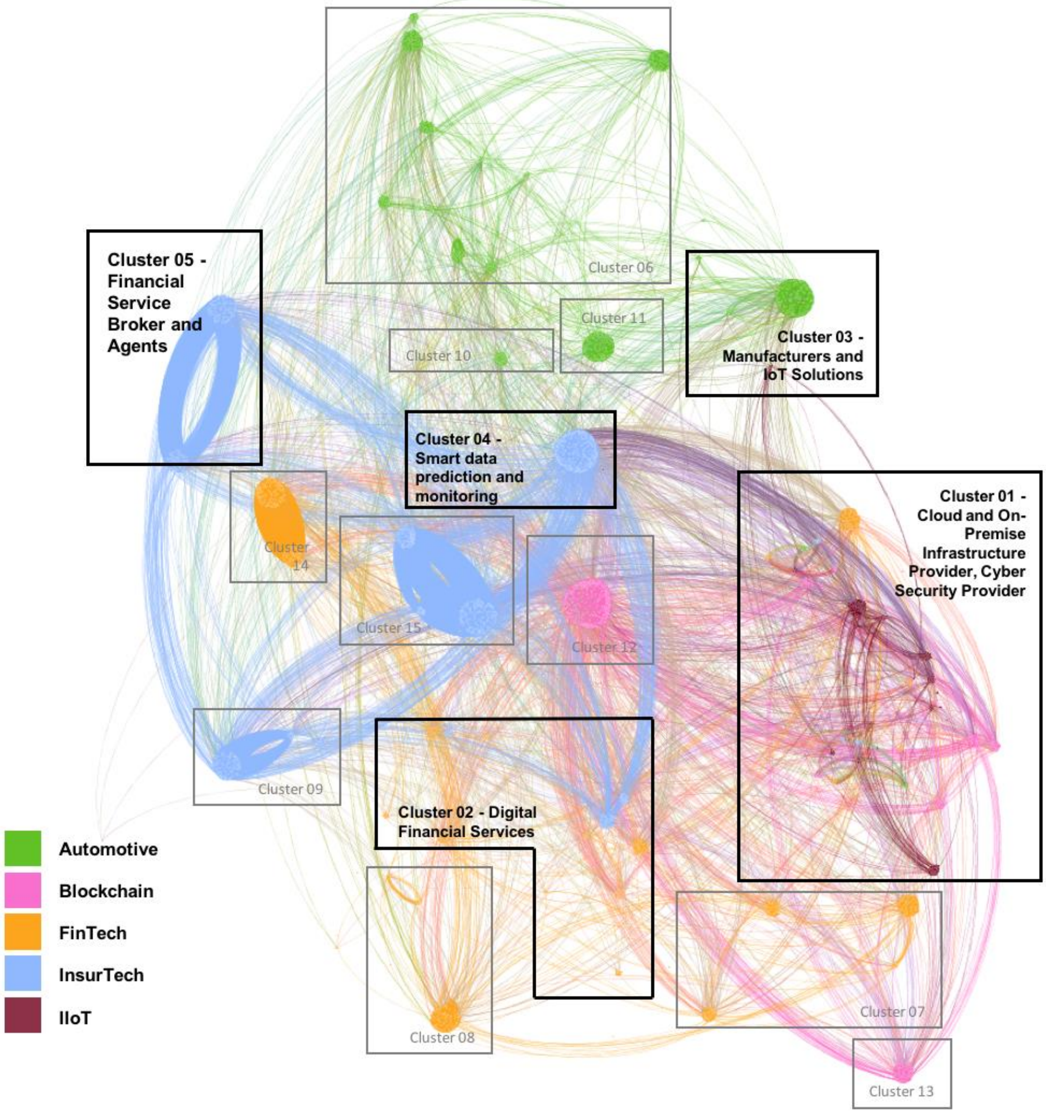

Figure 14. Visualization of the Clusters

10.6.1 Core Cluster

The first cluster, **Cloud and On Premise Infrastructure Provider, Cyber Security Provider**, contains organizations, and therefore, generic roles of all five ecosystems. Using the LSA Algorithm, we identified two topics from which we extract the first three keywords: 1) cloud, application, data, and 2) enterprise, web computing. These topics suggest that containing organizations have an overall cloud and web-computing topic.

Mapping the organizations of this cluster to their generic roles (in phase 1), this cluster contains organizations from three roles that we found in all ecosystems: cloud infrastructure, platform, or application providers, such as so-called "hyperscalers" Microsoft Azure, AWS, Google Cloud, or the Alibaba Cloud Platform. Based on the scalability of cloud infrastructure, such as AWS' Elastic Compute Cloud, or the Microsoft Azure Cloud Platform, or cloud applications, such as Dropbox, or Facebook, the organizations connected to these roles can be seen as the core of all digital platform ecosystems. Precisely because these generic roles build industry-independent services, they can be used in so many ecosystems. As many of these services, such as offered by AWS, are interpreted as commodities, these organizations follow a cost leadership strategy. In contrast, other innovative companies have developed new services based on these commodities, which now extend or substitute the value creation of incumbents (Westerman et al. 2014; Vial 2019). This is particularly visible in our financial ecosystem, where a large number of start-ups offer new payment or financing options such as crowd funding or crowd lending (Basole et al. 2018; Puschmann 2017). Also pay-per-use insurances in the insurance ecosystem or mobility data providers in the automotive ecosystem are largely building on cloud infrastructure, platforms, or services (Greineder et al. 2019).

Additionally, this cluster contains organizations in generic roles connected to data protection and security, such as the Cyber Security Provider, Digital Identity Provider, Fraud Prevention Provider, and Regulatory Authorities. Security-related organizations and regulatory authorities are a core component of the analyzed platform ecosystems. Notably, digital identity providers are similar to cloud services, as many cloud services require identification prior to their usage. Additionally, digital platforms are particularly confronted with regulatory issues such as the expensive insurance license that InsurTech Element had to acquire to provide property, accident and liability insurances as a service.

However, based on the similarity of their organizational descriptions, we also find disruptive technology roles, such as Mobileye, an organization that builds a camera-based system that serves as a basis for autonomous driving, in this cluster. Also smaller roles, such as Mining Pool, SaaS, and the Blockchain Community can be found here.

Figure 14 shows that this cluster is very connected, particularly with Clusters 04, 12, and 13. Clusters 12 and 13 represent the application and platform providers of the blockchain industry, which typically have a high interaction with other cloud-based services. We find this convincing, particularly since mobile, cloud-based services contributed greatly to digital transformation in various industries, e.g., cloud-based Fintechs like PayPal or TransferWise in the financial ecosystem.

10.6.2 Intertwined Clusters

The second cluster, **Digital Financial Services**, contains organizations from two ecosystems. Using LSA to check for topics, we found one topic from which we extract the first three keywords: 1) money, currency, digital. As these keywords suggest, the cluster only contains organizations from the financial and insurance industry.

Overall, this cluster consists of generic roles such as Robo-Advice / Portfolio Management, Multi-banking Aggregators, blockchain-based Smart Contracts, Cryptocurrency Exchanges, Instant or P2P Insurances, Risk Management, Saving Accounts and others. Hence, the roles assigned to this cluster reveals the underlying interconnectivity between the financial and insurance ecosystem also found by Basole et al. (2018). Many of these services are building on cloud services found in the first cluster. This may be due to the financial ecosystem being one of the first industries that started a digital transformation after the broad availability of cloud services (Puschmann 2017).

Due to the integration in digital platforms like Uber, Netflix, Airbnb, digital financial services, most prominently PayPal, have significantly contributed to the success of these platforms. In the case of Uber, customers, for example, do not have to use cash or credit cards to pay for their ride. Instead, the payment does not require any further interaction as Uber charges customers automatically, which is more convenient for the customer than prior payment methods.

Figure 14 also shows a sub-cluster in Cluster 02 is very connected to Cluster 04 and 05. This sub-cluster contains organizational roles, such as Instant Insurance, Smart Contracts Blockchain, and Cryptocurrency Wallet. Examples for this cluster include the cryptocurrency wallet MyEther-Wallet, or Trōv as Instant Insurance. However, organizations that conduct analytics in the financial and insurance ecosystem are also included in this cluster. Other than this connection, Cluster 02 is not very connected to the rest of the graph.

The third cluster, **OEMs and IoT Solutions**, also contains organizations from two ecosystems: the automotive and IIoT ecosystems. Using the LSA Algorithm, we identify one topic with the following keywords: 1) system, manufacture, develop.

Most of the assigned generic roles in this cluster mostly refer to manufacturing organizations. One example is PINpoint, which offers solutions to manufactures to cope with Industry 4.0, or Mobileye, which develop camera-based services that serve as the basis of autonomous driving. Hence, these roles are considered the innovative ones in the respective industries. Therefore, these roles are the attackers of value creation of the traditional roles in the respective ecosystems. Notwithstanding, these organizations cut some market shares of the value creation of traditional manufacturers, on the other side they force them to stay innovative as well.

Cluster 03 also contains some classical roles, such as car manufacturers like BMW and Daimler. As mentioned, these are the organizations that seem to be threatened by digital transformation in the respective ecosystems (Ceccagnoli et al. 2014; Remané et al. 2017).

Furthermore, the IoT can also reshape services in other industries, such as the insurance ecosystem, e.g., by providing insurances pay-as-you-drive insurance (Desyllas/Sako 2013).

We also consider this cluster as intertwined, since it reflects the current situation in many ecosystems, where innovative service providers try to break up and recombine the value creation of traditional manufactures, which in turn forces them to stay innovative. This behavior can also be observed in the financial or insurance industry (Puschmann 2017).

The fourth cluster, **Data Prediction and Monitoring**, contains organizations from two ecosystems, the insurance and IIoT ecosystem. Using the LSA Algorithm, we identify seven topics from which we extract the first three keywords: 1) software, develop, manage, 2) data, software, analytics, 3) manage, claim, AI, 4) business, process, claim, 5) claim, develop, analytics, 6) manage, base, property, 7) agent, AI, global.

Both of the organizations' assigned roles in this cluster refer to using data for monitoring or predicting purposes. This is also supported by the keywords of the identified topics.

Topic 3 and 7 particularly suggest that some of the organizations use AI for data science. Hence, the organizations connected to these topics use machine learning for price optimization, e.g., for the calculation of an adequate price regarding a specific risk in the case of insurances (Desyllas/Sako 2013). Other use cases are personalized marketing, e.g., based on the lifestyle or social media activities of potential customers, customer segmentation, e.g., according to their financial sophistication, age, location, and attitude or risk assessment (Desyllas/Sako 2013; Dorfleitner et al. 2017).

Moreover, topic 4 shows that some organizations in this cluster monitor and predict the outcome of business processes. For example, insurance companies are increasingly interested in claims predictions to calculate potential financial losses. Further examples are organizations like Cognotect and Fraugster.

Figure 14 shows Cluster 04 as central and connected to almost all other clusters. Additionally, Cluster 04 is assigned to a service-oriented and product-oriented ecosystem, which makes it a potential candidate for a future core cluster, such as Cluster 01 is now.

The fifth cluster, **Broker and Agents,** again contains organizations from two ecosystems, the insurance and financial industry with two generic roles: Robo Advisors / Digital Brokers and Personal Financial Management. Using the LSA algorithm, we can define three topics from which we extract the first three keywords: 1) business, online, management, 2) business, agency, way, 3) brokerage, business, automatic.

The topics suggest that the organizations in the cluster refer to agents or brokers that are either automating and/or managing the business. This cluster shows a typical transition from offline to online services due to digital technologies (see Kaltenecker et al. 2015).

Figure 14 shows that Cluster 05 is strongly connected to Cluster 02 “Digital Financial Services” and Cluster 04 “Data Prediction and Monitoring”. This, together with the first keywords, suggest that the included organizations offer digital services that either manage or automate financial services of organizations or investment banking. Examples in this cluster are organizations like FondsFinanz and Euroassekuranz.

10.6.3 Ecosystem-Specific Clusters

Ten of the identified clusters solely contain organizations from one ecosystem. Therefore, we consider these clusters as ecosystem-specific. We identified three automotive clusters (Cluster 06, 10, and 11), three financial clusters (Cluster 07, 08, and 14), two insurance clusters (Cluster 09, and 15), and two blockchain clusters (Cluster 12 and 13), which are discussed in this order subsequently.

Cluster 06 consists of the five topics marketplace, parts, peer, sale/dealership/operations, and base/buy/use. It contains automotive organizations connected to the generic roles Car Dealer, Mobility Service Aggregator, Parts Provider, Car Service Provider, OEM, Intelligent Infrastructure Provider, Mobility Service Platform, Car Rental Provider, and Public Transportation Provider. These roles represent the core roles of the traditional automotive industry and its components of individual transportation, such as by (rental) car, and public transportation. Notably, some of the traditional organizations are already developing digital services or platforms, such as myTaxi, the taxi hail service of Mercedes Benz. However, these services are not industry-dependent the cloud-based services found in Cluster 01.

Cluster 10 consists of topics connected to supplier/global/component, or China. It contains automotive organizations from the generic roles Tier 1-3 Supplier, and Car Service Provider. Therefore, this cluster contains organizations that produce and distribute necessary components for the car manufacturers (or OEMs). Also, these organizations seem to have a unique value creation, as the clustering did not detect similarities to organizations in other ecosystems.

Cluster 11 consists of the topics manage/base/administration, and outsourcing. It contains only automotive organizations from the generic role Value Added Service Provider. These organizations build digital services specific to the automotive industry, which can be accessed before, during, or after transportation. Examples are telematics services, navigation software, or intelligent driving assistance software.

Cluster 07 consists of the topics investment/online/social. It contains organizations from the financial ecosystem with the generic roles Stock Market, Robo-Advice/Portfolio Management, Crowdfunding, and Social Trading. Hence, with the stock market and portfolio management, the organizations in this cluster are core components of the financial ecosystem. However, also emerging actors that base their services on innovative technologies, such as social trading and crowdfunding can be found here. On common ground, these organizations enable access to capital or the capital market.

Cluster 08 consists of similar topics and also contains organizations only from the financial ecosystem. There, the generic roles Loans, Crowdlending, and Money Transfer can be found here. The generic role Money Transfer consists of organizations such as Western Union, which offers a global network of cash transfer independent from other banks. The rest of the organizations in this cluster provide money to private of business customers in two ways: traditional banks offer loans, and emerging players offer crowd lending platforms to connect creditors with debtors.

Cluster 14 consists only of organizations with the generic role Alternative Payment Solution originated in the financial ecosystem. The role is an umbrella for Fintechs whose applications and services concern payment and mobile payment transactions, such as the Sweden-based startup Klarna.

Cluster 09 consists of the topic compare/comparison/online. It contains only organizations from the insurance ecosystem with the generic roles Comparison Platform and Cross-Sellers. Comparison platforms, such as getinsured or impacthealth enable customers to form adequate decisions regarding different products and providers. Cross-seller, such as Simplesurance target the potential of selling further insurance to customers in digital environments, such as online shops, for example through selling luggage insurances after buying a flight ticket.

Cluster 15 consist of only one generic role from the insurance ecosystem, digital business services. These are services handled by external service providers in many aspects of the insurance ecosystem, including consulting, human resource management, and debt collection services.

Cluster 12 consists only of organizations connected to the generic role Blockchain Application Provider, which provide services for various topics, including invoice, e-commerce, e-payment. These organizations offer applications that are linked to on-chain services, such as voting, tokenization, asset linkages and naming registrations provided by decentralized applications. Moreover, some also offer off-chain services, where value is moved outside the blockchain.

Ultimately, cluster 13 consists of organizations in the generic roles Blockchain Platform Providers, underlying the applications of the prior cluster. Hence, these organizations build the technological basis to build, run, and test applications and thus extend the functionality of infrastructure elements. This also includes smart contract languages and scripts, testing tools, sandbox environments, integrated development environments, and frameworks for software development.

10.7 Discussion

10.7.1 Theoretical Contribution

Based on this study, three theoretical contributions have come to light.

First, we propose a methodological innovation to analyze ecosystems, by combining the strengths conceptual modeling and cluster analysis. Thereby, we apply and expand the work of Basole et al. (2018), and use text mining to identify core, intertwined, and ecosystem-specific clusters in ecosystems based on the similarities of the corresponding organizations, after we modeled the ecosystems consisting of generic roles and relationships between them following the approach of Riasanow et al. (2017). Next, we mapped the organizations in the 15 clusters to the previously identified generic roles. This aggregation allows to abstract from single organizations, and discuss and analyze ecosystems according to the value proposition of generic roles, which is particularly helpful for large ecosystems.

Second, in performing the clustering, we address the call for examining ecosystems as a structural entity (Adner 2017), particularly through identifying core and intertwined clusters. Cluster 01 provides three core roles, found in each of our ecosystems: cloud application, platform, and infrastructure providers, which offer industry-independent services and are, thus, the foundation of many platform ecosystems. These roles also highlight the transformation from on premise to cloud services as a central aspect of digital transformation in platform ecosystems. Thereby, we extend prior work of Kaltenecker et al. (2015), who analyzed five case studies in this context. The availability of cloud infrastructure eventually led to a plethora of digital services in all of our examined ecosystems. Notably, this cluster also identifies roles connected to data protection, digital identity, hardware providers, and regulatory authorities, as core of platform ecosystems. Clusters 02-05 show intertwined clusters, with roles from more than one organizations. These roles have the potential to become a core role in the future, as they demonstrated to be relevant in more than one ecosystem. For example, Cluster 02 and 05 show the critical role of digital financial services for platform ecosystems, e.g., also in the automotive ecosystems. As an example, Uber exclusively manages the payment of rides via digital financial services, such as PayPal, so that the customer does not have to bring cash. Cluster 03 shows that IIoT solution providers are breaking up and recombining the value creation of automotive OEMs (see Weill/Woerner 2015). Thereby, they are increasing the number of different services in an ecosystem and forcing the established players to innovate in order to stay competitive. Cluster 04 identified machine learning as one of the new technologies driving innovation in platform ecosystems. In our case, we observed this phenomenon particularly in the financial and insurance ecosystem, e.g., by enabling price optimization, personalized marketing, customer segmentation, and risk assessment. Hence, our clusters help scholars to also analyze digital transformation in other than our studied platform ecosystems. Also, the roles in the core or intertwined clusters can serve as a starting point when designing a new, or transforming an established ecosystem.

Third, the clusters reveal the underlying interconnectivity and complexity of platform ecosystems while providing important triangulated insights into ecosystem-specific differences. Moreover, as only one of the 15 clusters contains roles that can be found in all of the ecosystems, the distribution of our findings are similar to the oligopoly market structure of cloud platform providers, for example. There only a few large organizations, such as AWS or Microsoft remain to provide the hyper-scaling commodity services to a large, and growing, customer base. Or, on the other hand, most of the organizations in platform ecosystems offer specialized, complementary services, which are building on platforms. However, based on the intertwined clusters, we see that innovative roles, such as IIoT solution providers, extend their range from IIoT to the automotive ecosystem, for example, which can be understood as first step towards a commodity service.

10.7.2 Practical Contribution

Our analyses help practitioners in four important ways.

First, decision makers, e.g., from traditional organizations may apply our ecosystems to identify potential threats to their current market position, potential opportunities to adapt to trends, and shifts in customer needs.

Second, when designing new, or transforming established platform ecosystems, we advise practitioners to definitely account for the generic roles identified in our "core" Cluster 01, consisting of cloud and on premise infrastructure providers, and cybersecurity providers. Moreover, we also suggest analyzing the impact of the roles in the intertwined clusters (Cluster 02-05), as they represent roles that are extending their services to other ecosystems. Hence, the intertwined roles may have an effect in the particular ecosystem under investigation in the future, too.

Third, the cluster analysis is helpful to analyze the size and centrality of specific roles in platform ecosystems. This step may be helpful when analyzing the importance of specific roles for the ecosystem. For example, we found that Cluster 04 that concerns data prediction is very central to most other roles of the ecosystem. Such conclusions could not be drawn by simply using the e3 value method, or ecosystem-as-a-structure to model an ecosystem.

Fourth, our proposed method enables decision-makers to understand and analyze ecosystems from two perspectives, so that decision makers can understand the value streams between the organizations using the e3 value model and examine the similarity to roles of other ecosystem using the cluster analysis.

10.7.3 Limitations and Future Research

Our study is subject to limitations.

First, even though the coding of the organizations to the generic roles follows the structured approach proposed by Mayring (2010a) it is subject the subjective coding of the human coding process. Hence, we used a second coder and measured inter-coder reliability which was acceptable above 0.8 for each of the respective ecosystems. Further, we conducted 31 interviews with external industry experts to discuss and validate our developed ecosystems.

Second, our ecosystems are limited by the information provided by the Crunchbase database and our coding of roles. Future research could enhance our suggested method, e.g., by using web scrapping algorithms to include more information.

Finally, our analysis is limited to platform ecosystems. Hence, we suggest future research to examine our method in the context of different types of ecosystems.

10.8 Conclusion

This work provides a new method to analyze ecosystems, and identify similarities of the roles in the ecosystem, by combining the strengths of conceptual modeling using e3 value and cluster analysis using text mining. Applying this method to the automotive, blockchain, financial, insurance, and IIoT ecosystems, we found 15 organizational clusters based on the similarity of the containing organizations. Among these clusters, we identified one core cluster that contains organizations occurring in all ecosystems, and four intertwined clusters containing organizations from more at least two ecosystems. Our work contributes to ecosystem theory and the phenomenon of digital transformation on an ecosystem level in multiple ways. We encourage scholars, platform owners, and complementors that seek to analyze platform ecosystems to adapt our approach.

11 Managing the Co-evolution of Partnerships: The Microsoft Azure Cloud Platform (P8)

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Contribution of first author	Problem definition, research design, literature analysis, data analysis, interpretation, discussion

Table 29. Fact Sheet Publication P8

Abstract

The development of the Azure Cloud Platform business required a fundamental transformation of the Microsoft ecosystem. Prior to the roll out of Azure, Microsoft's value creation was contingent on the co-creation of products and services with a very large partner base that delivered those products and services on the customers' premises. For its cloud strategy to be successful, Microsoft had to motivate those partners to join and grow the Azure ecosystem, and to deliver the next generation of Microsoft products and services in the cloud. In its successful transformation, Microsoft adopted a two-phase change program based on six lessons learned. Phase One was based on two direct owner-centric mechanisms to grow the Azure partner base. Phase Two was based on four partner-centric mechanisms to shift the locus of control to the partners.

11.1 Motivation

Software platform ecosystems are creating and redesigning whole industries, accelerating innovation, and generating large profits (Jacobides et al. 2018). The platforms achieve this by enabling the functionality of products and services to be extended and redesigned by partners in the surrounding ecosystem (Tiwana 2015; Tiwana et al. 2010). So, platform owners must maximize the attractiveness of the platform to potential partners (Eaton et al. 2015).

Doing this, platform owners leverage sources of innovation beyond their organizational boundaries. Together with partners in their ecosystem, they innovate in an environment characterized by both competition and cooperation to satisfy customer needs (Sarker et al. 2012). In this way, the success of a platform ecosystem is contingent on the combined capabilities and business models of both the owners and the partners (de Reuver et al. 2017).

Critically, Microsoft built its Azure platform in response to emerging end-user customer demand for a "mobile first, cloud first" strategy and not in response to demands from its partners. The CEO of Microsoft, Satya Nadella, acknowledged this strategic driver for the Azure platform and linked it to the partner support required for its success when addressing 400,000 partners on the future of its platform-centric ecosystem in 2018:

"This company was built on enabling broad ecosystems and broad partner opportunity. We now need to redefine what it means to build an ecosystem in a mobile-first, cloud-first world"[12].

To do this, Microsoft had to transform[13] its highly profitable, product-centric licensing business model that delivered services on the customer's premises into one based on a cloud platform ecosystem that delivered services in the cloud. With 95% of Microsoft's existing revenue in this business space contingent on the distribution of products and services by its partners[14], a successful co-evolution of the partner ecosystem was critical to the success of Azure.

In its successful transformation of its partner ecosystem, Microsoft implemented six co-evolution mechanism in two phases. In the first phase – to motivate partners to join and grow the platform – Microsoft implemented two strategies. In one, Microsoft paid partners to join. In the other strategy, Microsoft offered partners innovative services supported only on the Azure ecosystem.

In the second phase – to encourage and engage partners to stay – Microsoft developed a shared vision of, and strategy for, business opportunities; established a learning platform for partners to develop new capabilities; increased collaboration among partners; and provided personal guidance to, and developed tools for, partners to develop complementary cloud-based services.

In the remainder of this paper, we briefly describe the Microsoft Azure platform, its complementary partners, and the challenges to the digital transformation process. Then, we describe the owner- and partner-centric mechanisms that Microsoft used to manage the co-evolution with its partners of the Azure ecosystem. To close, we present six guidelines for

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[12] Data extracted from https://partner.microsoft.com/en-US/

[13] For a very good example of a digital transformation see El Sawy, O., Kraemmergaard, P., Amsinck, H., and Vinther, A."How LEGO built the foundations and enterprise capabilities for digital leadership," MIS Quarterly Executive, (15:2), 2016, pp. 141-166.

[14] See https://www.idc.com/prodserv/custom_solutions/download/BusinessValueofMPNCoreBenefits.pdf

decision makers undertaking the digital transformation of a platform-centric ecosystem by highlighting Microsoft's lessons learned.

11.2 Case Background

Founded in 1975 by Bill Gates and Paul Allen, Microsoft Corporation is a world leader in software and hardware, with revenues of $110.40 billion in 2018[15]. Microsoft Deutschland GmbH, the subject of this case study, is one of the largest Microsoft businesses outside of the U.S. with 2,700 employees. Its core business activities are product marketing, and customer and partner support, with more than 31,500 local partner companies.

Since 2014, the Microsoft group has been restructuring to transform the on-premises Microsoft software service and product business from a product-centric organization into a business in which employees and partners leave the traditional software licensing and related product world behind them and think in terms of digital services delivered in the cloud. This required a major transformation of the Microsoft business model. For example, the regular software license and maintenance payments in an on-premises environment would be replaced by pay-per-use contracts in a cloud environment to implement the new “mobile first, cloud first” strategy.

In 2018, the Azure ecosystem supports building, testing, deploying, and managing applications and services through a global network of Microsoft-managed data centers. It provides software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS), listing over 600 services available in the Azure ecosystem under the headings: “Compute”, “Networking”, “Storage”, “Web + Mobile”, “Containers”, “Databases”, “Analytics”, “AI + Machine Learning”, “Internet of Things”, “Integration”, “Security + Identity”, “Developer Tools”, “Management Tools”, and “Microsoft Azure Stack”[16]. In addition, it supports multiple programming languages, and frameworks, including both Microsoft-specific and third-party software and systems.

Customers demanding access to services anywhere/anytime in a ‘mobile-first, cloud-first world’, was the primary driver of the digital transformation to the Azure ecosystem. This generated major challenges for Microsoft and its partners. Before describing those challenges, we describe the five pre-Azure types of Microsoft partners in 2014/2015 and their different business models that were the major causes of the challenges.

11.3 Five Types of Microsoft Partners 2014/15

Microsoft's pre-transformation partners managed separate but overlapping businesses. There were five primary types: Licensing software partners, Value added resellers, System integrators, Hosting partners, and Independent software developers. However, over time, partners in each of these partner types developed other businesses to serve the emergent needs of their customers, creating a complex portfolio of partner businesses to be transferred to the Azure ecosystem.

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[15] Data extracted from the latest annual report, see https://www.microsoft.com/en-us/annualreports/ar2018/annualreport

[16] For more information about the services, see the Azure Cloud Platform Service Catalogue at https://azure.microsoft.com/en-us/services/

Licensing software partners (LSPs) primarily supplied large customers with hardware and software, and also provided administrative services, such as license management (see Table 30). In addition, many LSPs had built up additional businesses in the area of service and system integration. Cloud computing would disrupt traditional LSP infrastructure and application server revenues, which would require LSPs to reinvent their business models in the medium term.

Partner	Service portfolio
Licensing Solution Partner (LSP)	- Software distribution - Hardware distribution - Provider management - Service and system integration
Value Added Reseller (VAR)	- Software distribution - Hardware distribution - Hardware / software warranty support - Help desk - Training - On-site IT support
System Integrators (SI)	- Project management - Security assessment - IT assessment and planning - Network assessment Network monitoring - Windows Server - Active Directory
Hosting Partner (HP)	- Data Center Hosting - Cloud Computing - Managed Applications - Managed Infrastructure - Virtualization - Back-up services - Disaster recovery
Independent Software Vendors (ISV)	- Database development - Software development - Mobile applications - Web applications - Business intelligence - Application support

Table 30. Partner Business Portfolios

Value added resellers (VARs) were specialist, local resellers of hardware and software products. Frequently, they offered other services, including installation, training, and support to small and medium-sized businesses. With the proliferation of cloud computing services, VARs were at risk of losing key business opportunities. In addition, they were at risk of losing their advantage of regional proximity to customers as that became less important in an anywhere/anytime environment.

System integrators (SIs) advised on and implemented solutions from different suppliers. SIs primarily offered customized services, including data migration, implementation, and support. However, they also sold software and hardware on which to implement the customized solutions. The shift to cloud computing would represent a new business for SIs as on-premises sales stagnated. In a cloud environment, Sis could invest in sustainable solutions that are specifically designed to support customized solutions and to increase quality (reliability), while both reducing the cost, and increasing the degree, of customization.

Hosting partners (HPs) operated individual servers, applications, and complete data center functions for their customers. These solutions were offered separately or in combinations of software, hardware and services. HPs would be direct competitors of cloud providers, which would lead to falling market sales and prices, and, consequently, reduced margins.

Independent software vendors (ISVs) developed specialized software extensions (add-ons), or complete solutions based on Microsoft products and services. The value of these services to customers was often contingent on their co-creation. In addition, ISVs offered installation, and configuration and consulting services to implement the software. For ISVs, a shift to the cloud environment would require adapting the sales and marketing processes to a cloud environment, for example, availability via online marketplaces and pay-per-use billing.

11.4 Six Challenges and Opportunities in the Cloud

While building Azure and planning the deployment of the Azure ecosystem, Microsoft investigated the barriers and drivers for partners to adopt the proposed new Microsoft on-line business environment. The investigation identified six challenges and opportunities for their partners in the new cloud environment.

First, as customers would be able to access Microsoft services directly from the Azure ecosystem, the business opportunities for reselling and licensing partners (LSPs) would be reduced. However, as large customers would initially still require the services of LSPs, the current LSP businesses would have a long tail.

Second, the transformed ecosystem would experience increased demand for managed services and the development of intellectual property. The expectation was that these markets would be, and now are, serviced by management consultants, ISVs, and new innovative partners. Therefore, Microsoft would need to expand this partner group and, particularly for ISVs, to deliver services on the Azure ecosystem.

Third, the business models of existing partners would continue to be successful because of the slow adoption of cloud computing in the German market. So, many partners would be reluctant to provide complementary services on the Azure ecosystem. This was a threat to speed to market and the building of critical mass in the cloud, where Microsoft was positioning itself as a fast follower to Amazon.

Fourth, a few partners were already highly knowledgeable about, and experienced with, cloud technology. There would be a high demand for training by these partners to build the necessary specific capabilities to develop and operate Microsoft products and services on the Azure platform. Even for these partners, the increase in innovation cycles would be a challenge, for example, the volume of releases would increase significantly in a cloud compared to the on-premises environment. Critically, failure to engage these partners would encourage them to join other cloud platform ecosystems.

Fifth, the deployment of the Azure ecosystem would disrupt Microsoft's relationships with its partners and customers. For example, many partners and customers would be faced with changes to the Microsoft contact responsible for the distribution of, and or support for, products and services.

Sixth, Microsoft, while it began a communication strategy through mass media and social media initiatives, was concerned that the increased awareness of the move to the cloud would not generate the speed of adoption by their partners that was required to successfully deploy the Azure ecosystem. This was because for existing Microsoft partners, the transition from delivering on-premises to on-Azure digital services required major changes to their business models, including the marketing and sales strategy, cost and profit calculation, and the portfolio of products offered.[17]

11.5 The Co-evolution of Azure

To respond to these challenges, Microsoft designed a two-phase transformation strategy. In Phase One Microsoft adopted owner-centric mechanisms, offering direct financial inducements to the partners to move to the cloud and indirect inducements by restricting access to new products and services to be cloud only. To build trust and support innovation in Phase Two, Microsoft shifted the emphasis to partner-centric mechanisms.

11.5.1 Owner-centric Co-evolution Mechanisms

Owner-centric mechanisms rely on traditional influence mechanisms, including financial incentives. These are easy to apply and generate immediate results. Microsoft identified and deployed five of these mechanisms: (1) financial (pay for moving), (2) preferential access to new products and services in the cloud, (3) cost reduction (price for contracts), (4) free services, and (5) new partners (competition).

Owner-centric Co-evolution Mechanisms	
1 – Financial	Financial incentives to (re-)sell cloud services instead of on premise solutions.
2 – Preferential access to new products and services in the cloud	Distinct functions and services are only available via Azure.
3 – Cost Reduction	Subvention of end customers through cheaper contracts for cloud services.
4 – Free services	Partners get licenses for ACP services for free to use Azure services and to increase their adoption.
5 – New partners (competition)	Microsoft is collaborating with innovative services providers and integrating them in the ecosystem, and thereby increasing the pressure on existing partners

Table 31. Owner-centric Mechanisms for the Co-evolution of Partners in the Microsoft Ecosystem

First, financial incentives for resellers were strictly contingent on partners delivering services in the cloud. For Microsoft as the platform owner, the trade-off was between the number of partners moving to the cloud and the cost of the financial inducement. For the partners, it was a trade-off between the financial inducements to move, and the direct costs and business risks of moving. For example, Microsoft rewarded LSP partners with a fixed payment if cloud services were sold.

Second, Microsoft specified that upgrades to major services, and new products and services, would be supported only on the Azure platform and not supported in an on-premises environment. For example, it is not possible to use Microsoft's Office on iOS without an Office

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[17] See the profitable business models based on Microsoft Cloud Services at https://partner.microsoft.com/de-de/solutions/cloud-partner-profitability

365 subscription to Azure. In this case, the end-users rather than Microsoft push the Microsoft partners to go cloud.

Third, Microsoft sold customers cheaper contracts for cloud based compared with on-premises services. This mechanism is different from the first mechanism above, because it does not necessarily lead to a payment. Importantly, cloud service contracts are designed on a per-user basis compared with a per device basis for on-premises contracts. The former allows a customer to use the software on a specified number of devices while only paying one fee for the service. In contrast, a separate license key for the service is necessary for each device in an on-premises environment.

Fourth, to boost business growth, partners received free licenses for Azure-based services for software development, training, and marketing. This mechanism also leveraged partner-centric mechanisms because Microsoft invested indirectly in knowledge transfer to, and business development of, the partners, increasing their skills to operate in the Azure ecosystem.

Fifth, Microsoft approached potential new partners to develop innovative cloud-based services. This strategy had two effects. One was to increase the range of services supported by the Azure ecosystem. The other was to increase the pressure on existing partners to move to the cloud to pre-empt their customers moving to the new partners.

The challenges explain why some Microsoft partners reacted negatively to Microsoft's digital transformation: They perceived it as an attack on their business model. For example, many of the resellers assumed that Microsoft no longer needed them. In response, Microsoft explicitly told them why the opposite was the case.

Microsoft pointed out that it had more than 3.6 million customers in Germany and could never support them with only 2,700 employees. Microsoft's only option was to collaborate with its 31,500 partners in Germany and their 250,000 employees. Within this framing, the direct payments, Microsoft spent 4.3% of its commercial revenue in 2017 on partner incentives[18], were presented as an investment by Microsoft in the future business growth in the cloud, where even the resellers would experience growth in their revenue.

11.5.2 Partner-centric Co-evolution Mechanisms

In Phase One, as described above, Microsoft incentivized its partners to move to the Azure platform. Microsoft treated the cost of this phase as start-up financing for the Azure platform strategy. Owner-centric mechanisms both discourage cooperation between platform owners and partners, and are also very costly if they are solely contingent on economic incentives. In addition, relying exclusively on owner-centric mechanisms can result in a backslash, in which complementors strive to transform the ecosystem to counter the exercise of power by platform owners. In the extreme, to increase their independence from the owner, partners may even support the platforms of competing providers.[19]

In Phase Two, the long-term goal was to support partners in building sustainable business models based on the Azure ecosystem. To do this, Microsoft adopted partner-centric rather than

[18] Data extracted from the latest annual report, see https://www.microsoft.com/investor/reports/ar17/index.html

[19] Buxmann, P., Diefenbach, H., & Hess, T. „Die Softwareindustrie“, Springer: Berlin, Heidelberg.

owner-centric co-evolution mechanisms. The locus of control moved to the partners, who choose how to rebuild their businesses in the cloud, see the following table.

Partner-centric Co-evolution Mechanisms	
6 – Personal Account manager	Personal account manager help to support business development of the largest distribution partners and provide insights about the strategic direction of Microsoft.
7 –Transformation Workshop	Business transformation workshops to innovate the business model to a recurring service business. These workshops are extended by firm-specific topics, e.g., for data security or compliance.
8 – Marketing Service Portal	Establishment of a marketing service portal to provide partners information for digital marketing: SEO, social media, and website design and architecture.
9 – Education portal	Microsoft's Partner University provides access to education programs (personal or online) to train professional and soft skills.
10 – Open Marketplace	Microsoft's Open Azure Marketplace allows partners to provide and distribute their proprietary services in the partner ecosystem. The marketplace can be used to leverage existing services and build solutions on top of them.
11 – Raking	Microsoft-recommended solution providers with proven expertise receive Gold or Silver expertise.
12 – Technical guidance	Partner Advisory Hours provide access to customized technical guidance during the design, development and deployment phases of a complementary solution.
13 – Free technical assistance	Partners can rely on technical advice and individual assistance free of charge in the presales phase of their complementary service.
14 – Exclusive technical service	Signature Cloud Support is an exclusive technical service that provides qualified partners with preferred technical support for select cloud solutions from Microsoft.
15 – Customer Satisfaction Index	The Customer Satisfaction Index is an online survey system that provides third party market research data at no cost, allowing partners to better analyze their sales markets.
16 – Regular communication	Regular newsletters keep partners up to date with news on the Microsoft partner network, new business opportunities, or training. Social media is used to push information about innovations in the Microsoft partner network.
17 – Technology Evangelists	Technology evangelists inspire indecisive partners with new technology. They are contact and discussion partners in forums, conferences and user meetings, participate in specialist lectures, publish articles in relevant media and write podcasts, webcasts or blogs.

Table 32. Partner-centric Mechanisms for the Co-evolution of Partners in the Microsoft Ecosystem

To support the existing partners in their transformation process to a cloud environment, Microsoft initially focused on partner channel management: The companies authorized in Germany for the distribution of Microsoft products and services to major customers were supported by their own partner sales organization. So, the first partner-centric co-evolution mechanism relied on Microsoft employees, the personal account managers in this sales support organization, to act as the first point of contact between Microsoft and the partners to share and build a common understanding of the new cloud based partnership.

Second, for the large number of small and medium-sized partners, content was, and still is, distributed through mass media, including publications, social media, and via the online offers in the Microsoft Partner Network (MPN). Adopting the partner-centric paradigm, Microsoft helped these partners to successfully develop cloud-based business models and services by providing business, technical, and sales and marketing support, workshops to position themselves in the Azure ecosystem and start a successful cloud business model. These workshops also helped to reduce partner concerns and fears about moving to a cloud environment. Data protection and digital marketing emerged as the most important topics for discussion.

Third, Microsoft established a marketing service portal to support digital marketing. The portal helped, and still helps, partners to extend their reach with SEO, to develop a social media strategy and provides guidance for website design and architecture. The goal of this portal is to provide partners with mechanisms to extend their potential customer base through a range of digital channels.

Fourth, an open marketplace called Microsoft Azure Open Marketplace helped partners to leverage proprietary solutions. There, cloud services are provided and distributed in the partner ecosystem. Other partners can search, access and use the services to build solutions on top of them. This marketplace is based on the Microsoft Partner Center, which provides partners a platform to market themselves and their solutions to the ecosystem.

Fifth, Microsoft began ranking its complementary partners. For example, a partner with very high proven expertise is ranked as Gold partner, whereas partners with less expertise are ranked as Silver or Bronze partners, depending on their service level and expertise. This motivated partners to develop their expertise.

The sixth, seventh and eighth partner-centric co-evolution mechanisms are based on technical support and assistance. First, Microsoft provided technical guidance for the design, development, and deployment phase of complementary services. To do this, Microsoft provides customized technical guidance during 'Partner Advisory Hours'.

Second, technical assistance is free during the pre-sales phase after the development of a complementary service. This helps to reduce the time to market for complementary services and keeps Microsoft informed about the most common problems during that phase, which helps to improve the ecosystem. Third, Microsoft provides exclusive technical service via a service called Signature Cloud Support for partners who qualify based on customers, revenue, and strategic impact.

The last three partner-centric co-evolution mechanisms were specifically designed to support the long-term development and sustainability of complementary relationships.

First, Microsoft uses a Customer Satisfaction Index collected via an online survey provided by an independent third party to collect data on partner sales and marketing activities.

Second, Microsoft relies on various mechanisms to stay in touch with their partners, including, for example, a regular newsletter to communicate recent innovations in the ecosystem, business opportunities, and trainings. This is also distributed via social media, including LinkedIn (one of the strategic acquisitions of Microsoft).

Third, technology evangelists were used to inspire partners and customers by providing examples of the advantages of innovative technologies at conferences, user group meetings, specialist lectures, and digitally via blogs, podcasts, videos, trainings, or webcasts. To support this, Microsoft restructured its partner organization, relabeled “one commercial partner”, into three areas “build-with”, “go-to-market”, and “sell-with” to help partners in the transformation process to the Azure ecosystem.[20]

In combination, the owner- and partner-centric mechanisms lower the barriers for partners to move to the Azure ecosystem, while the ecosystem itself remains a major barrier for Microsoft’s competitors to enter this market. Investments in the transformation of existing partners and their employees are also preventive measures to discourage potential new competitors from building a competing ecosystem. It is the emergent relationships described above between the Azure ecosystem, the Microsoft business model, and the partners’ business models, that is the source of their combined competitive advantage.

11.6 Lessons Learned

During the digital transformation since the deployment of the Azure platform and the corresponding co-evolution of Microsoft’s partners, Microsoft learned six lessons that guide the development of a new platform and its ecosystem. Two lessons guided the activities in Phase 1, and four lessons guide activities in Phase 2, see Figure 15.

Phase 1: Motivate partners to join and grow the platform

Provide owner-centric mechanisms to motivate partners to join and grow the platform

Pay them to come

Offer them innovative services

Phase 2: Engage and support them to stay

Shift the locus of control from Microsoft owner-centric mechanisms to partner-centric mechanisms to increase cooperation and collaboration

Develop a common vision of, and strategy for, business opportunities

Establish a learning platform for partners to develop new capabilities

Increase collaboration among partners

Provide personal guidance to, and develop tools for, partners to build complementary services

Figure 15. Summary of the Lessons Learned

[20] See https://blogs.partner.microsoft.com/mpn/one-commercial-partner-putting-partners-first/

11.6.1 Phase 1: Motivate Partners to Join and Grow the Platform

Pay them to come

Initially, some partners did not recognize the benefits from transformation. Therefore, Microsoft relied on owner-centric mechanisms to motivate partners to use, resell and build complementary services on the ACP. The model is learning by doing and experiencing the benefits. In this model, Microsoft directly supports this process financially by spending about 4.3% of its commercial revenue in 2017 on partner incentives, including for example the reselling of cloud services instead of on premise services, through lower cost contracts for cloud services, or by providing free licenses. This accelerated the adoption among partners, which is a prerequisite for growth through increased sales and building complementary services.

Offer them innovative services

Microsoft made the new services only accessible via the ACP. Therefore, partners had to join the ecosystem to gain access. This reduced the likelihood that they would switch to another digital ecosystem. In addition, Microsoft developed a ranking system for its partners with exclusive benefits increasing dependent on the engagement and quality of service. Finally, Microsoft co-created with innovative service providers and integrated them into the ecosystem to increase pressure on established partners.

11.6.2 Phase 2: Engage and Support Partners to Stay

In Phase 2, the locus of control shifts from Microsoft (owner-centric mechanisms) to the partners (partner-centric mechanisms) to increase cooperation and collaboration. Because owner-centric mechanisms are with cost, Microsoft adopted partner-centric mechanisms, focusing on collaboration with and between partners. This reinforced trust, collaboration and engagement. This shift was necessary because owner-centric mechanisms reduce trust between complementary partners, including platform owners and complementors. In this way, the shift complemented Microsoft's strategic shift to create reliable, long-term relationships with its partners. The partner-centric mechanisms are to build trust through personal communication, technical guidance, and support in the development, deployment, sales, and monitoring of complementary services.

Develop a common vision of, and strategy for, business opportunities

Developing a common vision and strategy for business opportunities was useful as both, Microsoft and its partners have the common goal of providing excellent services for their customers, now via cloud instead of on premise solutions. In all the stages of the digital transformation, Microsoft regularly updated its partners by distributing new insights about the ACP. To support their co-evolution, Microsoft conducted individual business transformation workshops together with partners to develop a common vision of, and strategies for, business opportunities. Besides the vision and strategy, these workshops are also intended to identify which new capabilities partners should acquire next.

In this process, Microsoft learned is to focus on transparency, which was practiced in all communication efforts, and particularly in the business transparency workshops to derive a new strategy for partners. Transparency is also important for the ranking process of their partners in gold, silver, and bronze partners. Another mechanism to foster transparency are the personal account managers that gave the largest customers direct access to the strategic directions of

Microsoft. Transparency is a prerequisite towards building reciprocal trust and a common shared vision in the ecosystem.

Establish a learning platform for partners to develop new capabilities

To educate partners to leverage complementary skills was the next lesson Microsoft learned. Co-evolution is only possible if partners manage to develop new capabilities that are required in the new cloud environment. To foster this development, Microsoft developed a training platform, the Microsoft Partner University, to provide courses and trainings. Further, business transformation workshops were used to develop a strategy with each partner together. After these workshops, the partners knew which skills they had to acquire next. Microsoft supported the partners in this process, too. These education mechanisms were combined with free access to new Microsoft services provided on the ACP to improve adoption.

Provide personal guidance to, and develop tools for, partners to build complementary services

As first, it is important to complement digital innovations with personal guidance. Therefore, Microsoft established personal account managers to help the largest partners in their transformation process. These account managers were also an important vehicle for the communication of strategic insights about the future direction of Microsoft. Another means of personal communication was achieved via technology evangelists who managed to inspire partners about the advantages and business opportunities that arise through cloud technology. Personal advice is also important for technical assistance and guidance. There Microsoft urged to support partners in their development, deployment, and presales process to reduce the time to market for individual services to generate organizational learning about the most common technical issues, which in turn helped Microsoft to continuously improve the ACP.

As some of the existing partners perceived the transformation towards a cloud environment as direct threat to their business model, Microsoft learned to not dismiss the emotional component of a transformation. One means towards resolving partner resistance was the use of specific technology evangelists to inspire partners about potential business opportunities. Second was again the individual business transformation workshop, where together with Microsoft a common vision and strategy was developed. During all these activities, Microsoft focused on the individual threats and challenges of their partners and tried to resolve them, e.g., through technical guidance and support for the development and deployment of new cloud services.

Increase collaboration among partners

Drawing on this organizational learning, Microsoft learned to leverage the complementary skills of their partners. Microsoft established the Microsoft Partner Center, which allows partners to present themselves and their solutions to the ecosystem. Further, the open Azure marketplace allowed partners to actively push their solutions and distribute it via the ACP to customers and partners. This process helped to validate and improve services, and it reduced the amount of double developed services. Further, it allowed to draw on specialist services that may be very difficult for some partners to develop by themselves. To increase collaboration and cooperation among partners is generally the strategy of Microsoft who wants to create reliable, long-term relationships with its partners. This is particularly useful as both, Microsoft and its partners have the common goal of providing excellent services for their customers, now via cloud instead of on premise solutions.

Criteria for platform owners to decide which mechanisms to use

There are three criteria to consider when choosing among owner- and partner-centric mechanisms for the appropriate co-evolution mechanisms: performance, diversity of complementary offerings, and specific investments by complementors (Yoffie/Kwak 2006).

First, performance: For the application of owner-centric mechanisms, both the use of considerable financial resources and a corresponding positioning in the market are required. If a platform owner does not have this as a prerequisite, he should focus on the application of partner-centric mechanisms. Particularly supposedly weaker platform owners offer themselves as attractive partners for complementors, because they do not have to fear a harsh influence on their business activities.

Second, diversity of complementary offerings: Platform owners who rely on the widest and most varied range of partner products and services must create long-term attractive cooperation for complementors, which speaks for the use of partner-centric mechanisms.

Third, specific investments by complementors: In order to optimally realize cross-platform offers, partners must invest specifically and irreversibly in service development. Complementors are therefore committed to a long-term, stable relationship with the platform owner.

11.7 Research Method

Following Yin (2014), we conducted an instrumental case study, selecting a company that would advance our understanding of platform owner and platform partner co-evolution mechanisms. Thirteen semi-structured, one hour interviews were conducted face-to-face or via Skype with senior executives (Myers/Newman 2007), including the Partner Sales Organization Lead, Head of Solution Sales Microsoft Azure, Azure Practice Development Unit (PDU) Lead, Partner Business and Development Lead, ISV Program Lead, CSP Program Lead, two Partner Development Managers, two Partner Technical Architects, a Cloud Solution Architect, and two Business Development Managers. The interviews were recorded and transcribed.

In addition, we were given access to executive presentations on the channel transformation and the Practice Development Unit strategy. We reviewed annual reports and other publicly available studies, statistics, and press reports. These multiple data sources enabled data triangulation (Miles/Huberman 1994). To identify the owner- and partner-centric co-evolution mechanisms that serve as the basis for our lessons learned, we adopted the qualitative content analysis protocols proposed by Mayring (2010b) to categorized the interview data, presentations, and publicly available information, and to organized them into owner- and partner-centric mechanisms, focusing on the co-evolution of the platform owner and the partners in the transformation to a cloud platform environment.

11.8 Concluding Comments

Platform owners should deploy a portfolio of the owner- and partner-centric mechanisms to develop and sustain the move from a traditional partner-based sales and service model to a partner-centric platform ecosystem environment with product and services delivered in the cloud. In the early stages of the transition to the cloud, owner-centric financial mechanisms can motivate potential early adopters to move. Subsequently, partner-centric mechanisms reduce the barriers for the majority of the partners to move to and stay on, the new cloud platform ecosystem.

In practice, platform owners frequently overly rely on owner-centric short-term mechanisms. Conscious of the importance of speed to market in the move to the cloud, these owners under deploy partner-centric mechanisms that are both lower cost and more effective long-term interventions than owner-centric mechanisms.

Microsoft overcame several obstacles after its introduction of the Azure platform. Following the lessons learned presented above, Microsoft implemented owner- and partner-centric co-evolution mechanisms to develop and grow the Azure ecosystem. In the first phase – to motivate partners to join and grow the platform – Microsoft deployed owner-centric mechanisms, paying partners, and offering them access to unique cloud-based innovative services to come.

In the second phase – to engage and support partners to stay – Microsoft developed a common vision of, and strategy for, business opportunities; established a learning platform for partners to develop new capabilities; increased collaboration among partners; provided personal guidance to, and developed tools for, partners to develop complementary services on the Azure ecosystem. By applying these co-evolutionary mechanisms, and shifting from owner- to partner-centric mechanisms, Microsoft achieved a successful co-evolution of its partner ecosystem. To do this, Microsoft deployed 17 different owner- and partner-centric mechanisms.

12 Platform Owner's Mechanisms to Manage the Co-evolution of Complementary Partners (P9)

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Table 33. Fact Sheet Publication P9

Abstract

Digital platforms that allow to recombine and redeploy value creation in new ways create the potential to radically change the way how organizations are doing business in their respective ecosystems. These changes in value creation led to a disruption of many well-established business models. To prevent this, particularly in platform ecosystems, where value is co-created among multiple stakeholders, platform owners need to find mechanisms on how to manage the transformation of their complementary partners. Doing so, we use co-evolution theory to analyzing four cases of successful ecosystem transformation. We identify 28 mechanisms for platform owners to manage the co-evolution of their complementary partners in three steps: before, during, and after the development of new complements on, or the transformation of established complements to, the new digital platform ecosystem. Organized in the three steps, the findings of our multiple case study shows that the management of co-evolution comprises of aligning, enabling, supporting, and motivating partners in the joint undertaking, while continuously maximizing the attractiveness of the digital platform ecosystem. Thereby, we contribute to literature on digital platform ecosystems, by 28 distinct providing mechanisms for platform owners to manage the co-evolution of their complementary partners, and show that these mechanisms can be used for dynamic capability development in the self-renewal phase of digital platforms.

12.1 Motivation

Digital platforms that have the capacity to combine and deploy value creation in new ways create the potential to radically change the way organizations are doing business in their respective ecosystems, which led to a disruption of many well-established business models (Lucas/Goh 2009; Rai/Tang 2014; Vial 2019). To prevent such disruptions, the importance of managing partnerships is increasingly noticed as strategic practice for platform owners to govern their ecosystems (Jacobides et al. 2018; Sarker et al. 2012; Teece 2017).

Moreover, as the market for information technology is continuously evolving and giving rise to a variety of innovations, platform owners need to find and execute mechanisms to manage the co-evolution of partners in the ongoing transformation of digital platform ecosystems (Vial 2019; Riasanow et al. 2019). Such digital platform ecosystems consist of digital platforms and applications specific to it as well as the stakeholders of the platform, i.e., platform owners and complementary partners (Tiwana 2014; Jacobides et al. 2018). We understand platform owners as individual or organization representing the legal entity that owns the platform (Tiwana 2014; Foerderer et al. 2018; Gawer/Henderson 2007). Complementary partners contribute additional value to the digital platform, e.g., in the form of applications (Tiwana 2014; Kude et al. 2012). Further, platform owners also rely on complementary partners to gain access to customers, or complementary resources and capabilities (Sarker et al. 2012; Lusch/Nambisan 2015). For example, platform owners may use and evolve boundary resources enabled by digital technologies to manage distributed, heterogeneous, and resource-integrating complementors (Eaton et al. 2015; Ghazawneh/Henfridsson 2013). While evolution describes the advancement of the ecosystem as a whole, co-evolution refers to the dynamics between and within the organizations, e.g., as platform owners and complementors in the ecosystem (Lewin/Volberda 1999; Montealegre et al. 2014; Tiwana et al. 2010).

Adopting this perspective, scholars already investigated the attempt to balance between control and generativity, e.g., the provision of boundary resources may facilitate the development of a robust ecosystem around a digital platform (Ghazawneh/Henfridsson 2013), or too strict control may face resistance from third-party complementors (Eaton et al. 2015). Apart from connecting generativity to governance in terms of control, other scholars found the evolution of architecture's generativity through the provision of boundary resources also affects the variety of third-party complementors (Tiwana 2014), which has led to the establishment of a co-evolutionary link between platform core and platform periphery (Staykova/Damsgaard 2015, 2018).

Broadening this perspective, recent studies have accounted for the co-evolution between IS capabilities and strategy (Tan et al. 2015), digital platform ecosystems and its environment (Ojala/Lyytinen 2018; Tiwana et al. 2010; Tan et al. 2016), and architecture and actors (West/Wood 2014). Co-evolution also occurs between two distinct groups of actors, e.g., users and complementors, as each of these groups adapts to the changes in the other (Song et al. 2018). Research on digital platforms acknowledges complements usually evolve on their own with no detailed guidelines from the platform owner (Woodward/Clemons 2014). We already know why complementors contribute to platform ecosystems, e.g., due to access to resources and capabilities, which depends on the platform owner's ability to provide integrated systems, to innovate, commercial capital, and reputations (Kude et al. 2012). However, we do not know which mechanisms platform owner can implement to manage the co-evolution of complementary partners (Jacobides et al. 2018; Puschmann 2017; Teece 2017).

Therefore, we conducted a multiple case study among four successful co-evolutions of platform owners and their complementors and identified XX mechanisms that platform owners' deployed in order to manage the co-evolution of their complementors in the respective ecosystems.

The theoretical contribution of our paper is twofold. On the one hand, we advance digital platform literature by examining XX mechanisms on how platform owners' can manage the co-evolution of complementary partners. On the other hand, we contribute to ecosystem theory by organizing the identified mechanisms in a three-stage model (before, during, after development or transformation of complements) to theorize how co-evolution can be managed from a platform owners' perspective. Practitioners, particularly platform owners with an existing ecosystem, or desiring platform owners, may use these findings to identify and evaluate potential mechanisms to guide the co-evolution of their complementary partners.

12.2 Co-evolution in Digital Platform Ecosystems

Below, we adopt this co-evolutionary viewpoint to study the transformation of partnerships in platform ecosystems.

In the organizational context, co-evolution theory assumes that change may occur between any interacting organizations, including change driven both by direct interactions on, and feedback from, an ecosystem (Lewin/Volberda 1999). While evolution describes the advancement of the ecosystem as a whole, co-evolution refers to the dynamics between and within the organizations as owners and members of ecosystems (Lewin/Volberda 1999; Montealegre et al. 2014; Tiwana et al. 2010). As a multilevel theory (Rai/Tang 2014), co-evolution provides a suitable lens for our goal to analyze digital platform ecosystems from both platform owners' and complementary partners' perspectives (Tiwana et al. 2010).

Since its resurrection in organizational science literature, co-evolution is a "core concept in studies of complex adaptive systems and the economy, focusing attention on reciprocal cycles of adaptation among one or more elements of an economic system" (Moore 2006), in which, for example, the architecture, governance and competitive environment of platforms mutually influence each other (Tiwana et al. 2010). While recognizing the importance of understanding the IT architecture as an underlying part of the digital platform ecosystem, researchers have acknowledged the interdependencies between architecture and governance, leading to the emergence of the co-evolution perspective (Ghazawneh/Henfridsson 2013; Tiwana et al. 2010).

Adopting a co-evolutionary perspective, scholars further investigate the co-evolution as an attempt to balance between control and generativity, e.g., governance versus architecture (Ghazawneh/Henfridsson 2013; Eaton et al. 2015). To encourage participation from third-party complementors, platform owners need to develop generativity of the architecture by introducing new boundary resources (e.g., APIs, SDKs, etc.) through a process of 'resourcing' (Ghazawneh/Henfridsson 2013). While this improves the overall generativity and facilitates the development of a robust ecosystem around the digital platform, it also leads to increased heterogeneity of actors, which calls for a better or tighter control regime, established through a process of 'securing' (Ghazawneh/Henfridsson 2013). The increased level of control over the access and use of boundary resources, however, may face resistance from third-party complementors, who can refuse the new terms imposed by the platform owner (Eaton et al. 2015). Subsequently, the resistance can lead to a process of adjustment, where, under pressure, the platform owner modifies the newly introduced boundary resources (Eaton et al. 2015).

Referred to as 'distributed tuning' (Eaton et al. 2015), this process of 'resistance and accommodating', which shapes the evolution of boundary resources, constitutes a particular manifestation of the co-evolution between architecture and governance.

Apart from connecting generativity to governance (in terms of control), researchers also state that the evolution of architecture's generativity through the provision of boundary resources also affects the variety of third-party complementors (Tiwana 2014). In particular, digital platforms enable the emergence of a variety of external complements due to the offering of stable and versatile interfaces (or boundary resources) (Baldwin/Woodward 2009; Tiwana 2014), researchers began to analyze closely the evolutionary patterns exhibited by these external complements. This shift has led to the establishment of co-evolution link between generativity (platform core) and variety (platform periphery) (Staykova/Damsgaard 2015, 2018).

The co-evolution between generativity and variety is a process, which is difficult to predict and guide (Staykova/Damsgaard 2018). While the generativity of the architecture spurs variety of complements, the latter usually evolve on their own with no detailed guidelines from the platform owner (Woodward/Clemons 2014). Furthermore, whilst most researchers assume that an increase in the level of generativity (that is increased number of boundary resources, such as APIs or SDKs) would lead to an increase in the number of third-party complements (Tiwana 2014; Baldwin/Woodward 2009), recent empirical research challenges this assumption (Um/Yoo 2016).

By investigating the evolutionary patterns of various third party complements over time, researchers also found evidence that the presence of more complementors, enabled by generativity, do not always lead to more variety. Boudreau (2012), for example, demonstrates that initially, present complementors offer more innovative complements in comparison to latecomers, who often provide complements similar to already existing ones. Increased variety of complements, however, is not always advantageous for a platform owner as it can be a source of various tensions between actors within the digital platform ecosystem including the platform owner (Wareham et al. 2014). In particular, third-party complementors often compete with one another (intra-platform competition) to attract demand-side users by upgrading their complements (Tiwana 2015). In some cases, they also compete with the platform owner by imitating some of the main platform functionalities or even complements, offered by the owner (Gawer/Cusumano 2014; Gawer/Henderson 2007).

Apart from observing solely the co-evolution of actors, architecture, and governance, as well as the capabilities and mechanisms within the digital platform ecosystem, researchers have also pointed out that ecosystems co-evolve together with their environment (Tiwana et al. 2010). Tan et al. (2016), for example, propose to trace the co-evolution of the competitive environment, IT affordances, and the platform configuration, which evolve from a closed platform to open platform and later community platform. They show that as the competitive environment in which digital platform ecosystems operate changes, platform owners can actualize various IT affordances in order to attract distinct users (users and third-party competitors alike), thus driving the ecosystem towards more openness.

Similarly, Ojala/Lyytinen (2018) argue that the actions in response to changing competitive environment lead to changes in the architecture and the corresponding 'control points' (governance), which regulate the access to the architecture. The introduced changes in the architecture affect the number of affiliated to the platform ecosystem actors and their interactions. Thus, Ojala/Lyytinen (2018) present the evolution of a digital platform ecosystem as influenced by the exchange between its environment, architecture, governance, and actors.

While the generativity-variety as a certain manifestation of early co-evolution research implies for co-evolution between architecture and third-party complementors as certain type of ecosystem actors, researchers also started to explicitly outline such interdependency by including wider set of ecosystem actors. Kim et al. (2013), for example, investigate the evolutionary path of online social networks, which function as digital platform ecosystems, as a configuration of three dimensions (technology, suppliers, and users), thus proposing that architecture and actors co-evolve. Similarly, West/Wood (2014) in their study on the development of the Symbian ecosystem briefly outline the co-evolution between architecture and ecosystem actors. Jha et al. (2016) also found in their research that architecture and a broad range of ecosystem actors (that is, intermediaries, community, institutions, and partners, etc.) co-evolve. Researchers have also acknowledged the co-evolution between two distinct groups of actors (e.g., users and complementors) as each of these groups adapt to the changes in the other (Song et al. 2018).

To put it in a nutshell, we already know how co-evolution between governance and generativity, generativity and variety, co-evolution of actors with architecture, the environment, or among several actors is taking place. Also, extant research provides us insight into why complementary partners contribute to platform ecosystems, i.e., due to access to resources and capabilities, which depends on the platform owner's ability to provide integrated systems, to innovate, commercial capital, and reputations (Kude et al. 2012). However, from the perspective of digital platform governance, we do not know which mechanisms platform owner can implement to manage the co-evolution of complementary partners (Jacobides et al. 2018; Puschmann 2017; Teece 2017).

12.3 Research Method

This section shows the employed research method comprising of multiple instrumental retrospective case studies based on semi-structured expert interviews, triangulated with secondary company data, such as reports, web sites, and third-party assessments.

12.3.1 Case Study Introduction and Research Setting

The case study approach is well established in the IS literature (Tsang 2014) and a preferred way of investigating real-life phenomena over which the researcher has little control (Yin 2014). We follow the approach of Kaltenecker et al. (2015) as a blueprint for the setup of our multiple case study, who are applying the guidelines of Gibbert/Ruigrok (2010) to "talk the walk" through our process of data collection and analysis to ensure methodological rigor.

Following the guidelines of Yin (2014), we used instrumental case studies because we selected companies that would advance our understanding of partnerships in platform ecosystems due to the introduction of a new digital platform. To produce generalizable results, we did not limit our sample to one specific industry. These case studies were based on theory building and development. The studies were also retrospective because we collected past data at a single point in time. We used a multiple case approach to ensure reliable data analysis and a general but through an understanding of the overall case context. We used the following criteria to select case studies. (1) The company had to be a well-established player in its respective industry. (2) The company had to be the owner of the digital platform. (3) The company was required to have an ecosystem consisting of complementary partnerships that were co-creating value based on the company's product or service offerings. (4) The company had introduced a digital platform that transformed the value creation or capture in the respective ecosystem.

Case	**Microsoft**	**SAP**	**Finning**	**CEMEX**
Year of founding	1975 (USA)	1972 (Germany)	1933 (Canada)	1906 (Mexico)
Industry	Software	Software	Manufacturing	Building materials
Revenue	110 bn. USD	23,46 bn. USD	3,674 bn. CAD	276,855 mn. MXN
Employees	124,000	96,000	12,000	42,000
Digital Platform	**Microsoft Azure**	**SAP Cloud Platform**	**Finsight**	**CEMEX Go**
Platform launch	2010	2012	2009	2017

Table 34. Overview of the Selected Case Companies

Table 34 shows an overview of the selected case companies. Further, all companies have international customers, and, they have subsidiaries around the world. All the companies are owners of digital platforms and started to manage the co-evolution of partners in the surrounding ecosystem after the introduction of the digital platform. Hence, all platform owners already relied on a partner ecosystem before introducing their digital platform.

12.3.2 Data Collection

To ensure the quality of data, we used triangulation on all case studies (Yin 2014). We used a semi-structured technique (Myers/Newman 2007). Each of the experts should have sufficient experience in the respective ecosystem, as well as with digital technologies. We use experts in a leading strategic position or information technology related function (Goldberg et al. 2016a) who have privileged access to information and knowledge on the subject (Bogner et al. 2009b). This allows us to draw different customer insights from various companies and long-time market experience from broad knowledge. All information was gathered starting in July 2017 and was concluded in January 2019.

Digital Platform	**Total**	**Interviewees**
Microsoft Azure	13 / 12h	(M1) Partner Sales Organization Lead (M2) Head of Solution Sales Microsoft Azure (M3) Azure Practice Development Unit Lead (M4) Partner Business and Development Lead (M5) ISV Program Lead

		(M6) CSP Program Lead (M7-8) Partner Development Managers (M9-10) Partner Technical Architects (M11) Cloud Solution Architect (M12-13) Business Development Managers
SAP Cloud Platform	9 / 9h	(S1) Vice President Digital Supply Chain (S2) Vice President Cloud Platform (S3) Product Manager Cloud Platform (S4) Chief Product Owner Cloud Platform (S5) Lead Architect Cloud Platform (S6) Developer Cloud Platform (S7) Developer Globalization Hub (S8) Developer Localization Hub (S9) Controlling Global Cloud
Finsight	3 / 3h	(F1) General Manager of Digital Transformation (F2) Team Lead of Finsight remote monitoring team (F3) Product Support Sales Manager
CEMEX Go	22 / 19h	(C1) Head of Digital Enablement Consulting Services (C2) External consultant to CMEX, responsible for open innovation (C3) Head of Digital Transformation Services and Development (C4-8) Inhouse Consultants, digital enablement and change management (C9-15) User Interface and User Experience Designers (C16-20) Inhouse consultants, business processes (C21-22) Software engineers

Table 35. Interviews

12.3.3 Data Analysis

Following Miles/Huberman (1994), we began with the within-case analysis. Therefore, we concentrated on the companies' individual transformation process and tried to identify how the individual platform owners' managed the co-evolution of their complementary partners. To identify the mechanisms, we had to go back and forth in the data in order to develop a cohesive story of the transformation process in each company. The information in the interview was cross-checked and supplemented with information from additional sources to provide a more complete picture.

As the next step, Miles/Huberman (1994) recommend a cross-case analysis. The objective is to extend external validity and enhance generalizability. As the first aim was to identify whether any co-evolution mechanism could be found within our case studies, we searched our data concerning on these mechanisms. As we explicitly asked for them during the interview, we found evidence within every case. Thus, we followed an open coding approach (Gläser/Laudel 2009; Wiesche et al. 2017). When we found a platform owner deploying a particular mechanism (e.g., develop an education portal to train their partners) all other cases were scanned for this mechanism. Using this approach, we were able to identify similarities and differences between the companies. Although the case companies differed demographically (e.g., age and size), several mechanisms were observed in all cases. If a particular mechanism was not observed for a particular company, we investigated the reasons behind the absence (e.g., financial incentives were especially important for Microsoft, while collaboration with start-ups was particularly important for CEMEX) by checking secondary data and revisiting recorded interviews. For example, when interviewees thought that a mechanism was obvious, they did not explain it in detail (such as the ranking of complementary partners in gold, silver, and bronze status). However, listening closely to the recorded interviews and checking secondary data helped clarify this fact. This approach was essential to revealing the big picture.

12.4 Results – Case Individual

In this section, we present the results of each case study separately.

12.4.1 Microsoft Azure

Founded in 1975 by Bill Gates and Paul Allen, Microsoft Corporation is a world leader in software and hardware, with revenues of $110.40 billion in 2018. Since 2014, the Microsoft group has been restructuring to transform the on-premises Microsoft software service and product business from a product-centric organization into a business in which employees and partners leave the traditional software licensing and related product world behind them and think in terms of digital services delivered in the cloud.

This required a significant transformation of the Microsoft business model and partner ecosystem, which Microsoft tackled through the introduction of the Azure cloud platform. For example, the regular software license and maintenance payments in an on-premises environment would be replaced by pay-per-use contracts on Azure. Azure supports building, testing, deploying, and managing applications and services through a global network of Microsoft-managed data centers, listing over 600 services available in the Azure ecosystem. Also, it supports multiple programming languages and frameworks, including both Microsoft-specific and third-party software and systems.

Microsoft's Azure ecosystem consists of more than 100,000 partners worldwide in 2019, with a steady increase from 68,000 in 2018 (M1, Interview). Hence it grows about more than 7,500 partners per month. Overall, Azure serves more than 3.6 million customers. In 2019, more than 28% of the annual revenue was due to cloud services provided via Azure (Microsoft 2018). As 95% of the revenue is generated via partner channels, Microsoft is heavily dependent on the complementary capabilities, access to customers, and services of its partners. Microsoft's partners manage separate but overlapping businesses, including distribution, licensing, reselling, support, system integration, project management, hosting, managed applications, and individual software (Microsoft 2018).

While building Azure and planning the deployment of the Azure ecosystem, Microsoft investigated the barriers and drivers for partners to adopt the proposed new Microsoft online business environment. The investigation identified challenges and opportunities for their partners in the new cloud environment.

First, as customers would be able to access Microsoft services directly from the Azure ecosystem, the business opportunities for licensing and reselling partners would be reduced. However, as large customers would initially still require their services, this business would have a long tail. Second, the transformed ecosystem would experience increased demand for managed services and the development of intellectual property. Therefore, Microsoft would need to expand this partner group and, particularly for individual software partners, to deliver services on the Azure ecosystem. Third, only a few partners were already highly knowledgeable about, and experienced with, cloud technology. There would be a high demand for training by these partners to build the necessary specific capabilities to develop and operate Microsoft products and services on the Azure platform. To respond to these challenges, Microsoft deployed several mechanisms to manage the co-evolution of its partners to generate benefits for all partners

No.	**Mechanism**	**Description**
Co_M01	Financial Incentives	Financial incentives to (re-)sell cloud services instead of on premise solutions
Co_M02	Preferential access	Distinct functions and services are only available via cloud
Co_M03	Cost Reduction	Subvention through cheaper contracts for cloud services
Co_M04	Free Services	Licenses to access the services for free
Co_M05	New partners (competition)	Collaboration with innovative service providers and integrating them in the ecosystem, and thereby increasing pressure on existing partners
Co_M06	Personal Account Manager	Personal account manager help to support business development of the largest distribution partners and provide insights about the strategic direction of Microsoft
Co_M07	Business Transformation Workshop	Business transformation workshops to innovate the business model to a recurring service business. These workshops are extended by firm-specific topics, e.g., data security or compliance
Co_M08	Marketing Service Portal	Establishment of a marketing service portal to provide partners information for digital marketing: SEO, social media, and website design and architecture
Co_M09	Education Portal	Microsoft's Partner University provides access to education programs (personal or online) to train professional and soft skills
Co_M10	Open Marketplace	Microsoft's Open Azure Marketplace allows partners to provide and distribute their proprietary services in the partner ecosystem. The marketplace can be used to leverage existing services and build solutions on top of them

Co_M11	Ranking	Microsoft-recommended solution providers with proven expertise receive Gold or Silver expertise
Co_M12	Technical Guidance	Partner Advisory Hours provide access to customized technical guidance during design, development and deployment phases of a complementary solution
Co_M13	Free technical assistance	Partners can rely on technical advice and individual assistance free of charge in the presales phase of their complementary service
Co_M14	Exclusive technical services	Signature Cloud Support is an exclusive technical service that provides qualified partners with preferred technical support for selected cloud solutions from Microsoft
Co_M15	Customer Satisfaction	The Customer Satisfaction Index is an online survey system that provides third party market research data at no cost, allowing partners to better analyze their sales market
Co_M16	Regular Communication	Regular newsletters keep partners up to date with news on the Microsoft partner network, new business opportunities, or training. Social media is used to push information about innovations in the Microsoft partner network
Co_M17	Technology Evangelists	Technology evangelists inspire indecisive partners with new technology. They are contact and discussion partners in forums, conferences and user meetings, participate in specialist lectures, publish articles in relevant media and write podcasts, webcasts or blogs.

Table 36. Microsoft's Mechanisms to Manage the Co-evolution of its Complementors

Financial incentives for resellers are strictly contingent on partners delivering services in the cloud. For Microsoft as a platform owner, the trade-off was between the number of partners moving to the cloud and the cost of the financial inducement: "*I like to invest time, money and love in a partner, but expect [the partner] to realize this subject on the radar, at least after three or four months*" (M1, interview). For example, Microsoft rewarded licensing partners with a fixed price if cloud services were sold (Co_M1).

Microsoft specified that upgrades to major services, and new products and services, would be supported only on the Azure platform and not supported in an on premise environment (Co_M02). For example, it is not possible to use Microsoft's Office on iOS without a subscription to Azure.

Microsoft sold customers cheaper contracts for cloud-based compared to on-premises services (Co_M03). This mechanism is different from the first above because it does not necessarily lead to a payment. Importantly, cloud service contracts are designed on a per-user basis compared to use the software on a specified number of devices while only paying one fee for the service. In contrast, a separate license key for the service is necessary for each device in an on premise environment.

To boost the digital platform, partners received free licenses for Azure-based services for software development, training, and marketing (Co_M04). "*We give the partners internal use rights so that they can use our technology on their own without paying for it, we give them training vouchers, we do road shows with them, we go with them at trade fairs and so on*" (M1, interview). Due to this mechanism, Microsoft invested directly in knowledge transfer to, and business development of, the partners, increasing their skills to operate in the Azure ecosystem.

Microsoft approached potential new partners to develop innovative cloud services (Co_M05). This mechanism had to effects. One was to increase the range of services supported by the Azure ecosystem. The other was to increase the pressure on existing partners to move to the cloud to pre-empt their customers moving to the new partners. While it is unlikely that many customers would combine moving to the cloud with changing their Microsoft partner, this mechanisms did also motivate the existing partners to innovate on the cloud to prevent new partners from taking the new low hanging fruit on offer, contributing to the rate of innovation on Azure.

However, Microsoft was also conscious that, some ecosystems, for example, mobile software ecosystems are driven by hypercompetitive dynamics, where app developers are constantly under threat of being outpaced (Kapoor & Agarwal, 2018). During the co-evolution the locus of control moved to the partners, who choose how to rebuild their businesses in the cloud, see co-evolution mechanisms Co_M06-17.

The next mechanism relied on Microsoft employees, the personal account managers in the sales support organization, to act as the first point of contract between Microsoft and the partners to share and build a common understanding of the new cloud-based partnership (Co_M06).

For a large number of small and medium-sized partners, content was and still is, distributed through mass media, including publications, social media, and via the online offers in the Microsoft Partner Network (MPN). Adopting the cooperative co-evolution paradigm, Microsoft helped these partners to successfully develop cloud-based business models and services by providing business, technical, and sales and marketing support, workshops to position themselves in the Azure ecosystem and start a successful cloud business model. "*We offer business transformation workshops for the partners in various forms. Then the topic of privacy is still a big topic in cloud sales, so that the customer brings objections and pretexts around the topic of privacy and cloud. In the meantime, we also offer workshops where lawyers can give our partners counter-arguments in the case of objections and pretexts in non-legal language*" (M7, Interview). These workshops (Co_M07) also helped to reduce partner concerns and fears about moving to a cloud environment. Data protection and digital marketing emerged as the most important topics for discussion.

Microsoft established a marketing service portal to support digital marketing (Co_M08). This portal helps partners to extend their reach with SEO, to develop a social media strategy and provides guidance for website design and architecture. The goal of this portal is to provide partners with mechanisms to extend their potential customer base through a range of digital channels.

Further, Microsoft's Partner University provides access to education programs (personal or online) to train professional and soft skills (Co_M09). This helped partners to develop the necessary skills to develop complementary solutions on Azure an encouraged them to innovate with the new skills or methods.

An open marketplace called Microsoft Azure Open Marketplace helped partners to leverage proprietary solutions (Co_M10). There, cloud services are provided and distributed in the partner ecosystem. Other partners can search, access, and use the services to build solutions on top of them. This marketplace is provides partners a platform to market themselves and their solutions to the ecosystem.

Next, Microsoft ranked its complementary partners (Co_M11). For example, a partner with very high proven expertise is ranked as a Gold partner, whereas partners with less expertise are ranked as Silver or Bronze partners, depending on their service level and expertise. This motivated partners to develop their expertise.

The next three mechanisms (Co_M12-14) are based on technical support and assistance. Microsoft provided technical guidance for the design, development, and deployment phase of complementary services. To do this, Microsoft provides customized technical guidance during ‘Partner Advisory Hours’ with “*roles such as Cloud Solution Architects, data scientist, (…) to help them [for partner] enablement*” (M4, Interview). In addition, technical assistance is free during the pre-sales phase after the development of a complementary service and keeps Microsoft informed about the most common problems during that phase, which helps to improve the ecosystem (Co_M13). Microsoft also provides exclusive technical services via a service called Signature Cloud Support for partners who qualified based on customers, revenue, and strategic impact (Co_M14).

The last three mechanisms (Co_M15-17) were designed to support the long-term development and sustainability of complementary relationships. First, Microsoft used a Customer Satisfaction Index (Co_M15) collected via an online survey provide by an independent third party to collect data on partner sales and marketing activities. Second, Microsoft relies on various mechanisms to stay in touch with their partners, including, for example, a regular newsletter to communicate recent innovations in the ecosystem, business opportunities, and training (Co_M16). This is also distributed via social media, including LinkedIn (one of the strategic acquisitions of Microsoft). Third, technology evangelists (Co_M17) were used to inspire partners and customers by providing examples of the advantages of innovative technologies at conferences, user group meetings, specialist lectures, and digitally via blogs, podcasts, videos, training, or webcasts, summarized by M7 as “*steady drops hollow the stone. It is an interplay of continuously bringing this message to the channel: cloud, cloud, cloud, cloud*” (M7, Interview).

12.4.2 SAP Cloud Platform

SAP, first, formed a cloud computing group in 2005, which finally resulted in the establishment of a separate on-demand business unit operating independently from the existing On-premises business. The On-demand division was equipped with decision-making powers and resource competences. The company tried to acquire the most innovative employees internally and sought experienced people externally. Some of the external employees had gained experience with transformation processes in other companies and industries.

SAP as the largest ERP provider, continuously moved from on premise to cloud with the introduction of its SAP S/4 HANA Cloud Platform. Based on its multi-cloud foundation (e.g., SAP’s own cloud, Alibaba Cloud), customers can access a multitude of cloud services based on a scalable infrastructure (SAP 2019b). These services constitute of analytics, blockchain, machine learning, collaboration, master data management, and many specialized services, which have been acquired by SAP. Among these acquisitions are, for example, SuccessFactors for human capital management, or Concur, a mobile travel and expense management service. Hence, some of the strategic acquisition are only accessible via the new cloud platform.

Moreover, SAP also offers API packages, for example for SuccessFactors, and different pricing and packaging mechanisms, which allows customers to tailor the platform to their needs.

Currently more than 1500 complements – applications developed by complementary partners – have been developed on the SAP Cloud Platform, and are available at the SAP App Center (SAP 2019a).

No.	Mechanism	Description
Co_S01	Co-Innovation contracts	Formalized joint investment into a new product or service built on top of the SAP Cloud Platform. The contribution of each party (platform owner, complementor) are written down in the contract.
Co_S02	Strategic Acquisition	Acquisition of specialized cloud organizations to increase the service portfolio on the SAP Cloud Platform, e.g., Fieldglass (vendor management), Ariba (procurement), SuccessFactors (human capital management), or Concur (travel and expense management).
Co_S03	Online Education Portal	openSAP provides access to education programs (only online) to train professional and soft skills

Table 37. SAP's Mechanisms to Manage the Co-evolution of its Complementors

12.4.3 Finsight

The third company is Finning UK Co. Ltd. This company is the world's largest dealership organization for products of Caterpillar Inc. It employs 12,000 staff globally and distributes construction machinery and equipment in Canada, the UK, and Ireland as well as in Latin American countries.

Finning is transforming in terms of the product portfolio offered to its customers. Doing so, it has actively invested in remote condition monitoring. Since early 2016, a dedicated digital division is building a digital platform ecosystem to achieve to connect assets and data analytics (Finning 2018). In the area of connected assets, Finning has been a particularly early mover. After the initial ideation and planning in 2009, the Finsight condition monitoring platform was introduced in 2012 (F1, Interview). After six years in active use, it currently connects closely to 20,000 assets primarily in the UK and Ireland, with the rollout in Canada currently underway. In the UK, a team of former service technicians continuously monitors all machines with data from GPS, acceleration, and fuel consumption sensors, from the engine control unit and other systems on board, such as seat belt checking. Also, as part of the monitoring package, oil samples from the engine or hydraulics systems are taken and analyzed at regular intervals, resembling a blood sample to assess human health. The common reaction to fault alerts is to send service mechanics to conduct preventive maintenance. Furthermore, the training of machine operators is offered to help the workers to use the equipment in the most efficient and secure ways.

To develop and extend Finsight, Finning maintains an ecosystem with several complementary partners. Being an exclusive dealer for Caterpillar, it is reliant on the manufacturer to align the interfaces into the on-board systems. A joint venture between Caterpillar and Trimble called "VisionLink" develops software to aggregate data from the telematics devices and provide networking capability. The latter is then sourced from Cisco Systems and then LTE cellular network providers such as British Telecom. Finally, the software engineers at Finning rely on software platforms, such as Microsoft Azure, to develop the applications and dashboards for the Finsight monitoring team (Finning Microsoft Customer Case, 2016). An interesting development, in terms of the co-evolution between Finning and Caterpillar, is the fact that the positive results of Finsight in the UK market contributed to Caterpillar making it mandatory for all their dealerships, globally, to offer a dedicated condition monitoring solution, facilitated via VisionLink. Furthermore, Finning is probing options of extending the product also to equipment from other OEMs, as the customers usually run a mixed fleet from all major manufacturers to reduce dependency.

No.	**Mechanism**	**Description**
Co_F01	Invest in operators	Equity investments into production and distribution partners
Co_F02	Joint venture	Setup a joint venture of current entities in the ecosystem. Formalized way of co-evolution, in which the capabilities for architecture and modularization are built in a new legal entity

Table 38. Finning's Mechanisms to Manage the Co-evolution of its Complementors

For building better capabilities in the run time, a platform owner can make equity investments into production and distribution partners, to successfully capture the leadership position in the ecosystem. Therefore, the operator must directly accept the governance of the platform owner. This helps to establish a stable architecture and set standards in the controlled entities. For example, Finning made an investment in the construction site optimization software company SITECH in the UK in order to "*provid[e] innovative technology solutions for customers' entire equipment fleet, regardless of the machine make, type or model*" (Finning Invests In Advanced Site Technology Acquiring SITECH Dealership, 2014). Thus, this constitutes a competitive move to challenge the co-dominance of Caterpillar in the condition monitoring field and to enhance the servicing capabilities of Finning.

As an alternative to establishing a separate and independent working body, the setup of a joint venture of current entities in the ecosystem was discussed. A joint venture (Co_F02) would represent a more formalized way of co-evolution, in which the capabilities for architecture and modularization would be built in a new legal entity. The approach of using a joint venture to govern an IT architecture also emerged at Finning, in whose ecosystem the joint venture VisionLink supplies the IT architecture on which Caterpillar and Finning are basing the monitoring solutions.

12.4.4 CEMEX Go

CEMEX is a multinational corporation in the building materials industry. The operations of CEMEX are distributed in 50 countries, with the number of locations for production and distribution exceeding 2,000.

Being a top priority of the global executive board, CEMEX has "*embarked on a bold digital transformation to achieve the best customer satisfaction of any business-to-business company*." (CEMEX Annual Report 2017). The core of this initiative is the creation of the digital platform, CEMEX Go. It was launched in 2017 to provide its customers with real-time data of their orders, GPS tracking of the cement or aggregate shipments, and make changes to their purchase orders through mobile and desktop applications. For the digital platform, a dedicated new brand was created to communicate the transformation to the customers as well as the employees and other parties in the ecosystem.

CEMEX's complementary partners in the ecosystem consist of external consulting and IT providers, education partners, various logistics partners, and suppliers, as well as retail partners. In a central role, there is a fully owned subsidiary called "NEORIS" that works as an IT service provider and digital consultancy for CEMEX as well as third parties. Also, CEMEX and its subsidiary NEORIS are founding members of a "digital hub" collaboration at the location of CEMEX's headquarters, which is described to be "a space where entrepreneurs, companies, universities, and investors converge to foster an ecosystem for Digital Transformation" (NEORIS 2018).

No.	**Mechanism**	**Description**
Co_C01	Channeling feedback	Identify, gather, organize, and distribute customer feedback within the firm and the ecosystem, requires a new management role to orchestrate the feedback
Co_C02	Standardization body / Working groups	Establishing a separate and independent working body to align the capabilities of the ecosystem partners through modularization and interface standardization
Co_C03	Information Platform	Central platform that enables to find resources to develop and extend digital skills
Co_C04	Collaborations with start-ups	Collaboration with innovative start-ups to enhance sensing and seizing capabilities
Co_C05	Innovation alignment	Align and synchronize the innovation capabilities of multiple actors in the ecosystem
Co_C06	Consulting services to external partners	See what is trending outside, and what is going on in different areas inside

Table 39. CEMEX's Mechanisms to Manage the Co-evolution of its Complementors

A mechanism to enhance capabilities in the run time that was proposed was called "Channeling CEMEX Go Feedback" (Co_C01). It addresses the weaknesses that many entities in the ecosystem are not provided with the feedback from the customer. The feedback management capability was assigned in the servicing stage of the ecosystem. The action to enhance this was detailed by the team into a process of feedback identification, gathering, organization, and distribution of all customer feedback within the firm and ecosystem. This would yield the following benefit: "*Having this co-ordinational feedback, we would have useful data for continuously improving the project. We would be creating more realistic user stories. For building each CEMEX Go Product backlog*" (C5, Interview). Afterwards, a new organization role is required to oversee the management of the feedback. One of the interviewees confirmed that this mechanism "*I analyzed (…) how the feedback of the platform, how the end-user feedback of the platform is gathered and how it is then distributed within the company*" (C7, C19, Interview).

Standardization and working group bodies were mentioned as a solution to facilitate the flow of information and communication in the ecosystem (Co_C02), and through that helping to develop better FUC. It was discussed that industry bodies are a suitable way to aggregate knowledge of a large number of independent players and act as an intermediary of knowledge in the ecosystem. This is, for example, helpful for the development of an innovation.

Information platforms (Co_C03) were suggested by three interviewees from CEMEX. There it was suggested, mainly, in the context of talent development, in that a central platform could enable employees to find more resources on how to extend their digital skills.

Collaborations with start-ups (Co_C04) were observed as a means to enhance sensing and seizing capabilities, which is realized through the establishment of the 'MTY Digital Hub', as part of a global initiative.

However, this is deemed necessary to align and synchronize the innovation capabilities (Co_C05) of multiple actors in the ecosystem. This could, for instance, be realized through regular interactions among R&D teams that can discuss how their innovation activities complement each other into an ecosystem-wide target picture. To some extent, this resembles the challenge of CEMEX to integrate all of the operational departments into the innovation process, as described earlier. This is mutually beneficial: "*So, this will create a win-win situation, where CEMEX will get a lot of good new ideas, fresh ideas, that are going to be applicable with CEMEX and at the same time they will have a pool of talent that they can join the company in the future*" (C12, interview).

Capabilities in the build time can be purposefully amended with competitive mechanisms in at least two ways. First, the initiation of consulting services to external partners (Co_C07) in the ecosystem. CEMEX described the advantages of such a consulting division as *"[CEMEX would] become more agile, for seeing opportunities. As what is trending outside, what is going on in different areas inside CEMEX. And I believe CEMEX has very cool core capabilities. We were talking about how we are experts in supply chain and logistics for example*" (C7, Interview). Also, for firms that are not currently partnering with CEMEX, the move to provide consulting services to them has a competitive character. This business offering ultimately also contributes new revenues from the customers, as C1 said, "it's important, also the opportunity to monetize this activity". With NEORIS, the IT servicing and consulting company, CEMEX is realizing this mechanism.

12.5 Discussion: Cross-case Conclusions

In the next step, we organize the mechanisms detected in the single case analyses based on their role before, during, or after the development of new complements on, or the transformation of established complements to, the new digital platform, see Figure 16. Organized as follows, we suggest a three step approach to manage the co-evolution of complementary partners from a platform owner perspective.

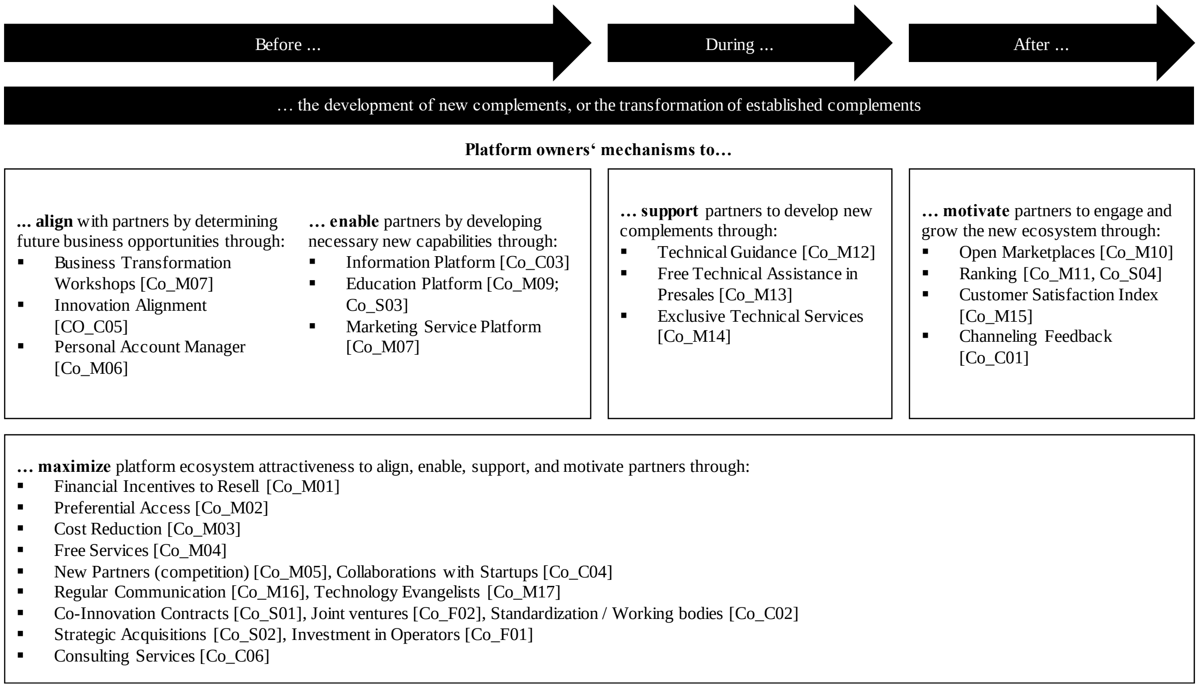

Figure 16. How to Manage Co-evolution of Complementary Partners as Platform Owner

To manage co-evolution of complementary partners from a platform owner perspective, the first two steps we identified are connected to the phase before the development of new complements on, or the transformation of established complements to, the new digital platform. There, platform owners can implement mechanisms to align and enable partners to co-evolve by determining future business opportunities and develop the necessary capabilities.

Align with partners and enable them to co-evolve

To initiate co-evolution in a platform ecosystem with already existing partnerships, platform owners need to align with partners about the future direction of the ecosystem. To create alignment among partners means to "evolve with the continual changes that occur in the organization's external and internal environment" (Vessey/Ward 2013). External alignment can be achieved through tree principles: matching co-evolutionary change rates, optimize self-organization, and synchronization of exploration and exploitation (Vessey/Ward 2013). To match co-evolutionary change rates, one of the platform owners in our case studies initiated business transformation workshops to discuss the impact of the transformation and business opportunities with the partners. Matching co-evolutionary change rates can also be created through innovation alignment, which may also be paired contractually. Besides enforcing alignment through contracts, or discuss opportunities in workshops, employees with a large extent of partner contact in the platform owner organization, such as personal account managers for large partners, may also discuss with partners to achieve alignment by providing insights into strategic decisions made by the platform owner.

However, only through alignment, partners are still not able to develop new complements – or transform their existing complements – on a new digital platform. One reason is a lack of capabilities, as one of the executives of one platform owner mentioned that "*only a few partners were experienced in the cloud environment and had the necessary skills*". So, three of the platform owners provided different solutions in order to bridge this gap with the goal to optimize self-organization of the complementary partners.

First is an information platform that allowed partners to gather information on how to extend their digital skills. Secondly, online educations platform where massive open online courses are accessible for free to partners to learn about different professional and technical topics, e.g., how to leverage IoT devices, or management and soft skills, such as leadership in digital transformation initiatives. Particularly these MOOCs were setup to invite partners to discuss their views, and raise important questions in the connected discussion forum, which is usually operated by platform owners' employees or invited scholars for some specific topics. Third is an education portal to provide material for partners to train their professional and soft skills. Whereas the second solution is only accessible online, this also offers the educational program for large partners in workshops.

Enabling partners to develop the necessary capabilities to co-evolve is connected to "resourcing" phase (Ghazawneh/Henfridsson 2013), as most of the material is accessible at no cost for complementary partners, and potential ones. Following the understanding of Ghazawneh/Henfridsson (2013), this enablement leads to an increased heterogeneity among complementary partners, as the partners may acquire the required capabilities at different speed.

Support partners to co-evolve

After they are aligned and enabled to co-evolve, complementary partners can start to develop new complements on, or transform their existing complements to, the new digital platform ecosystem. However, as the alignment and enablement leads to an increased heterogeneity among partners (Ghazawneh/Henfridsson 2013), platform owners' can deploy different mechanisms to support complementary partners in their development or transformation.

On the one hand, platform owners can deploy several mechanisms towards supporting partners from a technical perspective. There, platform owners established customized technical guidance during the design, development, and deployment phases of a complementary solution. However, due to their costs, it is not feasible for a platform owner to provide all support for all types of complementary partners. Synchronizing exploration and exploitation, for example, exclusive technical service is only offered to qualified (often large) partners and only for selected solutions, whereas technical support in the presales phase is accessible for all complementary partners.

On the other hand, platform owners can provide support in the marketing of complementary solutions. This can include, but may not be limited to, the establishment of a marketing service portal to provide partners guidance on how to market in a digital ecosystem through SEO, social media, help for website design and architecture.

However, Woodward/Clemons (2014) state that a variety of complements usually evolves on its own with "no detailed guidelines from the platform owner". Our case studies show that platform owners' no bridge this gap by enabling platform owners the necessary capabilities, and supporting them in the development of new complements on, or the transformation of established complements to, the new digital platform.

Motivate partners to engage and grow

Platform owners' engagement doesn't stop with the support of complementary partners. It also includes reinforcing the digital platform ecosystem. Therefore, platform owners make use of the competitive intra-platform dynamics among complementary partners (Tiwana 2015) to motivate partners to engage in and grow the digital platform ecosystem.

To foster collaboration among complementary partners, platform owners' may introduce open marketplaces, which allows sharing, discussing, and jointly developing complementary solutions. For example, if one of the complementary partners developed software to connect to other APIs outside the digital platform ecosystem, this solution can be licensed to other partners. Further, several digital platforms have established mechanisms to rank complementary partners based on their level of expertise and experience, e.g., in specific domains or technologies. This mechanism helped end-users to objectively determine the expertise of different complements on the digital platform, and also motivated partners to continuously improve their expertise to improve their ranking. To improve their services, platform owners can provide mechanisms to provide their complementary partners with feedback from customers, or end-users. Therefore, a regular customer satisfaction index, which measures the quality of services, or channeling customer feedback via different media in an unregularly manner, help.

During all steps continuously maximize the platform ecosystem attractiveness

Some of the identified mechanisms are not contingent on a specific phase of the co-evolution.

Initially, some partners did not recognize the benefits of the transformation. Studying market leadership based on a digital platform, Tan et al. (2016) observed the "seller side", i.e., Alibaba as the platform owner in their case, lowered the barriers of entry by providing free and inclusive access to resources and services. Also, one of our cases notably relied on financial incentives to motivate partners to use, resell and build complementary services on the new digital platform. The financial incentives were divided into bonuses for the reselling of cloud services instead of on premise services, lower-cost contracts for cloud services, or free licenses. Thereby confirming the findings of Tan et al. (2016), these mechanisms accelerated the adoption among partners, which is a prerequisite for growth through increased sales and building complementary services, in our case.

For example, Microsoft made the new services only accessible via Azure. Therefore, partners had to join the ecosystem to gain access. This reduced the likelihood that they would switch to another digital ecosystem. In addition, Microsoft developed a ranking system for its partners with exclusive benefits increasing dependent on the engagement and quality of service. Finally, Microsoft co-created with innovative service providers and integrated them into the ecosystem to increase pressure on established partners. This also accounts for CEMEX Go or the Finsight platform. Partners can only access the continuous monitoring solutions, e.g., for the monitoring of Caterpillar machines via Finsight.

12.6 Conclusion

Based on four case studies of successfully managed co-evolutions, this paper contributes to both theory and practice. Further, we acknowledge the limitations of this work and show fruitful avenues for future research.

12.6.1 Contribution

Based on this work two theoretical contributions arise. First, contributing to digital platform literature, we identified 28 mechanisms for platform owners to manage the co-evolution of complementary partners before, during, and after the development of new complements on, or the transformation of new complements to, the new digital platform ecosystem. This is contrary to the observation of Woodward/Clemons (2014), who state that complements evolve without the provision of guidelines from platform owners. Hence, the findings of our four case studies show that the management of co-evolution comprises of aligning, enabling, supporting, and motivating partners in the joint undertaking, while continuously maximizing the attractiveness of the digital platform ecosystem.

Second, building on these mechanisms, we understand co-evolution as a strategic practice that is a part of capability development. Following Teece (2017), digital platforms follow four phases in their lifecycle: birth, expansion, leadership, and self-renewal – with the eventual need for renewal being neglected too often. As "most platforms will, at some point, find that the need for fundamental renewal becomes evident for reasons of technological change or major market shifts" (Teece 2017), partners are required to transform their business model to remain competitive (Vial 2019; Jacobides et al. 2018). Hence it should be platform owners' core interest to prevent a business model eruption of complementary partners, and in turn, enable them to transform successfully to remain competitive after a "technological change or major market shift" (Teece 2017). Platform owners can achieve this by using co-evolution as a means for platform governance, particularly in the phase of an ecosystem self-renewal.

During the self-renewal of digital platform ecosystems, generative sensing, ambidexterity, and transformation (major) are the most relevant dynamic capabilities for platform owners. In the following table, we organized the identified mechanisms platform owners use to manage the co-evolution of complementary partners to the capabilities for self-renewal following Teece (2017).

Dynamic capability for self-renewal	**Mechanisms to manage co-evolution of complementary partners**
Generative sensing	▪ Business transformation workshops to sense business opportunities ▪ Innovation alignment to sense strategic alignment ▪ Personal account manager to sense changes in partners environment
Ambidexterity	▪ Exploiting owner- (financial incentives, cost reduction, free service), while simultaneously exploring partner-centric mechanisms (open marketplaces, co-innovation contracts, consulting)
Transformation (major)	▪ Enable partners to develop new capabilities due to information through education, information, and marketing platforms ▪ Provide technical guidance, assistance in the transformation process ▪ Provide tools for collaboration and cooperation among partners, like open marketplaces

Table 40. Mapping Mechanisms to Manage Co-evolution to Dynamic Capabilities for Self-renewal

Our presented co-evolution mechanisms can be understood as mechanisms to achieve these capabilities. For example, conducting business transformation workshops with complementary partners to identify future business opportunities can help to build the generative sensing capability. Balancing between the loci of control between owner- and partner-centric co-evolution mechanisms is an ambidextrous behavior. Acquiring capabilities to develop cloud-based services, co-innovation contracts, or the acquisition of innovative service providers represent can be a means to build transformational capabilities.

Practitioners, particular platform owners, can use the identified mechanisms to manage the co-evolution of complementary partners. Moreover, we provide platform owners a model to see which mechanisms are helpful to initiate a co-evolution, which are helpful during the development or transformation of complements in the new digital platform ecosystems, and which mechanisms motivate partners to engage and grow continuously. Furthermore, we also show that several mechanisms help to maximize the attractiveness of the digital platform ecosystem at all time of the co-evolution.

12.6.2 Limitations and Further Work

Our study is subject to limitations that entail pathways for future research. Further, our cases are limited by the information provided and coded. To account for this limitation, we conducted triangulation and accounted for publicly available information (Yin 2014). The selection of four cases as part of our exploratory multiple case study challenges the generalizability of our results (Yin 2014). Hence, generalizing the findings for all traditional platform owners that implement mechanisms to manage the co-evolution of complementary partners has to be done with caution.

Other studies that focus on this framework in different contexts such as different industries, different company sizes or different regions will provide helpful insights (Eisenhardt 1989). It would also be fruitful for future research to analyze if the findings can be applied to platform ecosystems of digital-native companies that have to transform their partner ecosystem.

In this study, we implicitly assume these complementary partnerships are directly comparable. However, we would be curious to build a taxonomy of the partnership patterns in digital platform ecosystems between platform owners, complementary partners, and end users following the guidelines of Nickerson et al. (2017). After the derivation and evaluation of this taxonomy, future research could re-evaluate if the identified mechanisms for platform owners to manage the co-evolution of complementary partners are suitable for all partnerships. The taxonomy could help established platform owners not only for managing the co-evolution of complementary partners, but also potential platform owners for the development of their platform ecosystem.

We also focus predominantly on the platform owners' perspective. In this line with the majority of the studies on digital platform ecosystems, it is worthwhile to focus on the perspective of complementary partners (Kude et al. 2012). Subsequently, the dynamics of digital platform ecosystems tend to produce monopolistic or oligopolistic market structures (Parker/Van Alstyne 2005; Parker et al. 2016), following the "winner-takes-it-all" principle (Hand 2002). Hence it would be interesting to see how complementary partners can be strengthened to increase their power, or which regulatory actions for the digital platform economy can be deployed (Clemons et al. 2019).

Part C

13 Summary of Results

With the nine publications embedded in this thesis, we addressed the three research questions that guided this research endeavor. Subsequently, we summarize the results for each research question before discussing their implications in the next section.

> ***RQ1***: *What does literature contribute to our understanding of co-evolution in digital platform ecosystems in digital transformation initiatives?*

Digital transformation is a novel phenomenon and not just "old wine in new bottles". Based on a structured transdisciplinary literature review, spanning 175 journal and conference articles, we identified 12 different and heterogeneous schools of thought (P1): dynamic capabilities, IS-enabled organizational transformation, transformational leadership, digital innovation, revolutionary or radical change, identity, cognition, and sensemaking, ecosystem, emergence, institutionalism, and contingency, business model, revolutionary or incremental change, ambidexterity, and service-dominant logic. For each of the identified schools of thought, we provide several aspects that have been discussed in the respective articles. Some of these schools of thought, e.g., dynamic capabilities, or evolutionary change, have been raised in prior organizational transformation approaches, whereas others like digital innovation were just found with regard to discussions on digital transformation. As digital transformation initiatives are usually large programs that may affect the whole organization in various matters, ranging from business processes to the entire partner ecosystem, the identified schools of thought can be considered jointly when discussing the phenomenon. Further, we found that the inter-organizational perspective of ecosystems has been widely ignored in the context of digital transformation, even though the value creation in platform ecosystems is contingent the co-creation of complementary partners.

Six properties guide co-evolution of actors in ecosystems. Based on the insight that digital transformation literature mostly disregarded its inter-organizational perspective and that we lack knowledge on how organizations, such as platform owners and complementors, co-evolve in these ecosystems, we conducted a structured literature review on co-evolution in business ecosystems (P2), spanning 44 journal articles. We organized literature along six properties. First, co-evolution can take on multi levels in ecosystem, e.g., between partners, customers, and regulatory authorities. Second, co-evolution can have multiple causalities in ecosystems, like cooperation or competition. Third, co-evolution follows a nonlinear process in ecosystems, we described as diffusion, hierarchical, network orchestration, or big bang process. Fourth, co-evolution in ecosystems can trigger mechanisms for positive feedback, in form of capabilities, architectural decisions, or managerial activities. Fifth, regarding path and history dependency, co-evolution in ecosystems can take place as Greenfield approach or build on legacy. Sixth, technology has been disregarded, or is understood as support or enabler of co-evolution in ecosystems.

> ***RQ2***: *Which configurational patterns emerge in the digital transformation of platform ecosystems?*

Emerging actors, i.e., value-added services providers, mobility service platforms, and aggregators, and disruptive technology providers, shape digital transformation in the automotive ecosystem. Based on qualitative content analysis using an inductive category formation, we analyzed 650 automotive organizations derived from the CrunchBase database.

The coding of these organizations and six interviews conducted with industry experts revealed 15 generic roles and the value streams between them, which we modeled using the e^3-value modeling method (P3). Our results show the central role of mobility service platforms, emerging disruptive technology providers, such as value-added resellers and disruptive technology providers, and the dissemination of industries, e.g., as OEMs collaborate with mobile payment providers, which all shape the digital transformation of the automotive industry.

Seven innovation patterns describe the digital transformation in the financial ecosystem. Based on qualitative content analysis using an inductive category formation, we analyzed 792 financial services organizations derived from the CrunchBase database. The coding of these organizations and four interviews conducted with industry experts revealed 22 generic roles and the value streams between them, which we modeled using the e^3-value modeling method (P4). Our results show that Fintechs are challenging the prevailing position of traditional financial institutions with digital technologies like mobile payments, robot advisors, and distributed ledgers. Moreover, we identify and discuss seven inter-organizational innovation patterns of the digital transformation in the financial industry: elimination of intermediaries, enhance transparency, cloud-based services, service aggregation, service integration, prosumption, and creation of a parallel universe. The roles of this ecosystem show the influence of blockchain technology on the financial ecosystem, which led us analyze the blockchain ecosystem in the subsequent paper.

Emerging actors in the blockchain ecosystem transform actors in other ecosystems due their strategic implications on governance, trust, and openness. Based on qualitative content analysis using an inductive category formation, we analyzed 479 blockchain organizations derived from the CrunchBase database. The coding of these organizations and five interviews conducted with industry experts revealed eleven generic roles and the value streams between them, which we modeled using the e^3-value modeling method (P5). Our results show that blockchain technology is fundamentally different from prior technologies regarding trust, governance, and openness, which has strategic implications for other ecosystems, e.g., the financial ecosystem we presented in the prior paper, where blockchain is creating new services in a ‘parallel universe’.

Digital transformation leads to three strategic implications for the insurance ecosystem. Based on qualitative content analysis using an inductive category formation, we analyzed 956 insurance organizations derived from the CrunchBase database. The coding of these organizations and seven interviews conducted with industry experts revealed 34 generic roles and the value streams between them, which we modeled using the e^3-value modeling method (P6). Moreover, we identify five strategic implications – customer centricity, coverage for the customer ecosystem, restructuring the organization to enable digital transformation, leveraging in-house collaboration, and integration of partners with complementary services in the ecosystem – for traditional insurance organizations. Ultimately, we compare the implications to the innovation patterns discovered in the finance paper (P4).

Similarities in platform ecosystems in digital transformation. We first provide a structured overview of the manufacturing ecosystem in digital transformation due to IIoT. By analyzing 601 organizations derived from CrunchBase, we identified 14 generic roles, verified in nine interviews with industry experts. We combine the strengths of qualitative content coding for ecosystems, and a quantitative text-mining based clustering to identify core clusters of platform ecosystems in digital transformation (P7). By drawing on the data of all ecosystems (P3-P6, IIoT) we discovered 15 clusters. Cluster 01 is the core cluster, containing roles of organizations from all five ecosystems, such as cloud application, platform, and infrastructure providers. Cluster 02-05 are intertwined, as they include roles from at least two ecosystems. The second cluster, digital financial services, contains generic roles of the financial and insurance ecosystem, such as P2P insurances, or aggregators, and money transfer. The third cluster, OEM and IoT services, contains generic roles of the automotive and IIoT ecosystem, such as OEMs and classical factory equipment providers. The fourth cluster, data prediction and monitoring, contains generic roles of the insurance and IIoT ecosystem, such as big data analytics, and IIoT data consolidation and monitoring providers. The fifth cluster, brokers and agents, contains generic roles of the financial and insurance ecosystem, such as digital insurance brokers and agents, and investment banking. Clusters 06-15 are ecosystem-specific that only include roles found in one ecosystem.

> ***RQ3***: *What are mechanisms for platform owners to manage the co-evolution of complementors in platform ecosystems in digital transformation initiatives?*

Managing the co-evolution of complementors is conducted in requires both owner- and partner-centric co-evolution mechanisms from a platform owner perspective. Based on an in-depth case study on the transformation of Microsoft's partner ecosystem due to the introduction of Azure, we identified five owner-centric, and twelve partner-centric co-evolution mechanisms Microsoft used to manage the co-evolution of its partners (P8). Prior to the roll out of Azure, Microsoft's value creation was contingent on the co-creation of products and services with a very large partner base that delivered those products and services on the customers' premises. For its cloud strategy to be successful, Microsoft had to motivate those partners to join and grow the Azure ecosystem, and to deliver the next generation of Microsoft products and services in the cloud. In its successful transformation, Microsoft adopted a two-phase change program based on six lessons learned. Phase One was based on two direct owner-centric mechanisms to grow the Azure partner base. Phase Two was based on four partner-centric mechanisms to shift the locus of control to the partners.

Mechanisms for platform owners' to manage the co-evolution of complementary partners before, during, and after the development of new complements on, or the transformation of new complements to, the new digital platform ecosystem. Based on the findings of a multiple case study, comprising of four cases, we identified 29 mechanisms platform owners' implemented to manage the co-evolution of complementary partners. We organized the mechanisms into three stages. First, platform owners start with mechanisms to align with partners by determining future business opportunities, and enable partners by developing necessary new capabilities. This is are relevant for the time before the development of new complements or the transformation of established complements. Second, platform owners support partners to develop new complements. Third, and relevant for the time after the development of new complements or transformation of established complements to the new digital platform, platform owners motivate partners to engage and grow in the new ecosystem. During all steps, platform owners maximize the ecosystem attractiveness through various mechanisms. These mechanisms are particularly relevant for the self-renewal of digital platform ecosystems.

Table 41 gives an overview of the key findings of this thesis.

P	**RQ**	**Findings**
P1	RQ1	▪ Digital transformation is a novel phenomenon and not just "old wine in new bottles" that builds on twelve schools of thought: dynamic capabilities, IS-enabled organizational transformation, transformational leadership, digital innovation, revolutionary or radical change, identity, cognition, and sensemaking, ecosystem, emergence, institutionalism, and contingency, business model, revolutionary or incremental change, ambidexterity, and service-dominant logic ▪ Digital transformation partially builds on prior organizational transformation approaches, such as dynamic capabilities, or identity, cognition, and sensemaking, whereas others like digital innovation were just found with regard to discussions on digital transformation ▪ The inter-organizational perspective is widely disregarded, hence we suggest future research on ecosystems
P2	RQ1	▪ Co-evolution in ecosystems builds on six properties: multilevel effects, multidirectional causality, nonlinearity, mechanism for positive feedback, path and history dependency, and technology ▪ Co-evolution in ecosystems build on cooperative and competitive mechanisms ▪ There is a gap in literature on which managerial actions drive co-evolution in ecosystems, particularly to drive positive feedback
P3	RQ2	▪ We analyzed 650 automotive organizations derived from the CrunchBase database ▪ The coding of these organizations and six interviews conducted with industry experts revealed 15 generic roles and the value streams between them ▪ We modeled the automotive ecosystem using the e^3 value method ▪ The 15 roles are: OEMs, $1^{st}/2^{nd}/3^{rd}$ tier suppliers, car (parts) dealer, car service provider, e-payment provider, cloud infrastructure provider, cloud platform provider, value added service provider, mobility market platform, mobility service provider, mobility service aggregator, public transportation provider, intelligent infrastructure provider, and consumers
P4	RQ2	▪ We analyzed 792 financial organizations derived from the CrunchBase database ▪ The coding of these organizations and four interviews conducted with industry experts revealed 22 generic roles and the value streams between them ▪ We modeled the financial ecosystem using the e^3 value method ▪ The 22 roles are: saving accounts, loans, fraud detection, risk management, stock market, portfolio management / robot advisor, personal financial management, money transfer, regulatory authority, crowd funding, crowd lending, cryptocurrency wallet, digital identity provider, cryptocurrency exchange, multi banking aggregator, social trading, alternative payment solution, cloud market platform, cloud infrastructure provider, cloud market platform, cloud application provider, and consumers ▪ We identified seven inter-organizational innovation patterns: elimination of intermediaries, enhance transparency, cloud-based services, service aggregation, service integration, prosumption, and the creation of a parallel universe

P5	RQ2	▪ We analyzed 479 blockchain organizations derived from the CrunchBase database ▪ The coding of these organizations and five interviews conducted with industry experts revealed eleven generic roles and the value streams between them ▪ We modeled the blockchain ecosystem using the e^3 value method ▪ The eleven roles are: blockchain infrastructure provider, blockchain platform provider, blockchain application provider, token-based community platform provider, miner / mining pool, mining solution and equipment provider, blockchain ancillary provider, blockchain alliances, blockchain community, blockchain consulting services, and consumers. ▪ These roles may transform other ecosystems due to their strategic implications on governance (governed by a community), trust (no trusted intermediary necessary), and openness (API server as open-source)
P6	RQ2	▪ We analyzed 956 insurance organizations derived from the CrunchBase database ▪ The coding of these organizations and seven interviews conducted with industry experts revealed 34 generic roles and the value streams between them ▪ We modeled the insurance ecosystem using the e^3 value method ▪ The 34 roles are: product development, underwriting, distribution management, policy services, billing & collection, claims & payment, asset management, global agent, independent broker, fraud detection, business service, claims partner, IT-service provider, service insurance, direct insurance, reinsurance, regulatory authority, comparison platform, digital broker / robo advisor, cross-seller, big data analytics / predictive, smart contract provider, instant insurance, peer-to-peer insurance, and e-payment provider

P7	RQ2	▪ We analyzed 601 organizations: 308 IIoT organizations derived from the CrunchBase database, 125 IIoT startups listed by CB Insight, and 200 IIoT platforms and solution providers from the IoT One database
		▪ The coding of these organizations and nine interviews conducted with industry experts revealed 14 generic roles and the value streams between them
		▪ We modeled the blockchain ecosystem using the e^3 value method
		▪ The 14 roles are: manufacturer, raw material supplier, factory equipment provider, sensor and connectivity provider, for or edge computing provider, IIoT hardware provider, cyber security provider, IIoT consulting services, cloud infrastructure, platform, or application provider, IIoT platform provider, IIoT solution provider, and consumer
		▪ Further, we used a quantitative text-mining based method to identify similarities among all modeled ecosystems (P3-P7) and identified 15 clusters
		    o Among the 15 clusters, we identified one core cluster, cloud and infrastructure, consisting of organizations from roles of all five ecosystems
		    o Cluster 02-05 - digital financial services, OEMs and IoT services, data prediction and monitoring, brokers and agents – are intertwined and consist of organizations from roles for two ecosystems
		    o Clusters 06-15 are ecosystem-specific and only contain organizations from roles of one ecosystem

<table>
<tr><td>P8</td><td>RQ3</td><td>Microsoft Azure presents a successful transformation of the partner ecosystem from on premise to a digital platform ecosystem
Microsoft used 17 mechanisms to manage the co-evolution of its partners:
Five owner-centric co-evolution mechanisms: financial incentives, preferential access to new products and services in the cloud, cost reduction, free services, new partners (competition)
12 partner-centric co-evolution mechanisms: personal account manager, transformation workshop, marketing service portal, education portal, open marketplace, ranking, technical guidance, free technical assistance, exclusive technical service, customer satisfaction index, regular communication, technology evangelists
We identified six lessons learned for managers that seek to transform their partner ecosystem, organized in two phases
Phase 1: pay them to come, offer them innovative services
Phase 2: develop a shared vision of, and strategy for, business opportunities, establish a learning platform for partners to develop new capabilities, increase collaboration among partners, provide personal guidance to, and develop tools for, partners to build complementary services</td></tr>
<tr><td>P9</td><td>RQ3</td><td>We identified 29 mechanisms for platform owners' to manage the co-evolution of complementary partners before, during, and after the development of new complements on, or the transformation of established complements to, the new digital platform ecosystem, organized in four steps:
Step 1: Align with complementary partners by determining future business opportunities through: business transformation workshops, innovation alignment, personal account managers, and Enable complementary partners by developing necessary capabilities through: information platforms, education platforms, marketing service platforms
Step 2: Support complementary partners to develop new complements through: technical guidance, free technical assistance, exclusive technical services
Step 3: Motivate partners to engage and grow the new ecosystem through: open marketplaces, ranking, customer satisfaction indices, channeling feedback
During all steps continuously maximize the digital platform ecosystem attractiveness to align, enable, support, and motivate partners through: financial incentives, preferential access, cost reduction, free services, new partners (competition), collaboration with startups, regular communication, technology evangelists, co-innovation contracts, joint ventures, standardization / working groups, strategic acquisitions, investments in operators, consulting services</td></tr>
</table>

Table 41. Overview of Key Results

14 Discussion

Based on the summary of our results we describe discussion themes that are of interest with regard to the body of knowledge. We reflect on extending the new organizational logic due to digital innovation, IS neglecting some specific natures of digital transformation, a combined method to analyze ecosystems, the generative nature of digital infrastructure drives the variety of actors in digital platform ecosystems, and that co-evolution of complementary partners can be help to achieve self-renewal in digital platform ecosystems.

14.1 Going Beyond a New Organizing Logic due to Digital Innovation

Drawing on the literature review on digital transformation (P1), we see that digital innovation requires a new organizational logic (Yoo et al. 2012; Yoo et al. 2010). Following Yoo et al. (2010), digital innovation builds on novel characteristics that are different from earlier technologies, e.g., reprogrammability, the homogenization of data, and the self-referential nature of digital innovations. Therefore, a new organizational logic is necessary to cope with these digital innovations (Um/Yoo 2016; Yoo et al. 2012). For example, the bankruptcy of Kodak shows that such a new organizational logic is difficult to achieve, particularly when the business model has been successful for a long time (Lucas/Goh 2009).

While this is certainly true, our results show that the effect of digital innovations goes beyond new organizational logics, and thus results in a transformation of the ecosystem an organization operates in. For example, new roles emerge like digital platforms or disruptive technology providers emerge in the case of the automotive ecosystem (P3), which fundamentally transform the value creation there. We also observe that a plethora of new service providers emerge, which build on digital innovations, such as robot advisors, mobile payment providers, or wallet providers (P4, P5, P6) in the case of the financial, insurance, and blockchain ecosystem. Moreover, digital innovations like blockchain may also result in completely new ecosystems, e.g., a financial system without banks as intermediaries (P5). This ecosystem may then in turn compete with established ecosystems, such as the financial or insurance ecosystem (P4, P6).

Particularly established organizations (so-called incumbents) face the challenge of digital transformation (Vial, Sebastian) due to an increased competition by emerging digital-native organizations (see P3-P7). By adopting digital innovations, incumbents try to compete with these newcomers that enter their markets. Highlighting the importance of analyzing digital transformation from an ecosystem perspective should help incumbents to identify who is or may threaten their current market position. Consistent with the conducted literature on digital transformation (P1), digital transformation can be studied from the perspective of an ecosystem. There we observe co-creation has become easier via the supply of boundary resources (Eaton et al. 2015; Ghazawneh/Henfridsson 2013). Particularly in digital platform ecosystems, the range of co-creation is central to create value for end users, which the shift from on premise to cloud in the Microsoft ecosystem shows.

14.2 IS neglects Specific Natures of Digital Transformation

By synthesizing literature on digital transformation in IS, management, and organization science disciplines, we observe that IS neglects the different natures of digital transformation (P1). For example, some IS scholars implicitly consider it as planned change approach (Matt et al. 2015; Chanias/Hess 2016; Kaltenecker et al. 2015). For example, the framework of Matt et al. (2015) comprises of four components – changes in value creation, structural changes, financial aspects, and use of technologies – contrary to our identified twelve schools of thought.

However, following an institutional theory logic, digital transformation may also occur as emerging phenomenon, resembled in a process of diffusion from the standard, which may be fast or slow, systemic or patchy (Besson/Rowe 2012). Further, some scholars argue that there is no best way to organize, lead, or transform an organization, which follows that the optimal course of action is contingent upon the internal or external emerging situation (Aguilera et al. 2008; Oehmichen et al. 2017). This leads to the notion that digital transformation cannot always be actively triggered or organized.

Another school of thought, which is only rarely considered in the notion of digital transformation in IS literature is transformational leadership. This may be due to the emphasis on the IT artifact in IS literature (Orlikowski/Iacono 2001). Nevertheless, soft factors of transformative leaders such as charisma, articulating and presenting a clear vision, motivating employees through inspiration and intellectual stimulation derived from exposing them to new and complex ways of thinking, and being considerate of their individual needs and desires (Hill et al. 2012) can play a major role in successful digital transformations. For example, the Berlin Philharmonic Orchestra realized that their fan base is much larger than the capacity of a concert hall during an event in Taiwan, which marked the birth for the idea of the digital concert hall (Uhl et al. 2013).

Transformation efforts may also destabilize and change the organizational identity (Nag et al. 2007). Notably, we only found one IS article examining the role of IT in the process of developing sustainable business processes. There, several IT affordances that created a context in which organizations can engage in a sensemaking process to understanding emerging environmental requirements were identified (Seidel et al. 2013). However, organizational identity includes those features of an organization that its members deem to be the most central, distinctive, and enduring (Albert/Whetten 1985). Hence IS scholars could take this stance to examine how a digital mindset (Piccinini et al. 2015a) or digital innovations (Yoo et al. 2012; Yoo et al. 2010) transform the organizational identity.

14.3 Towards a Combined Method to Analyze Ecosystems

Based on the idea of Böhm et al. (2010) to use qualitative content analysis using inductive category development Mayring (2010b) to model platform ecosystems, we extended this method (P3—P6) by evaluating the ecosystems using semi-structured interviews (Myers/Newman 2007) with industry expertise in strategic positions (Bogner et al. 2009b). One rationale to do so is the increased reliability of the ecosystem, even though we measured and ensured high inter-coder reliability in our qualitative coding process, i.e., all ecosystems achieved an alpha (Krippendorff 2004) of greater 0.8.

We see the proposed method to model ecosystems as particularly suitable to visualize large ecosystems, such as the financial (e.g., P5), where we used the data from more than 600 organizations. By drawing on a larger dataset, and validating it afterward with industry experts, we aim to provide a more reliable, and thus generic, ecosystem. This is contrary to the ecosystem-as-a-structure method (Adner 2017), which models each unique organization in the ecosystem, and thus provides no abstraction to more general roles, such as aggregators or integrators. Consequently, analyzing complex ecosystems in digital transformations is not feasible with the ecosystem-as-a-structure method. On the other hand, more data-driven methods to visualize ecosystems, such as clustering based on text mining (Basole et al. 2018) helps to detect similarities among organizations in an ecosystem. However, with this method, the level of abstraction is so high that individual organizations are difficult to identify in the ecosystem. Therefore, such models are of limited use for discussion with industry experts or to the visualization of a transformation in an ecosystem.

Consequently, we suggest building on the strengths of both methods (P7). First, qualitative content analysis can be used to develop generic roles of the actors in an ecosystem, and e^3 value can be used to model the ecosystem (consisting of generic roles and the value streams between them). Second, to detect similarities among the organizations of an ecosystem, we suggest drawing on data-based methods such as text mining.

14.4 The Generative Nature of Digital Infrastructures Drives the Variety of Actors in Digital Platform Ecosystems

Using quantitative measures to detect similarities among the developed ecosystems (P3-P7), we identified three generic roles, organized in two clusters, which occur in all of the ecosystems.

First are cloud infrastructure providers with services such as the AWS Elastic Compute Cloud. A cloud infrastructure provider consists of a shared pool of Internet-based configurable computing resources (e.g., servers, storage, applications, and services), which can be rapidly provisioned and released with minimal management effort (Youseff et al. 2008).

Second are cloud platform providers, such as the SAP Cloud Platform, Microsoft Azure, or the Alibaba Cloud Platform. The cloud platform provider offers an environment to develop, run, and test applications. From a technical perspective, an operating environment, APIs, programming languages are provided (Youseff et al. 2008). In some cases, developers are shielded from technical, infrastructure-related details. Programs are executed over datacenters, not concerning developers with matters of resource allocation (Böhm et al. 2010; Youseff et al. 2008).

Third are cloud application providers, such as Salesforce CRM or Dropbox. The cloud application provider hosts and operates applications, in contrast to the traditional software model, in an own or outsourced data center. Cloud applications are accessible for customers via the internet. The application provider has to ensure a smooth operation of the applications, including monitoring, asset or resource management, and failure or problem management (Böhm et al. 2010; Youseff et al. 2008).

By occurring in all of our developed ecosystems, the three generic roles presented above contribute to the generative nature of digital infrastructure (Tilson et al. 2010). By providing an extremely scalable basis for digital services lying on top of it, digital infrastructures lead to exceptional growth, regular leaps in performance, and radically decreasing costs not offered by physical infrastructures (Tilson et al. 2010; Brynjolfsson/Saunders 2009).

Consequently, the emerging actors in our developed ecosystems show that digital infrastructure (such as the three mentioned cloud-based roles) also drive the occurrence and variety of actors in digital platform ecosystems. For example, if a digital platform is established, it may also transform other ecosystems, such as cloud platforms that initially enabled a new provisioning model for software are now transforming the hotel, taxi, or gaming business (Verhage 2015; Weill/Woerner 2015). In the automotive ecosystem, we see that based on cloud services, a multitude of innovative actors, such as providers for mobility as a service (Uber, mytaxi, DriveNow, etc.) emerge building on the digital infrastructure provided (P3). Digital payment providers, such as PayPal or TransferWise, build on cloud services and transform the financial ecosystem. Ultimately, distributed ledgers can be understood as a new kind of digital infrastructure, which seeks to make central banks obsolete, as one of the desired outcomes of some visionaries (Condos et al. 2016; Mougayar 2015; Tapscott/Tapscott 2016).

But the potential for "upward or downward flexibility, however, can be restricted by sociotechnical and regulatory arrangements" (Tilson et al. 2010), such as the requirement of a banking or insurance license for the provision of specific financial services, or a passenger transport license to offer taxi services.

14.5 Co-evolution of Complementary Partners to Achieve Self-renewal in Digital Platform Ecosystems

Drawing on the single case study on Microsoft (P8), and the four cases in the multiple case study (P9), we see that a co-evolution of complementary partners can be managed by different mechanisms implemented from platform owners.

Contrary to the observation of Woodward/Clemons (2014), who state that complements evolve without the provision of guidelines from platform owners, particularly the findings of our multiple case study (P9) reveal several mechanisms platform owners deployed to manage the co-evolution of complementary partners. These co-evolution mechanisms help complementary partners before, during, and after the development of new complements on, or the transformation of established complements to, the new digital platform ecosystem.

Building on these mechanisms, we understand co-evolution as a strategic practice that is a part of platform governance. Following Teece (2017), digital platforms follow four steps in their lifecycle: birth, expansion, leadership, and self-renewal – with the eventual need for renewal being neglected too often. As "most platforms will, at some point, find that the need for fundamental renewal becomes evident for reasons of technological change or major market shifts" (Teece 2017), partners are required to transform their business model to remain competitive (Vial 2019; Jacobides et al. 2018). However, many platform owners benefit from the complementary resources, or capabilities partners use in a resource-integrating process to develop applications on top of the platform (Tiwana 2014; Kude et al. 2012; Sarker et al. 2012). Hence it should be platform owners' core interest to prevent a business model eruption of complementary partners, and in turn, enable them to transform successfully to remain competitive after a "technological change or major market shift" (Teece 2017). Platform owners can achieve this by using co-evolution as a means for platform governance, particularly in the step of an ecosystem self-renewal.

During the self-renewal of digital platform ecosystems, generative sensing, ambidexterity, and transformation (major) are the most relevant dynamic capabilities for platform owners. In Table 42, we organized the identified mechanisms platform owners use to manage the co-evolution of complementary partners to the capabilities for self-renewal following Teece (2017).

Dynamic capability for self-renewal	**Mechanisms to manage co-evolution of complementary partners**
Generative sensing	▪ Business transformation workshops to sense business opportunities ▪ Innovation alignment to sense strategic alignment

	▪ Personal account manager to sense changes in partners environment
Ambidexterity	▪ Exploiting owner- (financial incentives, cost reduction, free service), while simultaneously exploring partner-centric mechanisms (open marketplaces, co-innovation contracts, consulting)
Transformation (major)	▪ Enable partners to develop new capabilities due to information through education, information, and marketing platforms ▪ Provide technical guidance, assistance in the transformation process ▪ Provide tools for collaboration and cooperation among partners, like open marketplaces

Table 42. Dynamic Capabilities for Self-renewal

Our presented co-evolution mechanisms can be understood as mechanisms to achieve these capabilities. For example, conducting business transformation workshops with complementary partners to identify future business opportunities can help to build the generative sensing capability. Balancing between the loci of control between owner- and partner-centric co-evolution mechanisms is an ambidextrous behavior. Acquiring capabilities to develop cloud-based services, co-innovation contracts, or the acquisition of innovative service providers represent can be a means to build transformational capabilities.

15 Implications

The findings of this thesis have implications for both theory and practice.

15.1 Implications for Theory

The findings of this cumulative dissertation aim to contribute to the two distinct streams of research.

First, we contribute to literature on **digital transformation** through a literature-based analysis of articles, and a qualitative and quantitative analysis of digital transformation in four ecosystems.

By conducting an extensive transdisciplinary literature review in IS, management, and organization science literature, spanning 175 journal and conference articles, we get a more detailed view on the phenomenon, particularly due to the discussion of twelve heterogeneous schools of thought. Based on this, we can show that digital transformation is not only old wine in new bottles by highlighting the unique aspects of digital transformation, particularly the ecosystem, business model innovation, and digital innovation schools of thought. However, our findings show that digital transformation builds on prior organizational transformation literature connected to business process change, or transformation of organizational structures. This extends the discussion started by Markus (2004) if "technochange" is a new phenomenon compared to pure organizational or technological projects. Our work also extends the literature review of Besson/Rowe (2012) on IS-enabled organizational transformation, by accounting for the specifics only found in digital transformation literature. This clarification helps to revisit prior articles on digital transformation, and provides scholars twelve different lenses to examine the phenomenon of digital transformation. In the chapter on future research we reflect on the schools of thought that IS literature is currently neglecting, which are predominantly driven by management and organization science research, such as transformational leadership, or organizational identity. Moreover, our work helps to compare articles on digital transformation and shows that not all articles that claim to investigate digital transformation are actually studying this particular phenomenon. Bridging literature in the IS and management, and organization science domain, we acknowledge that technology and its relationship with organizational structures, processes, and outcomes have long been of interest to organizational researchers (Orlikowski 2000; Yoo et al. 2012; Yoo et al. 2010). In this ongoing discussion, different perspectives on technologies parallel to different research objectives in organizations exist (Orlikowski 2000). Thereby, digital transformation contributes to the ongoing discussion of using technology to trigger changes, e.g., to alter existing methods of operating (Orlikowski 2000). Ultimately, we hope that our work contributes to a consistent terminology that will help to consolidate this research stream as well as move it forward.

The findings of our literature review revealed many studies disregard the inter-organizational perspective. Hence, the developed ecosystems contribute to literature on digital transformation, by accounting for the ecosystem perspective. Thereby, we provide the generic roles of the actors, and the value streams between them, we identified and coded in the respective five ecosystems. Our approach of qualitative content coding using inductive category development helps to aggregate the unique organizations in the ecosystems to more generic roles. Following this process for more than 3000 organizations, we offer an exhausting but comprehensive overview of a plethora of organizations in the respective ecosystems undergoing a digital transformation. Drawing also from a development process over the coding of five ecosystems, our work contributes several actors that can be found in many ecosystems, such as service aggregators, or service integrators, which in turn helps scholars to develop their own ecosystems. Thereby, we account for the desired macro-economic perspective (Puschmann 2017; Jacobides et al. 2018) to analyze how established industry sectors are becoming blurred, e.g., as cloud platforms lay the foundation of cloud-based services in all the ecosystems. Our ecosystem analyses also account for the integration of digital technologies provided by multiple actors as a prerequisite for successful participation in an digital platform ecosystem (Vial 2019), as none of the generic roles is operating on its own or only with very few partners.

Second, we contribute the literature on **digital platform ecosystems** by exploring mechanisms for platform owners to manage the **co-evolution** of complementary partners. Co-evolution has been used as lens to examine dyadic changes between architecture and governance in terms of control (Tiwana et al. 2010), or between generativity and variety (Boudreau 2012; Tiwana 2015; Um/Yoo 2016). We account for co-evolution between actors, the platform owner and complementary partners, a lens that only few studies in platform literature chose (e.g., Song et al. 2018). By analyzing the mechanisms platform owners implemented, we show that one party can trigger the co-evolution process in a digital platform ecosystem. So, the management of co-evolution from a platform owner's perspective can be seen as part of the ecosystem governance, thereby extending Jacobides et al. (2018), as "behavior in an ecosystem, and ultimately its success, is affected by the rules of engagement and the nature of standards and interfaces". Hence, our mechanisms of managing co-evolution is helpful for scholars analyzing a transformation in ecosystems where "rules to pertaining hierarchy or membership may change over time" (Jacobides et al. 2018). Further extending Jacobides et al. (2018), our work contributes the understanding how partnerships in ecosystem vary over time, and what drives this variation, and how this is related to the development of complements on, or the transformation of established complements to, the a new digital platform.

Taking a more nuanced perspective, we categorize the mechanisms in owner- and partner-centric groups, and found that over time the locus of control switches to partner-centric mechanisms that help to build collaboration and cooperation among complementary partners, which in turn helps to grow the ecosystem, so that the platform owner is also benefitting in this co-evolution. Our mechanisms are particularly helpful for platform owners in the phase of renewal (Teece 2017), as they contribute to the development of the dynamic capabilities generative sensing, ambidexterity, and transformation (major). Moreover, we extend Teece (2017) by proposing a four-step approach for co-evolution in digital platform ecosystems, we help platform owners to identify which mechanisms to implement first, and which may be only helpful in a later phase of the transformation or self-renewal. Essentially, we show that platform owners can align with complementary partners by determining future business opportunities first. Second, platform owners can enable them to develop new capabilities. Then, partners can be supported to develop new complements, or transform their complements. In addition, as fourth step, partners can be motivated to engage and grow the renewed ecosystem. During all steps, platform owners can maximize the platform attractiveness.

15.2 Implications for Practice

The implications for practice of this thesis can be split up in to directions. First, the developed ecosystems may help organizations to conduct, plan, or analyze digital transformation on the ecosystem level. Second, particularly platform owners benefit from the studies on managing the co-evolution of complementary partners, when transforming or developing an ecosystem with an already established partner network.

Regarding the first direction for implication for practice, our generic roles and the visualizations of the developed ecosystems in this thesis can be applied by decision makers in organizations that are conducting a digital transformation. For example, OEMs can apply the automotive ecosystem to identify potential threats to their current market position and potential opportunities to adapt to trends or shifts in customer needs. As example, innovative OEMs introduced car-sharing platforms early, like BMW with Drive Now, or, more recently, Mercedes acquired a mobile payment provider to enhance their digital portfolio (Daimler AG 2017).

In a nutshell, organizations can use the generic roles and visualized ecosystems to analyze their position in the respective industries and their linkages to competitors or partners. According to Böhm et al. (2010) it is not the most important point to know, which generic role might take the largest share within the ecosystem, but to develop a unique value proposition based on core competencies. Further, organizations can also use the ecosystems to identify which organizations might be potential competitors or suitable (complementary) partners in the future. Moreover, our developed ecosystems we show that additional layers of services emerge. For example, in the case of the financial ecosystems, this means a recombination of financial services in the service integrator role, or the intelligent combination of existing services to generate a new service in the service aggregator role. These emerging roles show, typical for digital transformation, that the way value is delivered to the customer is changing fundamentally.

The clustering of all developed ecosystems to identify similarities among these advises practitioners to account for “cloud, and on premise infrastructure providers, cyber security providers”, and “smart data prediction and monitoring” for modeling future platform ecosystems in the context of digital transformation. In addition, the visualization of the roles in a data-driven approach helps to analyze the size and centrality of specific roles in digital platform ecosystems. This step helps to analyze the importance of specific roles for the ecosystem. For example, we found that the cluster that concerns data prediction is very central to most other roles of the ecosystem. Such conclusions could not be drawn by simply using the e^3 value method, or ecosystem-as-a-structure to model an ecosystem.

Regarding the second direction for implication for practice we provide mechanisms for platform owners to manage the co-evolution of complementary partners.

First, and foremost, the in-depth case study of the transformation of Microsoft’s partner ecosystem after the introduction of Azure shows five owner-centric co-evolution mechanisms, ranging from financial incentives to increased competition through integrating innovative service providers in the Azure ecosystem, thereby increasing the pressure on existing partners.

Second, we discovered twelve partner-centric co-evolution mechanisms, where Microsoft switched the locus of control towards the partner. There, Microsoft conducted transformation workshops with partners to generate strategic alignment and discuss future business opportunities, or developed open marketplaces that allowed partners to collaborate in the development of new services on top of the Azure platform. Based on the 17 co-evolution mechanisms Microsoft implemented, we provide six lessons learned organized in two phases for platform owners that are in the process of transforming their ecosystem. In the first phase, Microsoft motivated partners to join and grow the platform ecosystem by paying partners to come, and offering them innovative services. In the second phase, Microsoft focused on engaging and encouraging partners to stay by shifting the locus of control to the partners to increase collaboration and cooperation. In order to achieve this, Microsoft developed a shared vision of, and strategy for, business opportunities, established a learning platform for partners to develop new capabilities, increased collaboration among partners, and provided personal guidance to, and developed tools for, partners to build complementary services.

Third, we broadened our perspective by conducting a multiple case study covering four organizations. During this process, we discovered twelve further mechanisms for platform owners to manage the co-evolution of complementary partners. We organized the mechanisms based on their role before, during, or after the development of new complements on, or the transformation of established complements to, the new digital platform ecosystem. In the first step, platform owners should align with partners by determining future business opportunities through business transformation workshops, innovation alignment, or personal account managers. In the second step, platform owners should enable partners by developing necessary new capabilities through information, or education platforms, and marketing service portals. During the development or transformation of complements, platform owners should support partners through technical guidance, free technical assistance, or exclusive technical services. After the development or transformation of complements, platform owners should motivate partners to grow the new ecosystem through open marketplaces, ranking, customer satisfaction measurement, or channeling feedback. During all the steps, platform owners can maximize the ecosystem attractiveness to align, enable, support, and motivate partners through financial incentives, preferential access, cost reduction, free services, competition through new partners, collaboration with startups, regular communication, technology evangelists, co-innovation contracts, joint ventures, industry working bodies, strategic acquisitions, investments into operators, or consulting services.

16 Limitations

The studies embedded in this thesis and, consequently, the thesis' findings as a whole are subject to several limitations. These limitations result from the research approach we followed, from the cases and data sources, we selected, and from the scope, we defined for this thesis.

The conducted literature reviews (P1 and P2) are subject to some limitations regarding the **literature search and coding of the articles**. First, the literature search might not cover all relevant studies due to the choice of outlets, keywords, and time frame. For example, alternative terms for the phenomenon of digital transformation (P1) or co-evolution (P2) might yield additional relevant articles. To mitigate this risk, we drew on prior, excellent reviews, e.g., on IS-enabled OT (Besson/Rowe 2012) in the case of the literature review on digital transformation (P1), and complemented their search terms with keywords on digital transformation. Further, we followed the guidelines of Webster/Watson (2002) and conducted a forward and backward search to find more relevant articles, which would remain undiscovered otherwise. For the selection of relevant articles, we documented the inclusion and exclusion criteria we employed on all identified articles, following the guidelines of Okoli/Schabram (2010). As academic work, particularly in top journals, takes some time for publication, we also extended our search to conference articles (P1) and applied the same criteria as above on the identified articles to ensure we covered recent knowledge, too. Second, the literature reviews are limited by the coding of the articles to the respective schools of thought (P1) or co-evolution properties (P2). Therefore, we ensured that more coders did the coding of the respective articles. Accordingly, we exchanged a sample of the identified articles, coded them independently, and discussed the coding together afterward to clarify differences in our coding. Third, the avenues for future research that we derived from our results may be influenced by the authors' perspective and the topic. Further open issues might therefore exist, which can be discovered in future work.

The developed ecosystems (P3-P7) are subject to some limitations on the underlying **data and the coding** we employed. First, the underlying data of ecosystems is limited to available information provided by the CrunchBase database. However, we used a premium account to gather all available data. Some scholars argue that Crunchbase represents one of the most reliable sources for company data, and most importantly, for start-up data, as it is socially curated (Marra et al. 2015). To reduce the limitations of CrunchBase data, we also included further publicly available data sources, such as company websites, reports, press articles, or annual reports, to triangulate our coding. Second, the generic roles and the value streams between them in our ecosystems are limited to our coding of the CrunchBase data. To ensure consistent coding, we applied the following actions. Before the coders started coding the organizations from Crunchbase, both coded several organizations to become familiar with the coding scheme and then compared their coding for calibration purposes. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached consensus. This helped to eliminate individual disparities (Bullock/Tubbs 1990). Further, we followed the same approach for the identification of the value streams between the generic roles. To ensure consistent coding of the generic roles, and value streams between them, several coders coded the data set. To ensure the reliability of our coding, we used Krippendorff's Alpha (Krippendorff 2004) to determine the intercoder reliability. Krippendorff's Alpha was between 0.83 and 0.87 in all ecosystems (see P3-P7), reflecting acceptable intercoder reliability

(Krippendorff 2004). To validate our results, we further conducted interviews with industry experts to discuss our ecosystems and the inherent generic roles. Therefore, we only selected interviewees that are either working in a leading strategic position (Goldberg et al. 2016a), who have privileged access to information or knowledge on the subject (Bogner et al. 2009b). This allowed us to draw on broad expertise from long-time market experience and different customer insights from various companies.

The case studies (P8 and P9) are subject to limitations on **generalizability and reporting bias**, an issue inherent to such qualitative research approaches (Yin 2014). While we accept a certain degree of the idiosyncrasy of our findings, we still aim at generalizing from our results when possible (Gioia et al. 2013). In our study on the transformation of Microsoft's partner ecosystem (e.g., P8), we discuss the generalizability of our findings based on dimensions such as market position or partner base. Addressing generalizability in such settings requires a context-sensitive approach as findings can be generalized more straightforward in similar contexts (Davison/Martinsons 2016). Particularly in P8-9, we relied on interviews as the primary data source. Interview partners are subject to bias as well, such as the retrospective reporting bia**s** (Eisenhardt/Graebner 2007), which is of particular relevance for case studies where interview partners report earlier events. Similar to the expert interviews for the validation of the ecosystems, we interviewed different experts, e.g., within the Microsoft partner ecosystem across different levels of hierarchy and even from different organizations, to triangulate the information we gathered as a countermeasure to reporting bias (Bogner et al. 2009b).

17 Future Research

Throughout our studies on digital transformation and digital platform ecosystems, several issues for future research arose that we were not able to address within the scope of the publications embedded in this thesis. We hope that the issues laid out below can provide avenues for fruitful future research.

Integrate multiple schools of thought when studying digital transformation. By accounting for the schools of thought (P1) on organizational identity, sensemaking, and transformational leadership, particularly IS studies on digital transformation could learn from the findings of organization science or management literature. The other way around, IS literature accounts for the specifics of digital technologies in organizational transformation context, as the technological foundations may significantly influence the possibilities of organizational identity, operation, governance, and learning. Taking a broader stance is important when designing and organizational setup that empowers digital transformation.

Measure the success of digital transformation. While has built groundwork on clarifying the notion of digital transformation, and visualized how digital transformation materializes on the ecosystem level, we observed that it remains difficult to objectively measure the success of a digital transformation initiative or project. Moreover, the outcome of digital transformation is dependent on a multitude of different factors, such as organizational size, top management support, or the degree of exploration and exploitation of resources. Therefore, to measure the success of different digital transformation initiatives, several in-depth case studies could be conducted or a larger number of cases could be compared with configurational methods such as fsQCA (Ragin 2008; Fiss/Zajac 2006). Configurational methods allow for asymmetric relationships between predictors and the outcome, since they "view phenomena as clusters of interconnected elements that must be simultaneously understood as a holistic integrated pattern" (El Sawy et al. 2010a). In particular, this means that a predictor could be sufficient for a specific outcome, but not necessary. Furthermore, it also means that the interplay of different predictors leads to a specific outcome and that this interplay can be depicted through different configurations of predictors. Elements of configurations can have different degrees of relevance that can be depicted through the concept of core and peripheral conditions (Fiss 2011). Hence, we suggest to use the fsQCA method to examine the interplay of environmental and organizational factors via the method to derive patterns for successful digital transformation strategies. This configurative research method is particularly useful to examine digital transformation strategies, as it allows for equifinality (Ragin 2008), e.g., multiple ways can lead to a successful digital transformation, compared to unifinal methods like regressions.

Examine the impact of blockchain technology on other ecosystems. We suggest future research to determine the impact of blockchain technology on other ecosystems that the financial (P4) or insurance (P6), such as the IoT ecosystem. On an ecosystem level, blockchain technology has the potential to extend or substitute existing products or services, e.g., in the case of payments or identity management (P5, P4, P6). For example, blockchain technology could contribute to the interoperability of heterogeneous services and objects, which can be achieved through common standards and digital platforms (Mattila 2016; Mattila/Seppälä 2017). The unique identification of objects is of central relevance to the IoT (Broring et al. 2017). Hence, blockchain-based identity management for items, services, and their transactions could help to build such a concept.

Identify partnership patterns in digital platform ecosystems. Particularly in the case studies of platform owners managing the co-evolution of their complementary partners (P8, P9), we implicitly assume these complementary partnerships are directly comparable. However, we would be curious to analyze the multitude of partnerships we identified in the ecosystem papers (P3-P7) and build a taxonomy of the partnership patterns in digital platform ecosystems between platform owners, complementary partners, and end users following the guidelines of Nickerson et al. (2017). After the derivation and evaluation of this taxonomy, future research could re-evaluate if the identified mechanisms for platform owners to manage the co-evolution of complementary partners are suitable for all partnerships. The taxonomy could help established platform owners not only for managing the co-evolution of complementary partners, but also potential platform owners for the development of their platform ecosystem.

Complementary partners' perspective on co-evolution in digital platform ecosystems. In the studies we conducted, we focus predominantly on the platform owners' perspective (P8, P9) and in one publication, we account for the different steps a complementary partner conducts when developing a complement on, or transforming an established complement to, the new introduced digital platform ecosystem (P9). In this line with the majority of the studies on digital platform ecosystems, it is worthwhile to focus on the perspective of complementary partners (Kude et al. 2012). Subsequently, the dynamics of digital platform ecosystems tend to produce monopolistic or oligopolistic market structures (Parker/Van Alstyne 2005; Parker et al. 2016), following the "winner-takes-it-all" principle (Hand 2002). Hence it would be interesting to see how complementary partners can be strengthened to increase their power, or which regulatory actions for the digital platform economy can be deployed (Clemons et al. 2019).

18 Conclusion

Understanding the impact of digital transformation for organizations, and its surrounding ecosystem is gaining importance among scholars in various disciplines and practitioners in a plethora of industries. The goal of this thesis was to gain an empirical understanding of how platform owners can manage the co-evolution of complementors in digital platform ecosystems in digital transformation initiatives. We first focused on literature on digital transformation to clarify the phenomenon and differentiated it to prior organizational transformation, and literature on co-evolution in ecosystems. Second, we developed and analyzed five ecosystems – automotive, blockchain, financial, insurance, and IIoT – to identify how digital transformation materializes on an ecosystem level. In order to do so, we coded 3478 organizations into 96 generic roles of actors in the ecosystems, identified the value streams between them, and validated the findings through 31 expert interviews. Moreover, taking on quantitative similarity measures to compare the five ecosystems, we identified 15 clusters and some roles occurring in all ecosystems. Finally, based on four case studies, we identified 28 co-evolution mechanisms for platform owners to manage the co-evolution of complementary partners in digital platform ecosystems, organized into four steps. Our findings elevate literature on digital transformation by providing twelve schools of thought to discuss the phenomenon appropriately, and contributes to literature to the understanding how partnerships in ecosystem vary over time, and what drives this variation, and how this is related to the development of complements on, or the transformation of established complements to, the a new digital platform. We hope that our work sparks future research on digital transformation and digital platform ecosystems.

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Appendix

Appendix A: Literature Search Results on Digital Transformation

This appendix contains the selected management, organization science, and IS journal and conference articles of the literature review of the article P1, ordered by the 12 schools of thought. The description of the schools of thought can be found in the paper.

School of Thought	∑	**Mgmt /OS JNL** **IS JNL** **IS CONF**	**Source(s)**
Dynamic capabilities/RBV	**32**	7	(Cui et al. 2011; Helfat/Peteraf 2015; Menon/Yao 2017; Ocasio et al. 2018; Agarwal/Helfat 2009; Berente et al. 2016; Wiedner et al. 2017)
		17	(Ash/Burn 2003; Battleson et al. 2015; Daniel/Wilson 2003; Hackbarth/Kettinger 2004; Hanelt et al. 2017; Li et al. 2017; Orlikowski 1996; Singh et al. 2011; Iannacci 2014; Karimi/Walter 2015; Chatfield/Bjørn-Andersen 1997; Barua et al. 2004; Elliot 2011; Leonardi/Bailey 2008; Mani et al. 2010; Mithas et al. 2011; Tillquist et al. 2002)
		8	(Andersen/Ross 2016; da Silva Freitas et al. 2016; Nwankpa/Roumani 2016; Tumbas et al. 2015; Mueller/Renken 2017; Tan et al. 2017; Tiefenbacher/Olbrich 2017; Chatfield et al. 2015)
IS-enabled OT	**25**	-	
		22	(Baskerville/Smithson 1995; Tan/Pan 2003; Wei et al. 2005; Hsiao/Omerod 1998; Robey/Boudreau 1999; Robey/Sahay 1996; Straub/Watson 2001; Markus 2004; Subramanian/Lacity 1997; Ranganathan et al. 2004; Clemons/Hann 1999; Teo et al. 1997; Zhu et al. 2004; Baskerville 2003; Besson/Rowe 2012; Crowston/Myers 2004; Gregor et al. 2006; Pillay et al. 2012; Nan 2011; Cooper et al. 2000; Power/Gruner 2017; Moody et al. 2016)
		3	(Omar/Elhaddadeh 2016; Bilgeri et al. 2017; Hartl/Hess 2017)
Transformational leadership	**21**	19	(Barrick et al. 2014; MacKay/Chia 2013; Sonenshein 2010; Vera/Crossan 2004; Bednar et al. 2013; Boudreau/Robey 2005; Cho/Hambrick 2006; DeCelles et al. 2015; Hill et al. 2012; Triana et al. 2014; Zhao/Zhou 2004; Dalpiaz/Di Stefano 2018; Haynes/Hillman 2010; Herrmann/Nadkarni 2014; Nakauchi/Wiersema 2014; Quigley/Hambrick 2012; Wowak et al. 2016; Zhang 2006; Zhang/Rajagopalan 2010)

		2	(Roepke et al. 2000; Eseryel/Eseryel 2013)
		-	
(Digital) innovation	**21**	1	(Kannan-Narasimhan/Lawrence 2018)
		9	(Lucas et al. 2013; Srivastava/Shainesh 2015; Lyytinen/Rose 2003; Trantopoulos et al. 2017; Carlo et al. 2014; Wamba/Chatfield 2009; Lucas/Goh 2009; Zhu et al. 2006; Fichman et al. 2014)
		11	(Böhl et al. 2016; Chanias/Hess 2016; Ross et al. 2016; Lehmann/Rosenkranz 2017; Berghaus/Back 2017; Mocker/Fonstad 2017; Roecker et al. 2017; Petrikina et al. 2017; Chanias 2017; Remané et al. 2017; Hong/Lee 2017)
Revolutionary/ radical change	**16**	2	(Amis et al. 2004; Huy et al. 2014)
		14	(Audzeyeva/Hudson 2016; Fiedler et al. 1995; Klecun 2016; Sayer 1998; Wastell et al. 2007; Caron et al. 1994; Cooper 2000; Moreton 1995; Noble 1995; Sarker/Lee 1999; Stoddard/Jarvenpaa 1995; Silva/Hirschheim 2007; Lyytinen/Newman 2008; Lyytinen et al. 2009)
		-	
Identity, cognition, sensemaking	**15**	13	(Fiss/Zajac 2006; Mantere et al. 2012; Nag et al. 2007; Voronov/Yorks 2015; Westpahl/Bednar 2005; Sliwka 2007; Balogun et al. 2015; Sonensheim 2009; Sonenshein/Dholakia 2012; Durand et al. 2007; Gylfe et al. 2015; Johnson/Hoopes 2003; Plambeck/Weber 2010)
		1	(Seidel et al. 2013)
		1	(Haffke et al. 2016)
Ecosystem	**13**	3	(McDonald/Westpahl 2003; Jacobides et al. 2018; Koka/Prescott 2008)
		2	(Yeow et al. 2018; Baesens et al. 2014)
		8	(Staykova/Damsgaard 2015; Schmidt et al. 2017; Nischak et al. 2017; Paavola et al. 2017; Riasanow et al. 2017; Constantiou et al. 2017; Riasanow et al. 2018a; Riasanow et al. 2018b)
	11	4	(Oehmichen et al. 2017; Paroutis/Heracleous 2013; Chittoor et al. 2009; Plowman et al. 2007)

Emergence, institutionalism, and contingency		6	(Ferioli/Migliarese 1996; Mangan/Kelly 2009; Shao et al. 2016; Stafford/Turan 2011; Mindel/Mathiassen 2015; Heikkilä 2013)
		1	(Lienhard et al. 2017)
Business model	**8**	2	(Rindova et al. 2011; Jones 2003)
		1	(Feller et al. 2011)
		5	(Hanelt et al. 2015a; Hildebrandt et al. 2015; Piccinini et al. 2015a; Remané et al. 2016a; Remané et al. 2016b)
Evolutionary/ incremental change	**4**	-	
		4	(Abraham/Junglas 2011; Cunningham/Finnegan 2004; Tillquist 2000; Harkness et al. 1996)
		-	
Ambidexterity	**2**	0	
		1	(Gregory et al. 2015)
		1	(Horlacher et al. 2016)
Service-dominant Logic	**1**	-	
		1	(Barret et al. 2015)
		-	
n/a	**7**	-	
		5	(Rowe 2018; Majchrzak et al. 2016; Loebbecke/Picot 2015; Aral et al. 2013; Agarwal et al. 2010)
		1	(Ebbeson 2015)
Total	**175**	51	
		85	
		39	

Table 43. Literature Search Results Organized in the Identified Schools of Thought

Appendix B: Data Basis for the Clustering of the Ecosystems

This section provides an overview of the data of the underlying ecosystems, consisting of the keywords we entered in Crunchbase, the time stamp we extracted the organization data, the size of the initial and final data set, and the value of Krippendorff's Alpha for the coding of each ecosystem.

Ecosystem	**Keyword(s)**	**Date of data extraction**	**Initial data set**	**Final data set**	**Generic roles**	**Krippendorff's Alpha**
Automotive	"automotive"	October 20, 2016	728	650	15	0.87
Blockchain	"blockchain"	December 11, 2017	500	479	11	0.87
Fintech	"fintech"	October 02, 2017	1,000	792	22	0.85
InsurTech	"InsurTechs" AND ("FinTechs AND "Insurance")	March 26, 2018	1,424	956	34	0.87
IIoT	"IIoT" AND "Industrial IoT"AND "Industrial Internet of Things" AND "Industry 4.0"	May 29, 2018	633	601	14	0.83
Total			4,285	3,478		

Table 44. Data Basis for the Ecosystems

Appendix C: List of Interview Partners for the Ecosystems

This section provides a short overview of the interview partners, their job positions, the respective ecosystem we discussed with them, and the duration of the interview.

Ecosystem	**No.**	**Job position of the interviewee**	**Duration**
Automotive	A1	Department Manager, OEM	00:29 h
Automotive	A2	CEO, Value Added Service Provider	00:30 h
Automotive	A3	CEO, Automotive Consultancy	01:21 h
Automotive	A4	CEO, Value Added Service Provider	00:33 h
Automotive	A5	Division Manager, OEM	00:28 h
Automotive	A6	Inhouse Consultant, Automotive Consultancy	00:30 h
Financial	F1	Account Manager, Venture Fund	00:38 h
Financial	F2	Senior Analyst, Investment bank	00:47 h
Financial	F3	Fintech, Founder	00:49 h
Financial	F4	Fintech, Founder	00:33 h
Insurance	In1	Broker Carer, Leading Insurance Company	00:43 h
Insurance	In2	Head of Digital Automotive, Leading Insurance Company	00:38 h
Insurance	In3	Partner Insurance Digital, Management Consultancy	00:42 h
Insurance	In4	Senior Manager Inhouse Consulting, Specialist Insurance Company	00:31 h
Insurance	In5	Founder, InsurTech	00:40 h
Insurance	In6	Head of Life Insurance, Leading Insurance Company	00:39 h
Insurance	In7	Deputy Board Member, Leading Insurance Company	00:40 h
Blockchain	B1	Senior Manager, Blockchain Lab, big four Accounting/Consulting	00:45 h
Blockchain	B2	Consultant, big four Accounting/Consulting Company	00:45 h
Blockchain	B3	Consultant, Blockchain Consultancy	01:00 h
Blockchain	B4	COO & Co-Founder, Blockchain Consultancy	01:00 h

Blockchain	B5	Independent Blockchain Consultant	00:30 h
IIoT	Io1	Head of Department “Industry 4.0”, Manufacturer	00:55 h
IIoT	Io2	Project leader for Industry 4.0, Consulting	00:43 h
IIoT	Io3	Head of Production, Manufacturer	00:42 h
IIoT	Io4	Partner for Industry 4.0, Consulting	00:34 h
IIoT	Io5	Head of Industrial Research and Innovation, Manufacturer	00:32 h
IIoT	Io6	Process Manager, Equipment Provider	00:30 h
IIoT	Io7	Inhouse Consultant for Industry 4.0, Manufacturer	00:36 h
IIoT	Io8	Partner for Industry 4.0, Consulting	00:28 h
IIoT	Io9	Partner Manufacturing, Consulting	00:43 h

Table 45. Expert Interviews for the Validation of the Ecosystems

Appendix D: Generic Roles of the IIoT Ecosystem

Role	Description	Example
Consumer	Consumers receive the final product or service in exchange for money or data. The customer may contribute value to the ecosystem, e.g., through co-creation of goods or services. All value-adding activities are eventually paid by the consumer. In the IIoT ecosystem, consumers are typically B2B companies. In some cases, this role may be a prosumer, by simultaneously providing data in order to receive a service.	
Manufacturer/OEM	The Manufacturer/OEM represents the owner of a (smart) factory that is consuming product or service offerings from other roles, e.g., to develop or improve the products of its own or other companies' products. This may include raw materials, machines, and digital innovations. Hence, manufacturers are demanding IIoT technology to improve production, operational processes, and structures. In many cases, the manufacturer is an OEM or similar.	BMW, CAT, Siemens, General Electric
Raw Material Supplier	The Raw Material Supplier supplies the manufacturer with the materials required for the production. It represents a role from the classical manufacturing industry, which has barely changed through IIoT.	3M, Covestro
Factory Equipment Provider	The Factory Equipment Provider offers hardware, software, and its maintenance for the manufacturer/OEM, such as machines for production and automation, which are required in the manufacturing process. Many representatives of this role were already in place before the emergence of IIoT. The provision of maintenance for the equipment is an integral part of the value creation of this role.	PINpoint, Rootstock Software
Sensor and Connectivity Provider	Sensor and Connectivity Providers offer connectivity for entities used by the manufacturer/OEM. This includes sensors to connect machines already in use, or sensors for new machines, or robots that allow connectivity to the manufacturing process. The sensors can be used to collect data, which is an essential prerequisite for IIoT applications, or offer wireless network connectivity for IoT devices, and thus, a connection to the cloud.	Alien Technology, Libelium, Verizon, Acent Systems
Fog and Edge Computing Provider	The Fog and Edge Computing Provider offers hardware and software for edge computing (computing done directly or close to the edge or sensor). This approach helps to reduce latency for mission-critical computation, which acts as middleware of IIoT applications. It includes embedded chips and interfaces for IoT-enabling devices and edge gateways for collecting and processing data over factory networks.	Atmel, Litmus Automation, Nebbiolo

IIoT Hardware Provider	The IIoT Hardware Provider offers connected hardware, technology, or machines used for the digital factory. Members of this role typically possess proven expertise in the engineering required for the hardware (and often for the complementary software).	Kuka, EOS, Rethink Robotics
Cyber Security Provider	Cyber Security Providers offer products and services to ensure the security and safety of all cyber and connected operations in the smart factory. They develop solutions for IIoT and industrial control systems in heavy industries (amongst other industries). The goal is to prevent attacks of cyber-criminals.	WIBU Systems, Device Authority
IIoT Consulting Services	IIoT Consulting Services provide help for manufacturers in various aspects. Their portfolio ranges from an assessment of capabilities, developing IIoT roadmaps, to selecting and implementing different solutions of the IIoT.	Accenture, Hut-Grip
Cloud Infrastructure Provider	Cloud Infrastructure Providers consist of a shared pool of Internet-based configurable computing resources (e.g. servers, storage, applications, and services), which can be rapidly provisioned and released with minimal management effort (Youseff, Butrico, & Da Silva, 2008).	Amazon EC2
Cloud Platform Provider	Cloud Platform Providers offer an environment to develop, run, and test applications. From a technical perspective, an operating environment, application programming interfaces (APIs), and programming languages are provided. Developers are shielded from technical, infrastructure=related details. Programs are executed over datacenters, not concerning developers with matters of resource allocation (Böhm et al., 2010).	C3 IoT, Scope AR, Microsoft ACP
Cloud Service Provider	The Cloud Service Provider hosts and operates applications, in contrast to the traditional software model, in an own or outsourced data center. Cloud applications are accessible for customers via the internet. The application provider has to ensure smooth operation of the applications, including monitoring, asset/resource management and failure/problem management (Böhm et al., 2010).	RtTech Software, Maana, Eigen Innovation
IIoT Platform Provider	The IIoT Platform Provider offers a platform dedicated to the IIoT. It uses the underlying cloud infrastructure to provide a market place for proprietary or complementary IIoT services or solutions. It represents the foundation for different technologies and interfaces to be handled over one common platform. The IIoT market provider offers an environment in which different components of the Industrial Internet of Things can be connected, and services from third parties can be deployed and offered. It can be seen as the “glue component” and heart of the paradigm Industrial IoT.	Siemens MindSphere, GE Predix, PTC ThingWorx

IIoT Solution Provider	The IIoT Solution Provider offers complete solutions of hardware and software to manufacturers. Therefore, he/she uses the offerings of other providers like the Industrial IoT Hardware Provider, Sensor & Connectivity Provider, Fog & Edge Intelligence Provider, and the Added Value Service Provider or partly fulfills those roles himself. Compared to the Hardware or Sensor provider, he/she is not only offering the product but rather a complete solution to perform a service.	Alleantia, Konux, Xometry, KAESER

Table 46. Generic roles of the actors in the IIoT Ecosystem

The next section intends to provide an overview of the data extracted from Crunchbase for one company, i.e. Alleantia, which we used in the IIoT ecosystem.

Organization Name	**Alleantia**
Source Link	https://www.crunchbase.com/organization/alleantia
Categories	Energy Efficiency, Industrial Automation, Industrial Manufacturing, Internet of Things, Machinery Manufacturing
Headquarter	Pisa, Toscana, Italy
Short Description	Industry 4.0 plug&play. Enabling an Open ecosystem of Machines and Applications.
Description	Industry 4.0 is changing every aspect of how industry operates. Every process and activity can be optimized, networked, and made smarter by exploiting machines' embedded intelligence to manage their operations, production processes, integrate information across enterprise own processes and within the extended supply chain. Alleantia provides the most scalable and cost-effective Industrial IoT solution in the market for data collection, information standardization and distribution from wire to cloud, to implement pervasive machines data access and comprehensive information sharing within the enterprise and across its extended supply chain. Alleantia software connects in few seconds any device — from complex machinery to simpler sensors — to create a complete and interoperable digital twin for each new or legacy industrial equipment, supporting a vast majority of industrial protocols and communication interfaces with a innovative, agile codeless 'driver' model Instantly feed selected data into multiple enterprise IT applications and clouds through certified 'IIoT Apps', with full control from end user. Alleantia software provides multiple ways to use machine data, from Digital Twin IIoT Apps that instantly feed machine information to IT development platforms, or publish machine data using specific communication protocols, to Alleantia IIoT Apps using machine data within embedded applications or public application platforms, to Application Ecosystem IIoT Apps with many Industry 4.0 applications "connected by Alleantia". Dozens of Application partners, hundreds of systems and machines connected, large customers and machines manufacturers adopting our technology makes Alleantia

	software the reference solution for implementing an open, scalable and future-prood Industrial IoT architecture, supported by bespoken hardware vendors such as Dell, Advantech and Cisco.
CB Rank	30,147
IPO State	Private
Stock Exchange	-
Valuation at IPO	-
Acquisition Status	-
Number of Lead Investors	1
Number of founding investors	5
Funding Status	Seed
Last funding day	10.09.2015
Last funding amount	$25,000
Total funding amount	$567,155
Number of employees	11-50
Category groups	Energy, Internet Services, Manufacturing, Science and Engineering, Sustainability
Operating status	Active
Founded data	31.05.2011
Company type	For profit
Website	http://www.alleantia.com

Table 47. Crunchbase data for the organization Alleantia

Appendix E: Clusters

Table 48 provides an overview of the calculated clusters. The metrics include, number of organizations assigned to this cluster as well as the number of ecosystems and roles present in the cluster. Additionally, we provide the number of topics from the LSA.

Cluster	Number of organizations	Number of ecosystems	Number of roles	Number of topics
1	390	5	34	2
2	282	2	13	1
3	149	2	5	1
4	266	2	2	7
5	143	2	2	3
6	282	1	9	5
7	149	1	4	1
8	99	1	3	8
9	124	1	2	1
10	104	1	2	7
11	240	1	1	2
12	156	1	1	8
13	54	1	1	1
14	284	1	1	6
15	45	1	1	3

Table 48. Cluster Overview

Following, we provide the results from the Louvain algorithm and the LSA for each of the 15 calculated clusters.

Cluster 01

This section shows the results for Cluster 01. The following figure presents the coherence values, which are maximized for a number of topics of two topics. Therefore, we extracted the two topics: 1) cloud, application, data, 2) enterprise, web computing.

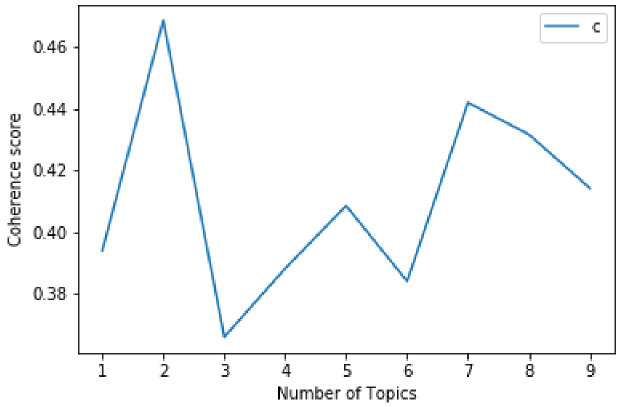

Figure 17. Coherence values for number of topics of Cluster 01

Further, the following table shows the assigned roles to Cluster 01. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
57	FinTech	Technology, IT and Infrastructure
43	IIoT	Disruptive Technology Provider (Software)
31	Blockchain	Platform, Application Provider
30	Blockchain	Infrastructure, Platform, Application Provider
28	IIoT	Sensor & Connectivity Provider
27	Blockchain	Ancillary Service Provider
26	Blockchain	Infrastructure Provider
19	IIoT	Disruptive Technology Provider (Software),Sensor & Connectivity Provider
15	IIoT	Consulting
10	IIoT	Disruptive Technology Provider (Hardware)
10	IIoT	Fog / Edge Intelligence Provider

10	FinTech	Fraud Prevention Provider
10	IIoT	Cyber Security Provider
8	All	Cloud Infrastructure Provider
8	FinTech	Digital Identity Provider
7	All	Cloud Platform Provider
6	Blockchain	Mining Solution Provider
4	Blockchain	Token-Based Community Platform Provider
4	All	Cloud Application Provider
4	IIoT	Disruptive Technology Provider (Software),Fog / Edge Intelligence Provider
4	Blockchain	Blockchain Consulting
4	Blockchain	Platform Provider, Ancillary Service Provider
3	IIoT	IIoT Platform Provider
3	IIoT	Sensor & Connectivity Provider, Fog / Edge Intelligence Provider
3	Blockchain	Blockchain Alliances
3	IIoT	Fog / Edge Intelligence Provider, Disruptive Technology Provider (Software)
3	IIoT	Software Provider
2	Blockchain	Miner / Mining Pool
2	FinTech	Regulatory Authorities
2	Automotive	SaaS
2	Blockchain	Ancillary Services
1	Blockchain	Blockchain Community
1	Blockchain	Infrastructure, Platform Provider

Table 49. Roles assigned to Cluster 01

Cluster 02

This section shows the results for Cluster 02. The following figure presents the coherence values, which are maximized for one topic. Therefore, we extract: 1) money, currency, digital.

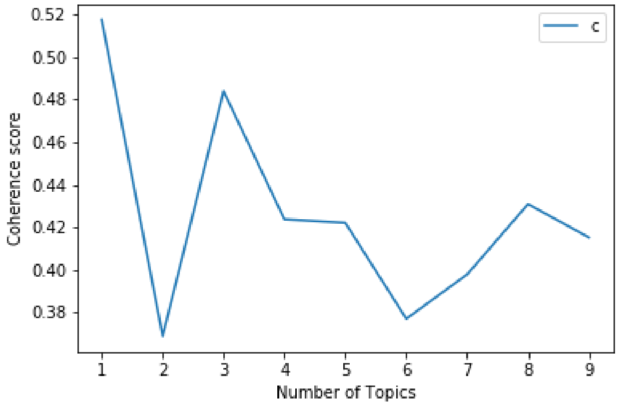

Figure 18. Coherence values for number of topics of Cluster 02

The following table shows the assigned roles to Cluster 02. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
41	InsurTech	Smart Contracts Blockchain
39	FinTech	Analytics
29	FinTech	Aggregator
29	FinTech	Cryptocurrency Exchange
27	FinTech	Money Transfer
24	FinTech	Personal Financial Management
21	InsurTech	Instant Insurance
17	InsurTech	P2P Insurance
15	FinTech	Risk Management
12	FinTech	Online Bank
12	FinTech	Finance Market Platform
11	FinTech	Cryptocurrency Wallet

5	FinTech	Saving Accounts

Table 50. Roles assigned to Cluster 02

Cluster 03

This section shows the results for Cluster 03. The following figure presents the coherence values, which are maximized for a number of topics of one topic. Therefore, we extract: 1) system, manufacture, develop.

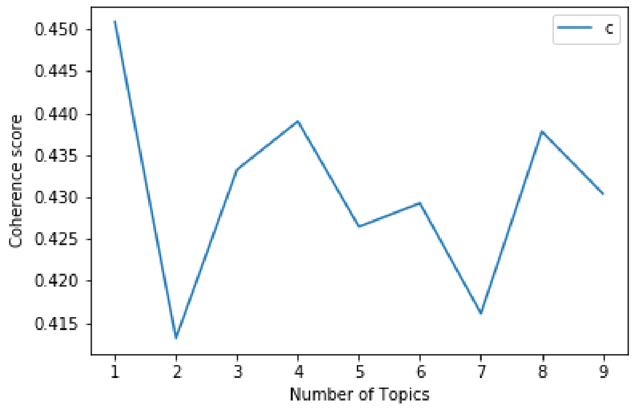

Figure 19. Coherence values for number of topics of Cluster 03

The following table shows the assigned roles to Cluster 03. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	**Ecosystem**	**Role**
122	Automotive	Technology Provider
11	Automotive	E-Car Maker
9	Automotive	Intelligent Infrastructure Provider
4	Automotive	Car Manufacturer
3	IIoT	Classical Factory Equipment Provider

Table 51. Roles assigned to Cluster 03

Cluster 04

This section shows the results for Cluster 04. The following figure presents the coherence values, which are maximized for a number of topics of seven topic. Therefore, we extract: 1) software, develop, manage, 2) data, software, analytics, 3) manage, claim, AI, 4) business, process, claim, 5) claim, develop, analytics, 6) manage, base, property, 7) agent, AI, global.

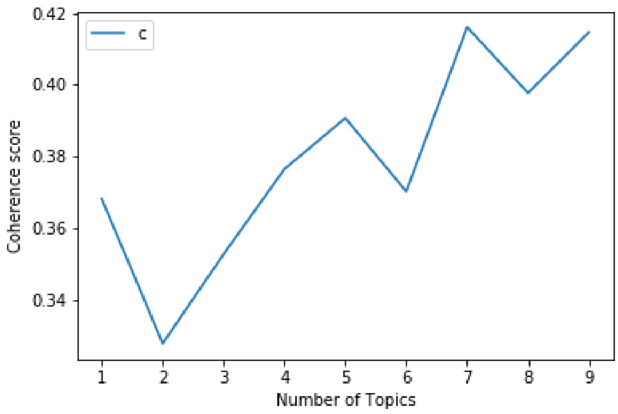

Figure 20. Coherence values for number of topics of Cluster 04

The following table shows the assigned roles to Cluster 04. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
265	InsurTech	Big Data Analytics / Predictives Software
1	IIoT	IIoT Data Consolidation / Monitoring

Table 52. Roles assigned to Cluster 04

Cluster 05

This section shows the results for Cluster 05. The following figure presents the coherence values, which are maximized for a number of topics of three topic. Therefore, we extract: 1) business, online, management, 2) business, agency, way, 3) brokerage, business, automatic.

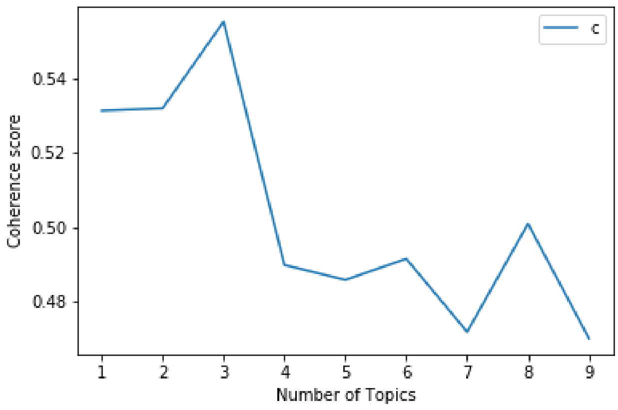

Figure 21. Coherence values for number of topics of Cluster 05

The following table shows the assigned roles to Cluster 05. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
142	InsurTech	Digital Insurance Agents/Broker
1	FinTech	Investment and Banking

Table 53. Roles assigned to Cluster 05

Cluster 06

This section shows the results for Cluster 06. The following figure presents the coherence values, which are maximized for a number of five topics. Therefore, we extract: 1) marketplace, online, parts, 2) peer, part, marketplace, 3) parts, peer, use, 4) sale, dealership, operations, 5) base, buy, use.

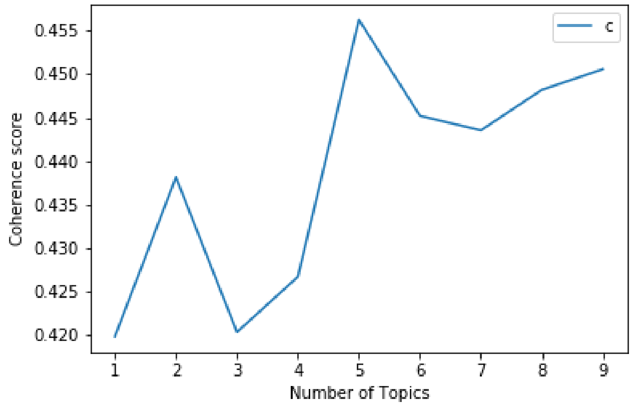

Figure 22. Coherence values for number of topics of Cluster 06

The following table shows the assigned roles to Cluster 06. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	**Ecosystem**	**Role**
58	Automotive	Car Dealer
54	Automotive	Platform Provider
36	Automotive	Parts Provider
35	Automotive	Car Service Provider
30	Automotive	OEM
29	Automotive	Market Platform
21	Automotive	Mobility Service Platform
10	Automotive	Car Rental Provider
9	Automotive	Physical Service Provider

Table 54. Roles assigned to Cluster 06

Cluster 07

This section shows the results for Cluster 07. The following figure presents the coherence values, which are maximized for topic. Therefore, we extract: 1) investment, online, social.

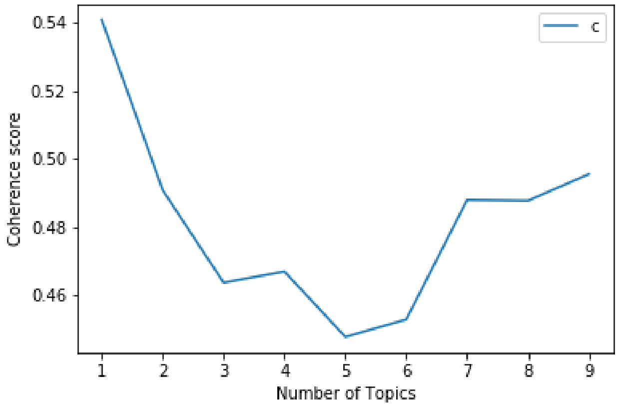

Figure 23. Coherence values for number of topics of Cluster 07

The following table shows the assigned roles to Cluster 07. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	**Ecosystem**	**Role**
56	FinTech	Stock Market
45	FinTech	Portfolio Management
38	FinTech	Crowdfunding
10	FinTech	Social Trading

Table 55. Roles assigned to Cluster 07

Cluster 08

This section shows the results for Cluster 08. The following figure presents the coherence values, which are maximized for eight topics. Therefore, we extract: 1) peer, marketplace, online, 2) peer, online, grow, 3) marketplace, online, global, 4) global, lender, person, 5) grow, invest, fast, 6) borrow, online, fund, 7) invest, investor, access, 8) fund, marketplace, P2P.

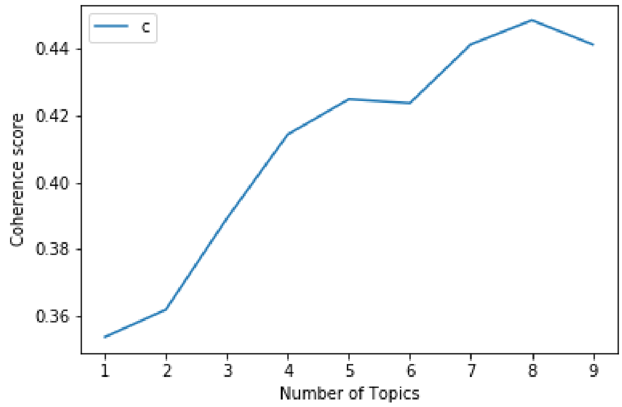

Figure 24. Coherence values for number of topics of Cluster 08

The following table shows the assigned roles to Cluster 08. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
86	FinTech	Loans
10	FinTech	Crowdlending
3	FinTech	B2B

Table 56. Roles assigned to Cluster 08

Cluster 09

This section shows the results for Cluster 09. The following figure presents the coherence values, which are maximized for one topic. Therefore, we extract: 1) compare, comparison, online.

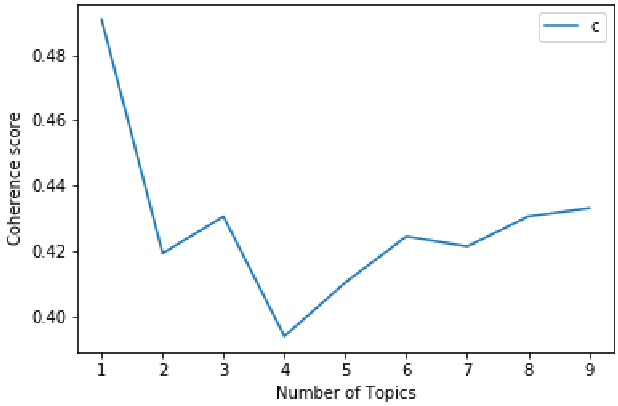

Figure 25. Coherence values for number of topics of Cluster 09

The following table shows the assigned roles to Cluster 09. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
101	InsurTech	Comparison Platform
23	InsurTech	Insurance Cross-Sellers

Table 57. Roles assigned to Cluster 09

Cluster 10

This section shows the results for Cluster 10. The following figure presents the coherence values, which are maximized for seven topics. Therefore, we extract: 1) supplier, global, component, 2) China, people, republic, 3) equipment, global, aftermarket, 4) system, market, leader, 5) supplier, design, aftermarket, 6) wheel, largest, north, 7) group, stamp, parts.

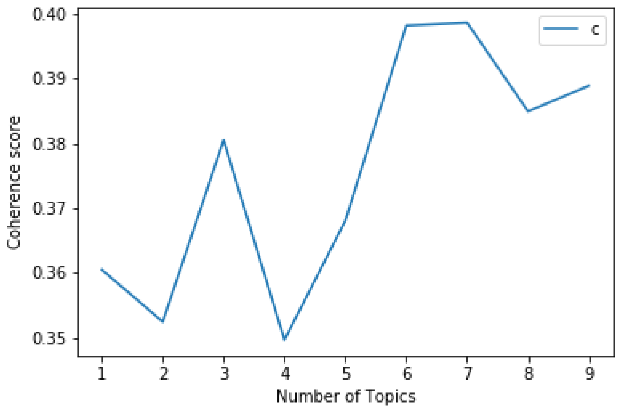

Figure 26. Coherence values for number of topics of Cluster 10

The following table shows the assigned roles to Cluster 10. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles

Number of organizations	**Ecosystem**	**Role**
101	Automotive	Tier 1-3
3	Automotive	Consulting

Table 58. Roles assigned to Cluster 10

Cluster 11

This section shows the results for Cluster 11. The following figure presents the coherence values, which are maximized for two topics. Therefore, we extract: 1) manage, base, administration, 2) outsourcing, administration, benefit.

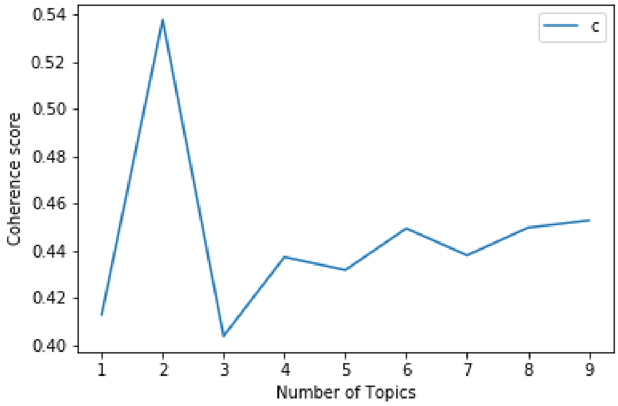

Figure 27. Coherence values for number of topics of Cluster 11

The following table shows the assigned roles to Cluster 11. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
45	Automotive	Value Added Service Provider

Table 59. Roles assigned to Cluster 11

Cluster 12

This section shows the results for Cluster 12. The following figure presents the coherence values, which are maximized for eight topics. Therefore, we extract: 1) business, small, invoice, 2) small, invoice, online, 3) e-Commerce, online, facilitate, 4) bill, app, e-Pay, 5) bill, medium, freelancer, 6) online, app, get, 7) network, account, new, 8) secure, sale, merchant.

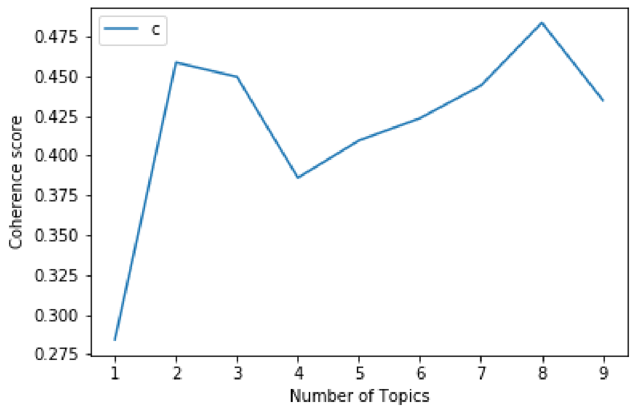

Figure 28. Coherence values for number of topics of Cluster 12

The following table shows the assigned roles to Cluster 12. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
284	Blockchain	Application Provider

Table 60. Roles assigned to Cluster 12

Cluster 13

This section shows the results for Cluster 13. The following figure presents the coherence values, which are maximized for six topics. Therefore, we extract: 1) secure, base, decentral, 2) secure, asset, decentral, 3) decentral, payment, digital, 4) asset, payment, secure, 5) peer, data, base, 6) peer, real, estate.

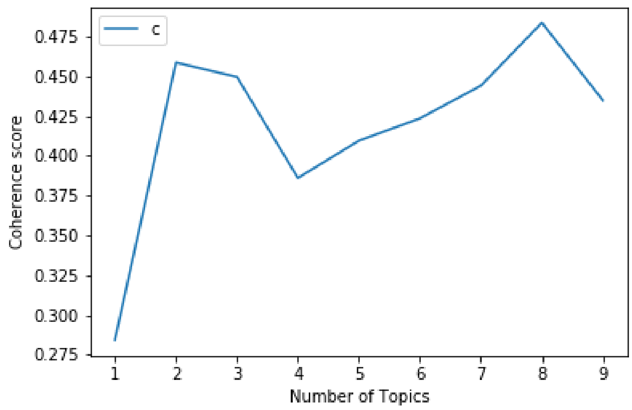

Figure 29. Coherence values for number of topics of Cluster 13

The following table shows the assigned roles to Cluster 13. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
54	Blockchain	Platform Provider

Table 61. Roles assigned to Cluster 13

Cluster 14

This section shows the results for Cluster 14. The following figure presents the coherence values, which are maximized for one topic. Therefore, we extract: 1) base, contract, chain.

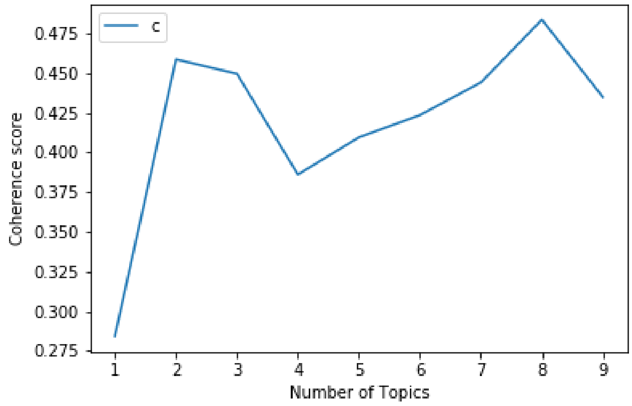

Figure 30. Coherence values for number of topics of Cluster 14

The following table shows the assigned roles to Cluster 14. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
156	FinTech	Payment Solutions

Table 62. Roles assigned to Cluster 14

Cluster 15

This section shows the results for Cluster 15. The following figure presents the coherence values, which are maximized for three topics. Therefore, we extract: 1) parking, manage roadside, 2) parking, roadside, assistance, 3) roadside, time, data.

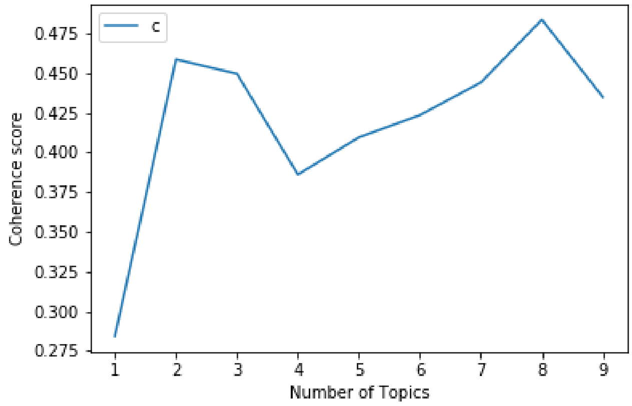

Figure 31. Coherence values for number of topics of Cluster 15

The following table shows the assigned roles to Cluster 15. Additionally, we show the amount of organizations per role that are included in this cluster, and the originating ecosystem of the roles.

Number of organizations	Ecosystem	Role
240	InsurTech	Digital Services

Table 63. Roles assigned to Cluster 15

Appendix F: Sensitivity Analysis and Prediction Accuracy

We conducted a sensitivity analyses to ensure the robustness of our results (Basole et al., 2018).

Specifically, for our network modeling, we conducted different similarity threshold at penalty levels between 0 and 1 in 0.1 increments, threshold levels at 0%, 10%, 15% and 20% and a variation of ±0.5 on the resolution parameter of the Louvain modularity algorithm.

The resolution parameter represents more relaxed or stringent weight among the similarity of the edges in the graph. We compare two KPIs: first, the average number of ecosystem present in in each cluster and second the number of clusters.

The table shows that the number of ecosystems and clusters does not change too much. The only outlier here is with input factor of penalty 0 and threshold 20%. This is the only point, where the graph resolves in many clusters.

Hence, as we introduce edges manually through the penalty factor, the number of clusters decreases with the increase of the penalty factor.

Penalty	Threshold	Resolution Factor										
		0.5	**0.6**	**0.7**	**0.8**	**0.9**	**1**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**
0	0%	3.87 / 47	3.69/ 33	3.41/ 24	3.05/ 20	2.76/ 17	2.35/ 14	2.15/ 13	2.37/ 16	2.23/ 13	2.33/ 15	2.46/ 31
	10%	3.86 / 46	3.75/ 40	3.47/ 32	3.46/ 28	3.41/ 24	3.05/ 21	2.89/ 19	3.12/ 17	2.65/ 17	3.42/ 45	3.65/ 65
	20%	1.78 / 216	1.69/ 212	1.70/ 209	1.61/ 204	1.55/202	1.56/202	1.49/198	1.44/ 195	1.61/ 207	1.53/ 202	1.57/ 202
0.1	0%	3.45 / 31	3.94/ 17	4.58/ 12	4.50/ 8	4.86/ 7	5.00/ 4	5.00/ 4	5.00/ 3	3.71/ 7	5.00/ 3	4.00/ 3
	10%	2.94 / 17	3.35/14	3.82/ 11	4.44/ 9	4.29/ 7	4.33/ 6	4.43/ 7	4.80/ 5	4.80/ 5	5.00/5	5.00/ 5
	20%	2.30 / 20	1.57/ 14	3.14/ 14	3.07/ 14	3.21/ 14	3.67/ 12	3.15/ 13	3.38/ 13	3.45/ 11	3.9/ 10	3.91/ 11
0.2	0%	1.96 / 24	2.44/ 16	2.58/ 12	3.13/ 8	3.29/ 7	3.50/ 6	3.50/ 6	2.50/ 10	2.00/ 11	2.23/ 13	2.25/ 12
	10%	1.78 / 18	2.13/ 15	2.42/ 12	2.20/ 10	2.40/ 10	3.40/ 7	3.86/ 7	4.00/ 6	4.00/ 6	4.60/ 5	3.00/ 7
	20%	2.13 / 23	2.20/ 20	2.21/ 19	2.56/ 16	2.59/ 17	2.53/ 15	2.83/ 12	2.93/ 14	3.00/ 14	3.00/ 16	2.92/ 12
0.3	0%	1.61 / 23	1.58/ 19	2.07/15	2.56/ 9	2.63/8	2.57/ 7	2.83/ 6	2.00/ 6	4.00/ 5	3.00/ 6	1.57/ 30
	10%	1.76 / 17	1.75/ 16	2.07/ 14	1.92/ 13	2.42/ 12	2.70/ 10	2.55/11	2.78/9	3.63/ 8	2.88/8	2.78/ 9
	20%	1.57 / 28	1.80/ 25	1.70/ 20	2.23/ 22	2.21/ 19	2.39/ 18	2.22/ 18	2.56/ 16	2.29/ 14	2.46/ 13	2.47/ 17
0.4	0%	1.50 / 24	1.59/17	1.62/ 13	1.69/13	2.00/ 8	2.14/ 7	3.00/ 7	3.50/ 6	2.17/ 6	2.40/ 5	1.32/ 38
	10%	1.50 / 20	1.50/ 16	1.87/ 15	2.21/ 14	2.33/ 12	2.33/ 12	2.36/ 11	2.27/ 11	2.17/ 12	2.82/ 11	3.25/ 8
	20%	1.46 / 28	1.84/ 25	1.77/ 26	2.09/ 23	2.14/ 22	2.10/ 20	2.05/20	2.16/ 19	2.26/19	2.07/15	2.19/ 16
0.5	0%	1.35 / 23	1.56/ 18	1.50/ 16	1.67/ 12	1.78/ 9	2.00/ 8	2.57/ 7	3.00/ 6	3.50/ 6	3.00/ 6	2.40/ 5
	10%	1.43 / 23	1.59/17	1.53/ 15	1.93/ 15	2.25/ 12	2.17/12	2.27/11	2.46/13	2.27/11	2.42/12	2.55/ 11
	20%	1.55 / 29	1.43/ 28	1.77/ 26	1.77/ 26	2.00/ 24	1.95/ 22	2.14/ 22	2.00/ 20	2.10/ 21	1.94/ 18	2.00/ 21
0.6	0%	1.29 / 24	1.50/ 16	1.38/ 16	1.50/ 12	1.64/ 11	2.11/9	2.43/ 7	2.71/7	2.67/6	3.00/ 6	1.83/ 6
	10%	1.36 / 25	1.40/ 20	1.38/ 16	1.80/ 15	1.86/ 14	1.92/13	2.08/12	2.31/13	2.18/ 11	2.09/ 11	2.097 11
	20%	1.40 / 30	1.54/ 28	1.63/ 27	1.69/ 26	1.73/ 26	2.00/ 24	2.04/ 23	1.96/ 24	2.04/ 23	1.96/ 23	2.10/ 21
0.7	0%	1.29 / 24	1.35/ 17	1.38/ 16	1.75/ 12	2.00/ 11	2.11/ 9	2.22/ 9	2.62/ 8	2.63/ 8	2.67/ 6	2.97/7

	10 %	1.36 / 25	1.38/ 21	1.37/ 19	1.44/ 16	1.53/ 15	2.00/ 13	1.85/ 13	1.83/ 12	2.00/ 14	2.07/ 13	2.09/ 11
	20 %	1.42 / 31	1.41/ 29	1.57/ 28	1.59/ 27	1.77/ 26	1.85/ 26	1.73/ 26	1.93/ 27	1.86/ 22	2.05/ 22	2.00/ 23
0.8	0%	1.21 / 24	1.28/ 18	1.38/ 16	1.36/ 14	1.46/ 13	1.81/ 11	1.89/ 9	2.33/ 9	2.13/ 8	2.50/ 6	2.08/13
	10 %	1.36 / 25	1.32/ 25	1.40/ 20	1.38/ 16	1.60/ 15	1.87/ 15	1.92/ 13	1.92/ 13	2.17/ 12	1.93/ 14	2.00/ 14
	20 %	1.45 / 33	1.44/ 32	1.57/ 28	1.64/ 28	1.70/ 27	1.81/ 26	1.74/ 27	1.84/ 25	1.81/ 26	1.92/ 25	1.95/ 22
0.9	0%	1.25 / 24	1.28/ 18	1.38/16	1.31/ 16	1.38/13	1.73/ 11	1.82/ 11	2.18/11	2.00/ 9	2.00/ 9	2.01/10
	10 %	1.32 / 25	1.36/ 25	1.32/22	1.41/17	1.56/ 16	1.73/ 15	1.79/14	1.85/ 13	2.00/ 12	2.07/ 14	2.10/15
	20 %	1.35 / 34	1.42/ 31	1.43/ 30	1.64/ 28	1.71/ 28	1.52/ 27	1.85/ 26	1.68/ 28	1.92/ 26	1.85/ 26	1.96/ 24
1	0%	1.21 / 24	1.30/ 20	1.31/ 16	1.31/ 16	1.46/ 13	1.83/ 12	1.73/ 11	2.00/ 10	1.90/ 10	2.33/ 9	2.50/ 8
	10 %	1.30 / 27	1.38/ 24	1.38/ 21	1.37/ 19	1.39/ 18	1.79/ 14	1.64/ 14	1.86/ 14	1.77/ 13	1.93/ 15	1.93/ 14
	20 %	1.40 / 35	1.39/ 33	1.41/ 32	1.34/ 29	1.41/ 29	1.75/28	1.59/ 27	1.75/ 28	1.85/ 26	1.96/ 25	1.85/ 26

Table 64. Sensitivity Analysis

The following table shows the results for predicting the individual ecosystems by using the mean of 100 iterations using the Louvain algorithm. We use the same approach as the quantitative part of our method, following Basole, Park, and Chao (2018), except for assigning a weight of 1 to nodes in the same role. We do this in order to predict how well the algorithm would perform, when using a quantitative approach only.

Ecosystem	**Mean prediction accuracy of 100 iterations**
Automotive	60,37%
Blockchain	55,49%
FinTech	52,34%
IIoT	54,56%
InsurTech	43,34%
Average	**53,22%**

Table 65. Prediction Accuracy for Individual Ecosystems using Cosine Similarity Measures and the Louvain Algorithm

Appendix G: Publication P1

Tobias Riasanow, David Soto Setzke, Markus Böhm, Helmut Krcmar*

Clarifying the Notion of Digital Transformation: A Transdisciplinary Review of Literature **

Abstract – We refer to the organizational transformation process of using digital technologies to radically transform organizations as digital transformation. Yet, within and in-between management, organization science, and information systems literature, there is considerable disagreement on the characteristics of an organization's digital transformation. Hence, we conduct a transdisciplinary review of literature, spanning 175 articles, regarding digital transformation and prior achievements regarding organizational transformation. As result, we identified twelve schools of thought to discuss the phenomenon of digital transformation. We show that digital transformation is building on existing schools of thought, while highlighting new ones, such as digital innovation and ecosystem.

Keywords: **digital transformation, organizational transformation, literature review**

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1. Motivation

The market is constantly evolving and giving rise to disruptive digital technologies, such as 3D printing, data analytics, and mobile computing (Nambisan et al., 2017), forcing established organizations to transform in order to remain competitive (Yoo et al., 2010; Lucas et al., 2013). We refer to the organizational transformation (OT) process of using and combining digital technologies in new ways to radically transform an organization as digital transformation (DT). The success of purely digital organizations such as Netflix, Spotify, or Amazon, as well as the bankruptcy of traditional companies such as Kodak or Blockbuster, are examples of DT (Goh et al., 2011). Under this heading, scholars from information systems (IS), management, or organization science are contributing to a growing body of knowledge concerning this phenomenon (e.g., Agarwal et al., 2010; Fitzgerald et al., 2013; Majchrzak et al., 2016; Rowe, 2018).

Yet, within and in-between these literature streams, there is considerable disagreement regarding what the characteristics of an organization’s DT are. This is reflected in inconsistencies, overlapping and contradictory definitions, and different and heterogeneous schools of thought. However, the diversity of theories and concepts from different disciplines often encourage compartmentalization of perspectives that do not enrich each other. For example, technology and its relationship with organizational structures, processes, and outcomes has long been of interest to organizational researchers (e.g., Orlikowski, 2000). However, digital innovations build on novel characteristics that differ from earlier technologies, e.g., reprogrammability, the homogenization of data, and the self-referential nature of digital technology (Yoo et al., 2010). Recognizing these characteristics, IS scholars have analyzed the influence of digital technology on firm’s strategies, structures, and processes (e.g., Bharadwaj et al., 2013; Fichman, 2014; Oswald et al., 2018). Management and organization science focus on the development of a new organizational logic to organize innovation in a digital world (Yoo et al., 2012), including transformational leadership, identity, cognition, and sensemaking (Nag et al., 2007; Rindova et al., 2011).

Because we lack clarity about the exact nature of DT, it is difficult to appropriately compare, analyze, and discuss the phenomenon. Consequently, we conduct a structured literature review, drawing on existing DT articles and prior OT studies, to present the underlying schools of thought of DT and to discuss their differences.

This paper is organized as follows. First, the literature-based research methodology is presented. Second, we present the results of the literature review, which consists of inconsistencies in the understanding of DT in management, organization science, and IS literature, and present 12 different and heterogeneous schools of thought to examine DT. Third, we clarify the notion of DT based on these schools of thought and show how prior achievements in OT inform discussions of DT. Then, we discuss the contributions and limitations of our findings. The paper concludes with avenues for future research.

2. Design of the literature review

This section describes the design of our literature review-based methodology to clarify the notion of DT and compare it to prior achievements regarding OT in management, organization science, and IS literature. We followed the guidelines of Webster/Watson (2002) to conduct a concept-centric literature review.

Consistent with the title of this paper, we constrained our structured literature review to DT and prior achievements regarding OT in some important dimensions. Most notably, we focused our attention on the management, organization science, and IS literature. This design choice is supported by two considerations. First, the topic of DT and its precursors is simply too huge to be acceptably covered in a single survey paper if prior work is to be recognized in any serious fashion. Second, OT is increasingly enabled by digital technologies, which is one of the key concerns of management, organization science, and IS literature. A second notable distinction with respect to the scope of this article is that it moves beyond OT. Therefore, we explicitly searched for DT articles that were not included in prior excellent literature reviews on OT, such as that of Besson/Rowe (2012). They analyzed the discourse on OT and suggested understanding IS-enabled OT as a process, not as a teleological model of diffusion. Most importantly, they highlighted that most OT theories were developed during the 1980s and should therefore be considered as “pre-Internet theories of transformation”. This invites us to reassess prior OT literature in the era of DT, particularly because digital technologies fundamentally differ from prior technologies (Yoo et al., 2010). Therefore, the third notable distinction is that we focus on clarifying the notion of DT, which we aim to derive through a comparison to prior research on OT.

We first focused on leading IS outlets, i.e., the AIS Senior Scholars’ Basket of Journals (Association for Information Systems, 2011). Extending Besson/Rowe (2012), we applied the terms in Table 1 using the Scopus database to the titles, abstracts, and keywords of the publications. Using the described search terms, we identified 107 relevant journal articles. A forward and backward search (Webster/Watson, 2002), based on the gathered articles, found 10 additional articles in leading IS journals, resulting in a total of 117 articles. We did not limit the publication year, context, or method of the articles. Following Okoli/Schabram (2010), we reviewed the articles manually and filtered them according to an iterative set of exclusion criteria. Therefore, articles that did not address DT, or focused on aspects of OT, such as Otim et al. (2012), who examined the effect of IT investments on the downside risk of firms, were excluded. Using this set of exclusion variables, we eliminated 32 articles. In the end, we selected 85 relevant IS journal articles.

Outlet		Search terms	Hits	Selected
IS Journals	MISQ	“organizational transformation” OR “transformation of the firm” OR “business transformation” OR “radical change” OR “revolutionary change” OR “radical transformation” OR “revolutionary transformation” OR “disruptive transformation” OR “strategic transformation” OR “technochange” OR “strategic change” OR “transformational” OR “digital transformation”	30	22
	EJIS		26	20
	JSIS		16	13
	ISR		14	9
	JIT		13	8
	JMIS		9	7
	ISJ		7	4
	JAIS		3	2
Management/OS Journals	SMJ	Search terms as mentioned AND > 2003	25	22
	Org. Sci.		22	14
	AMJ		28	10
	ASQ		6	2
	AMR		5	2
	MS		3	1
IS Conferences	ICIS	“digital transformation” AND > 2015		16
	AMCIS			11
	ECIS			9
	PACIS			3
			Grand Total	**175**

Table 1: Literature search results.

Second, to examine management and organization science literature, we applied the same search terms to the titles, abstracts, and keywords of articles published in six selected high-ranked management and organization science journals according to the FT50 ranking. We limited the publication year to 2003 but did not limit the context or the employed research method and found 89 articles. We again used the same set of exclusion variables (Okoli/Schabram, 2010) and excluded 38 articles that did not focus on OT, such as Pathak et al. (2014), who studied the impact of divestiture intensity and contextual factors on CEO compensation, leading to a selection of 51 relevant articles.

As a third step, we extended our search to leading IS conferences using the search term “digital transformation”, see Table 1. We limited our search to contributions since 2015, as we assume that older high-quality conference papers should have already been published in leading journals. Again, the articles that resulted from the search were selected according to the exclusion criteria defined above. This step yielded an additional 39 articles, resulting in a grand total of 175 articles. The full list of selected articles and the respective coding can be found in the Appendix of the paper.

3. Findings from the literature review to clarify Digital Transformation

To structure the findings of the literature review, we first analyze the inconsistencies in the understanding of digital transformation within and between management, organization science, and IS. Second, we present 12 different and heterogeneous schools of thought that we identified in DT and prior OT literature. Third, we discuss DT according to the identified schools of thought.

3.1 Inconsistencies in the understanding of Digital Transformation within and management, organization science, and IS literature

As a first step toward clarifying DT, and to provide an overview of the existing understandings of DT, we searched for explicit definitions of the phenomenon. In the selected publications, we found 51 articles explicitly using the term DT: 12 in IS journals, 39 in IS conferences, and 0 in management and organization science journals. Reading the selected articles, we identified six different definitions, which are presented in Table 2 ranked by their number of citations in Scopus.

Source	Definition of Digital Transformation	Citations
Fitzgerald et al. (2013)	DT is "the use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements (such as enhancing customer experience, streamlining operations or creating new business models)"	231
Matt et al. (2015)	DT affects large parts of companies and even goes beyond their borders, by impacting products, business processes, sales channels, and supply chains	178
Bley et al. (2016)	DT leads to an increasing interconnectedness of classical horizontal value chains in a complex value network	23
Haffke et al. (2016)	DT "highlights the transformational nature of digital technologies for businesses, especially in large corporations with a long non-digital history. Specifically, DT encompasses the digitization of sales and communication channels, which provide novel ways to interact and engage with customers, and the digitization of a firm's offerings (products and services), which replace or augment physical offerings"	9
Nwankpa/Roumani (2016)	"DT is defined as an organizational shift to big data, analytics, cloud, mobile and social media platforms (…) fueled by digital innovations"	9
Horlacher et al. (2016)	"DT goes beyond merely digitizing resources and involves the transformation of key business operations, products, and processes, culminating in revised or entirely new business models"	6

Table 2: Definitions of Digital Transformation.

The definition of DT used most often is provided by Fitzgerald et al. (2013). According to their definition, the main differentiator between DT initiatives and any other OT initiative that involves the implementation of digital technologies is the notion of novelty associated with the technologies that are implemented. However, the restriction of DT initiatives to those involving new digital technologies is problematic because the perception of novelty is always a matter of perspective.

Nambisan et al. (2017) tried to resolve this by defining a digital innovation as the use of digital technologies during the process of innovating, which is new to the adopting organization but may already be well established in other organizations. A typical example is the use of cloud services in the newspaper industry (Karimi/Walter, 2015), even though such services are already well established in the software industry (Leimeister et al., 2010). Surprisingly, the term DT is only rarely mentioned in digital innovation literature, which has gained momentum in recent years. Literature on digital innovation focuses on the enhancement of physical products or a new organizational logic (Yoo et al., 2010) or the orchestration of digital innovations (Nambisan et al., 2017), which are also critical elements of transformations (Fichman, 2014). This school of thought has its origin in marketing theory and was later adopted in IS and organization science (e.g., Vargo/Lusch, 2004; Lusch/Nambisan, 2015).

In some cases, mostly driven by IS scholars, DT is connected to specific digital technologies. For example, Nwankpa/Roumani (2016) identified DT with specific technologies such as cloud computing, big data, and mobile and social media platforms. However, the drastic speed of technological advancements, suggests that DT should not be defined by the use of very specific technologies that could be outdated in just a few years.

Particularly often studied in the IS discipline is the development of technology-enabled business models inherent to DT and their implications for an organization’s governance and operation (e.g., Piccinini et al., 2015; Horlacher et al., 2016; Nwankpa/Roumani, 2016). This school of thought regards business model innovation as a constitutive element of DT. However, it also concerns the development of digital business strategies (Bharadwaj et al., 2013), new management roles, e.g., Chief Digital Officers (CDOs) (Tumbas et al., 2017), new organizational cultures (Piccinini et al., 2015), and IS capabilities, e.g., for the development of a digital platform ecosystem (Tan et al., 2015), to achieve business model innovation.

Up to this point, the debate is contingent on an intra-organizational point of view in which OT processes are examined independently from their effects on organizations’ external environments. However, transforming business models means changing the way value is delivered to customers. In particular, Haffke et al. (2016: 2) emphasized the effects on “sales and communication channels, which provide novel ways to interact and engage with customers” and a “firm’s offerings (products and services), which replace or augment physical offerings”. To be successful, the evolution of a company’s business model needs to be complemented by a co-evolution on the customer and partner side (Rai/Tang, 2014). For example, Apple’s App Store shows that DT does not just affect the organization with its internal value creation processes. Apple heavily invested in resources (e.g., the software development kit for iOS) that helped the organization establish an ecosystem of connected developers and customers (Eaton et al., 2015). Today, the majority of applications is created by external software development companies or independent developers (Sarker et al., 2012). Recognizing this interdependence, researchers have extended the intra-organizational perspective with an inter-organizational perspective (e.g., Riasanow et al., 2018).

One of the key challenges researchers face when following the debate about DT is related to the level of abstraction applied to the phenomenon. Some researchers treat DT as an industry-level phenomenon (e.g., Bley et al., 2016), which changes the way organizations within and across industries compete. Others regard it as an organizational-level phenomenon with DT representing a change process that pervades major parts of an organization (e.g., Fitzgerald et al., 2013; Horlacher et

al., 2016). Still others interpret DT as a change program consisting of a number of separate transformation initiatives (Matt et al., 2015). The debate is further complicated by the fact that, in the current debate, the terms DT and digitalization are often used interchangeably (Haffke et al., 2016). Particularly in healthcare settings, DT is often simply understood as the process of digitization, i.e., transforming analogue to digital (e.g., Agarwal et al., 2010). Haffke et al. (2016) highlight that digitalization can be used interchangeably with DT, which is particularly relevant for large corporations with a non-digital history. This proliferation of terms and classifications makes it difficult for researchers to obtain an overview of the existing body of knowledge regarding DT.
For this reason, we aim to clarify the notion of the relevant terms and illustrate the relationships of the underlying schools of thought.

3.2. Different and heterogeneous schools of thought to examine Digital Transformation from an organization transformation perspective

We aim to achieve the proposed clarification of DT by examining the different and heterogeneous schools of thought of the underlying theories and concepts. Based on an analysis of the definitions, we have already identified schools of thought such as digital innovation.
To provide a full overview of the selected articles, we followed the guidelines of Webster/Watson (2002) and coded the theories of the selected articles in management, organization science, and IS literature. Second, we identified 12 schools of thought based on our coding, see Table 3.

Schools of Thought	∑	**Mgmt/ OS journals**	**IS journals**	**IS conferences**	**Example(s) from the selected articles**
Dynamic capabilities/RBV	**32**	7	17	8	(Ash/Burn, 2003; Agarwal/Helfat, 2009)
IS-enabled OT	**25**	-	22	3	(Orlikowski, 2000; Besson/Rowe, 2012)
Transformational leadership	**21**	19	2	-	(Rindova et al., 2011; Hill et al., 2012; Barrick et al., 2014)
Digital innovation	**21**	1	9	11	(Lucas/Goh, 2009; Yoo et al., 2012; Nambisan et al., 2017)
Revolutionary/radical change	**16**	2	14	-	(Romanelli/Tushman, 1994; Amis et al., 2004)
Identity, cognition, sensemaking	**15**	13	1	1	(Nag et al., 2007; Balogun et al., 2015)
Ecosystem	**13**	3	2	8	(Eaton et al., 2015; Jacobides et al., 2018)
Emergence, institutionalism, and contingency	**11**	4	6	1	(Aguilera et al., 2008; Oehmichen et al., 2017)
Business model	**8**	2	1	5	(Feller et al., 2011; Amit/Zott, 2012)
Evolutionary/incremental change	**4**	-	4	-	(Harkness et al., 1996; Cunningham/Finnegan, 2004)
Ambidexterity	**2**	-	1	1	(Gregory et al., 2015)
Service-dominant Logic	**1**	-	1	-	(Barret et al., 2015)
n/a	**6**	-	5	1	Research Commentaries, e.g. (Loebbecke/Picot, 2015)
Total	**175**	51	85	39	

Table 3: Schools of thought coded in the selected articles.

Each of the subsequent sections about the different and heterogeneous schools of thought is organized as follows. First, a brief description and information about the coding is provided. Second, we analyze articles on prior OT within and in between management, organization science, and IS literature. As third, we discuss the school of thought regarding DT. We could not code seven studies to a school of thought, as they did not mention a theoretical background (e.g., Loebbecke/Picot, 2015).

3.2.1 Dynamic capabilities/RBV

Based on a resource-based view (RBV) of a firm, organizations achieve superior performance via resources and capabilities that are firm specific. Organizational capabilities are an organization’s ability to organize its resources effectively to achieve strategic goals, such as OT (Grant, 1991). In changing environments, the dynamic capability perspective can help to explain how and why organizations change (Teece et al., 1997). Building on the definition of Grant, dynamic capabilities are defined as an “organization’s ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments” (Teece et al., 1997: 516), which reflects the majority of the coded articles in this school of thought. We also included articles concerning organizational resources or work routines in this school of thought.

In management and organization science, e.g., entrepreneurial dynamic capabilities of top management (Agarwal/Helfat, 2009) are found to be relevant in prior OT. To analyze dynamic capabilities in more detail, its microfoundations were added in tripartite form, i.e., sensing, seizing, and reconfiguring components (Teece, 2007). For example, the managerial cognitive capability "language and communication" can have a positive impact on the dynamic capability "reconfiguring", which may in turn help overcome resistance to change (Teece, 2007).

In IS literature, OT is often conducted to develop new dynamic capabilities, e.g., for the development of a new IT architecture (Gregory et al., 2015), the integration of IT across business processes (Ash/Burn, 2003), or the implementation of a new business model based on IT (Singh et al., 2011). However, most of the dynamic capabilities in IS literature are connected to the development of technological artifacts or business models, whereas management and organization literature also identified dynamic capabilities related to the cognitive and social aspects of OT, e.g., to overcome resistance to change.

In summary, the development of dynamic capabilities plays a major role in OT in management, organization science, and IS literature. Therefore, its importance in DT is not surprising because dynamic capabilities are considered to be essential factors to react to disruptive innovations (Karimi/Walter, 2015). Compared to prior OT, some argue that DT requires new capabilities that differ from prior dynamic capabilities, e.g., digital platform capabilities for the DT in the newspaper industry (e.g., Karimi/Walter, 2015).

3.2.2 IS-enabled OT

Technology and its relationship with organizational structures, processes, and outcomes have long been of interest to organizational researchers (e.g., Orlikowski, 2000; Yoo et al., 2012). In this ongoing discussion, different perspectives on technologies parallel to different research objectives in organizations exist (Orlikowski, 2000). When technology is used for change, i.e., where people use new technology to alter their existing method of operating, this may lead to redefined work distributions, shifts in the types of collaboration, and changes in learning methods (Orlikowski, 2000).

This organizational research-based discussion of the impact of OT on organizations has also informed IS research, as Markus (2004) states "using IT in ways that can trigger major organizational changes creates high-risk, potentially high-reward situations”. In this light, Besson/Rowe (2012) highlight the potential deep structure transformation of an organization through IT, which they call IS-enabled OT. IS-enabled OT focuses on “the nature of IT capabilities and organization designs that will enable firms to exploit the business potential of IT” (Sambamurthy/Zmud, 1999: 262).

Consequently, though using different names, management and organization science and IS eventually discuss the same phenomenon from the same perspective, namely, the impact of technology on organizing and vice versa.
IS-enabled OT was not coded in the DT articles. Following Yoo et al. (2010), we consider this school of thought as a precursor of DT because it does not reflect the unique characteristics of digital technologies, e.g., reprogrammability, the homogenization of data, and the self-referential nature of digital technology.

3.2.3 Transformational leadership

OT achieved via transformational leadership includes articulating and presenting a clear vision, displaying charisma, motivating employees through inspiration and intellectual stimulation derived from exposing them to new and complex ways of thinking, and being considerate of their individual needs and desires (Hill et al., 2012).

Management and organization science literature in this school of thought recognizes organizational identity redefinition as a key mechanism for OT (Rindova et al., 2011). The outcome of the transformation process may be influenced by a CEO’s charisma, board gender diversity and the power of women directors, frontline employees, middle managers’ emotional investment, or managerial cognitive capacity (e.g., Helfat/Peteraf, 2015). Another critical aspect is a CEO’s transformational leadership because the impact of the leadership styles of the CEO and top management affect organizational learning (e.g., Vera/Crossan, 2004).

Articles in IS discuss specific elements of transformational leadership, e.g., the alignment of IT human resources with the business vision (Roepke et al., 2000) or the challenges of managing self-organized global development teams in transformations (Eseryel/Eseryel, 2013).

Nevertheless, major transformations may provoke employee resistance, especially because DT has an impact on the entire organization and beyond. Therefore, transactional leadership is not sufficient to carry out a DT project. Instead, transformational leadership is essential to communicate the vision and to obtain active involvement from the different stakeholders that are affected by the transformation (Matt et al., 2015). The essence is to observe the limitations of the organizational culture and transform it adequately if some of the central assumptions are invalid, e.g., via environmental changes or the diffusion of technologies that fundamentally alter the organization (Chatfield et al., 2015). Accounting for empowerment, we observe that DT often dovetails with the creation of a new executive role, i.e., the introduction of a Chief Digital Officer (CDO) (Matt et al., 2015), which shows that a role with decision power in the executive board is important to deal with the speed of digital innovations. The fact that companies are eager to react accordingly is shown by the number of active CDOs, which has doubled every year since 2003 to over 2,000 CDOs in 2015 (Horlacher et al., 2016).

3.2.4 Digital innovation

Building on prior innovation literature, digital innovation is the use of digital technology during the process of innovating (Yoo et al., 2012; Nambisan et al., 2017). Digital innovation further requires a firm to revisit its organizing logic and its use of corporate IT infrastructures (Yoo et al., 2010).

Many DT articles build on transformations due to digital innovations (e.g., Fichman, 2014). Following Yoo et al. (2010), digital innovations build on novel characteristics that differ from earlier technologies, e.g., reprogrammability, the homogenization of data, and the self-referential nature of digital technology. Therefore, new organizational logic is necessary to cope with digital innovations (Yoo et al., 2010; Yoo et al., 2012). The case of Kodak shows that such new organizational logic is very difficult to achieve, particularly when an organization’s business model has been successful for more than one century (Lucas/Goh, 2009). As a result, Kodak filed for bankruptcy, even though they initially invented digital cameras, the disruptive technology that destroyed their traditional core business (Lucas/Goh, 2009).

Moreover, digital innovation also presents a new perspective in the ongoing discussion between organization and technology, driven by management and organization science scholars (Orlikowski, 2000). Therefore, the notion of OT due to digital innovations may provide a bridge between management and IS literature for discussions concerning the DT phenomenon.

3.2.5 Revolutionary/radical change

Revolutionary or radical change asserts that change is discontinuous, fast, and systemic (Besson/Rowe, 2012). Revolutionary or radical changes may occur at several levels in OT. In prior OT literature, we found that radical change may have a significant impact on the organizational structure by “adding, splitting, transferring, merging or deleting organizational units” (Schwarzer/Krcmar, 1995;

Girod/Whittington, 2015). This could lead to greater integration and control at the organizational level (Berente et al., 2016). Many of the articles coded to this school of thought draw on the punctuated equilibrium model, which understand OT as radical process (Gersick, 1991; Romanelli/Tushman, 1994). In some OT projects, activities are coordinated by a new position in the organizational hierarchy (Rindova et al., 2011), which often implies a shift in the organizational hierarchy and the locus of decision-making (Amis et al., 2004). Amis et al. (2004) recognized the decentralization of decision-making authority as controversial, and far reaching.

This concept is also found in IS literature, e.g., in the failure of radical changes at TELECO (Sarker/Lee, 1999). Stoddard/Jarvenpaa (1995) notice tactics for radical change, often motivated by prior crises and failures, are to make use of outsiders, and to qualify employees for change who fit with new the new culture and organizational structure.

The concept of revolutionary change fits many DT articles, especially when it is intended to enable faster decision-making, to ensure necessary resources are available, or to eliminate administrative barriers to increase the information flow, as shown in the case of the digital transformation of LEGO (Andersen/Ross, 2016). Therefore, organizations may create a separate DT department, establish a Chief Digital Officer (CDO) as a responsible change agent on the management board (Haffke et al., 2016), or establish cross-functional, self-organized agile teams around the products or services offered (Ross et al., 2016).

3.2.6 Identity, cognition, and sensemaking

This school of thought is grounded in behavioral theories of a firm. In prior articles, we found that organizational identity is connected to OT because, during transformation attempts, the organizational identity is often destabilized and is susceptible to change (Nag et al., 2007). Organizational identity includes those features of an organization that its members deem to be the most central, distinctive, and enduring (Albert/Whetten, 1985). Taking a social constructionist view, organizational identity entails members' consensual understanding of who they are as an organization, which appears to be critical to organizational survival and growth (Nag et al., 2007). Further, a strong organizational identity and an organization's members' efforts to preserve the collective practices that characterized their work may also hinder OT (Nag et al., 2007).

Management studies advice, if the decision to change the organizational identity is made in an OT, a shift in the interpretative schemes of the organization's members follows (Balogun et al., 2015). This requires sensemaking and sensegiving on the part of senior managers, e.g., to direct lower-level employees toward a new desired organizational reality (Balogun et al., 2015).

Besides the mentioned management articles, we only found one article in IS literature connected to this school of thought, which examined the role of IT in the process of developing sustainable business processes. In this process, four functional affordances originating in information systems (reflective disclosure, information democratization, output management, delocalization) were developed that create a context in which organizations can engage in a sensemaking process to understand emerging environmental requirements (Seidel et al., 2013).

Not explicitly, but implicitly mentioned in several articles, DT also requires a sensemaking process. In DT projects, senior managers should encourage "employees to develop a digital mindset in order to increase the acceptance and use of digital technologies" (Piccinini et al., 2015: 10). Supporting this view, Chatfield (2015: 16) argued that a culture that "encourages and rewards smart motivated employees with entrepreneurial problem-solving capability and their experimental use of disruptive technologies" is required. Yet, a transformation of the organizational identity and the sensemaking process during a DT and its differences to prior OT remain unexplored.

3.2.7 Ecosystem

This school of thought analyzes when and why ecosystems emerge and what makes them distinct from other governance forms (Jacobides et al., 2018).
On the ecosystem level, prior OT studies in organization science and management have considered repositioning costs, which are important if OT involves shifts in the firm's activity system (Menon/Yao, 2017). Other studies have examined environmental effects on OT, such as negative media coverage (Bednar et al., 2013). Based on these findings, Jacobides et al. (2018) developed a theory of ecosystems to explore when and why ecosystems emerge.

Using digital technologies, potential co-creation has become easier via the supply of boundary resources (Grover/Kohli, 2012). As an example, Apple provided a digital platform to distribute iOS applications. Because most of these applications were developed by third parties, these developers had to learn a specific programming language and align their development process with the Apple platform (Eaton et al., 2015). Apple supported third-party developers heavily via the supply of boundary resources (Eaton et al., 2015). Apple relies heavily on co-creation with complementary partners, which played a major role in the successful DT (Sarker et al., 2012). However, while Apple's partners gained access to a huge customer base, they were critically affected by the DT project, e.g., changes in the boundary resources or the payment process for applications. Therefore, if DT means the introduction of a digital platform, the organizational change goes beyond IS-enabled OT because the business models of co-creating partners are affected. Riasanow et al. (2017) demonstrated that emerging players that build mobility service platforms have brought about a substantial transformation in the automotive ecosystem. These examples show that competition takes place via ecosystems of co-creating partners in DT, which implies a fundamental difference compared to prior notions of OT.

3.2.8 Emergence, institutionalism, and contingency

We grouped three theoretical lenses in this school of thought. In prior articles, we first found that OT can also be an emerging phenomenon, which may not be actively triggered by decision makers, which is contrary to the viewpoint that considers OT to be a process of planned change (Markus/Robey, 1988). Second, following an emerging change phenomenon, institutionalism views OT as imported from the outside; it resembles a process of diffusion of a standard, which may be fast or slow, systemic or patchy (Besson/Rowe, 2012). Third, contingency theory states there is no best way to organize, lead, or transform an organization (Aguilera et al., 2008). Instead, the optimal course of action is contingent upon the internal or external (e.g., emerging) situation (Aguilera et al., 2008). Comparing companies listed in broad stock indices (i.e., S&P 500), contingent on the situation of an organization, different drivers of strategic change could be observed (Oehmichen et al., 2017). First, organizations can leverage broad industry knowledge if they possess experienced directors. Second, managers lacking access to such information on potential change can use external experienced directors for strategic advice (Oehmichen et al., 2017).
Again, similar to “identity, cognition, and sensemaking”, most DT articles do not cover the same terms and vocabulary as management and organization science literature. However, there are some cases, such as the bankruptcy of Kodak due to not innovating the organization as mentioned before (Lucas/Goh, 2009), which can be interpreted as emerging change. This leads to the conclusion that DT may not always be actively triggered or organized, e.g., as in the case of co-creating partners being affected by the emerging digital transformation of Apple (e.g., see Eaton et al., 2015). Ultimately, the process of institutionalizing in DT remains unexplored.

3.2.9 Business model

Many articles on business models consider its innovation (Amit/Zott, 2012), e.g., with the goal of substantially transforming value creation, innovation, or firm performance (Amit/Zott, 2001).

In prior OT literature in management, organizations have used business model innovation to trigger changes in product development, production, and distribution (e.g., Rindova et al., 2011). As such, the Italian luxury housewares and kitchen utensil provider Alessi successfully transformed its existing products for hotels and restaurants by combining concepts from the industry register (products as functional tools) with distinctive formal properties (value of form) (Rindova et al., 2011). Particularly radical projects involve a major change in products and value creation activities, often leading to a new product category and representing a break with the past (Jones, 2003).

IS literature focused on increasing possibilities for business model innovations via new technologies and systems, such as e-commerce (e.g., Barua et al., 2004). New technologies require a change in core competencies and resources, such as the introduction of RFID to create a more efficient supply network (Wamba/Chatfield, 2009). By means of these technologies, organizations have become aware that value is increasingly generated through networks with business partners that combine their complementary capabilities, e.g., partnerships with distributors (Barua et al., 2004). One means toward business model innovation is to generate new distribution channels, such as the acquisition of new customers online for retailers, manufacturers, distributors, or wholesalers (Barua et al., 2004), or the provision of home health care enabled by telemedicine (Singh et al., 2011).

Prior OT studies in organization science have also noted that competitive pressure induces agents (managers or firms) to focus their attention on nearby competitors (Johnson/Hoopes, 2003). In addition to rival companies, competition may also take place via the marketplace and increasing firm performance is central to prior OT (e.g., Agarwal/Helfat, 2009).

In some cases, organizations conduct DT to react to high perceived pressure on their business models (Kaltenecker et al., 2015). One reason for high pressure is that digital innovations reduce entrance barriers and allow emerging players to enter new markets at high speeds (Fitzgerald et al., 2013), such as Uber and Airbnb, which seriously threaten established organizations operating in the same industry. Building on these prior achievements, DT particularly focuses on business model innovation (Loebbecke/Picot, 2015). This materializes in the high degree of digital technologies contributing to the value creation of an organization (Lucas et al., 2013). As examples for business model innovations in DT, we identified the transformation from on-premise service provision to a cloud provision (Kaltenecker et al., 2015) and the development of data-driven business models in the context of big data (Loebbecke/Picot, 2015), automotive (Piccinini et al., 2015; Riasanow et al., 2017), or financial (Puschmann, 2017) industries. Moreover, the business model of partners is affected in DT, e.g., due to co-creation mechanisms (Puschmann, 2017).

3.2.10 Evolutionary/incremental change

Analyzing prior studies, we found evolutionary change states where OT is continuous, slow, and patchy, a type of organizational Darwinism (Besson/Rowe, 2012), e.g. business process change (BPC) (Jurisch et al., 2012).

Often referred to in IS literature, BPC is defined as an OT initiative "to improve and (re)design business processes to achieve competitive advantage in performance through changes in the relationships between management, information, technology, organizational structure, and people" (Kettinger/Grover, 1995: 12). Contrary to a revolutionary or radical type of change, evolutionary change in the context of BPC focuses on incremental changes in business processes (Teo et al., 1997; Ertl et al., 2018).

However, we did not find any articles connecting DT to evolutionary change. One reason for this may be the disruptive impact of digital innovation that triggers DT (Fitzgerald et al., 2013; Puschmann, 2017).

3.2.11 Ambidexterity

Organizations can use existing resources to foster efficient processes (exploitation), e.g., via optimization, or to create novel potentials (exploration), e.g., via research or experimentation (March, 1991). Ambidexterity means to pursue two disparate things at the same time, such as to focus on exploration and exploitation simultaneously (March, 1991). The notion of ambidexterity is often connected to the use of technology, particularly in IS literature (e.g., Gregory et al., 2015).

In some management and organization science studies, organizations focus on exploitative uses of technology to increase efficiency, standardization, and reduce costs in processes or routines (Berente et al., 2016), e.g., via a new information system for material planning can be used to create process efficiencies (e.g., Dey, 2001). Particularly IS studies focus on the exploration of new technologies, such as the implementation of a remote patient monitoring system to create the option of home care services (Singh et al., 2011) or the use of RFID to orchestrate a supply chain network (Wamba/Chatfield, 2009).

However, we only found one DT study connected to ambidexterity. Gregory et al. (2015) studied the transformation program of a large commercial bank and identified ambidexterity in six areas: portfolio decisions, platform design, architecture change, program planning, governance, and delivery. They found that a continuous balancing of explorative and exploitative behavior, e.g., in the case of platform design: standardization versus differentiation, is necessary (Gregory et al., 2015).

3.2.12 Service-dominant logic

Service-dominant (S-D) logic views what a firm does not primarily as the production and offering of tangible goods or, for that matter, any output (tangible or intangible) but rather as the exchange of services that occurs when one actor uses its skills and capabilities for the benefit of another actor (Vargo/Lusch, 2004; Lusch/Nambisan, 2015). Rarely used in our sample of selected articles, S-D logic can be a suitable lens to understand (digital) innovations (Barret et al., 2015) and to contribute to the ongoing discussion between organization and technology. In a resource integrating, service-exchange activity, coordinated through institutional arrangements for mutual value creation, service ecosystems are established (Lusch/Nambisan, 2015). IT plays a crucial role in service ecosystems and therefore in service innovation because resources are combined and exchanged in new ways that co-create value for actors engaged in the service ecosystem (Barret et al., 2015). Therefore, S-D logic provides a helpful lens to understand DT from an organizational or ecosystem perspective.

4. Discussion

Based on this study, four theoretical contributions have come to light. First, the findings of the 12 identified schools of thought show that DT significantly builds on prior OT in management, organization science, and IS literature. Therefore, this study enlarges the excellent literature review of Besson/Rowe (2012). However, our findings show that DT is not only old wine in new bottles by highlighting the unique aspects of DT, particularly via the ecosystem, business model innovation, and digital innovation schools of thought. Therefore, we expand on the study of Fitzgerald et al. (2013), who understand DT primarily as an inter-organizational transformation. Further, we expand on the study of Nambisan et al. (2017) because we understand DT as OT based on the transformative impact of leveraging digital innovations. We also account for the fact that organizations are interconnected in complex ecosystems (Lusch/Nambisan, 2015).

Second, we note that organization and management science articles begin to account for the specifics of digital innovation and the required new organization logic (Yoo et al., 2012). Drawing on IS articles on IS-enabled OT based on specific technologies (e.g., sensor networks, big data, cloud computing) could inform this discussion. Further, we refer to management and organization science studies, which address in particular transformational leadership, identity, cognition, and sensemaking. These schools of thought are central drivers of DT that are not yet reflected in IS literature. However, some schools of thought, such

as dynamic capabilities, are relevant to both disciplines. Further, we note that this requires an organizational setup that empowers DT, such as the ambidextrous use of digital technology.
Third, we also highlight conflicts and heterogeneous views, derived from prior OT studies, which remain salient for DT. Because prior OT is viewed as either radical or evolutionary, both schools of thought may be suitable lenses for DT, depending on the particular case. However, we only found DT articles connected to radical change. This may be due to the disruptive nature of digital innovations that drive DT. Furthermore, decision makers may not always actively trigger DT because DT can be also the result of institutionalizing change based on an emerging phenomenon. Moreover, DT is a new stream in the ongoing discussion of the relationship between organizing and technology, having its roots in the new organizational logic due to digital innovations. In this context, we identified relatively disparate discussions in management, organization science, and IS literature. Therefore, our review helps compare prior OT studies to DT and enriches the discussion between different schools of thought in and between the mentioned disciplines.

Fourth, we reject the idea that DT is connected to a specific technology such as cloud computing (Nwankpa/Roumani, 2016) and understand it as being driven by any digital innovation, e.g., blockchain or artificial intelligence. Drawing on this understanding, we also reject the idea that DT can be used interchangeably with digitization, which is the mere process of turning analogue into digital and does not necessarily have to be connected with an OT.
Further, this study provides three practical contributions. First, we invite practitioners and scholars to apply the identified schools of thought when talking about DT or comparing it to prior OT. In particular, we provide 12 schools of thought to enlighten discussions about DT.

Second, managers can obtain insights about what is new for DT compared to prior OT. For example, DT does not exclusively influence an organization but also the ecosystem, including the co-creation of partners, and is often connected to a substantial business model innovation.

Third, this discussion of DT helps decision makers to understand and analyze the different aspects of the current discussion on technology and organization, particularly due to digital innovations.

5. Limitations and Future Research

Our study is subject to some limitations. First, the identified articles are limited to our search terms and selected databases. However, we also drew on Besson/Rowe (2012), who conducted an excellent review of IS-enabled OT, and complemented their search terms with keywords on DT.

Second, this study is limited by the coding of the articles to the respective schools of thought. Therefore, we also compared our results to Besson/Rowe (2012). Accordingly, all the articles they reviewed are also included in this work. Further, we ensured that a broad amount of DT articles was included by opening the search to recent conference publications.

Our findings suggest five avenues for future research. First, because DT also affects partners in the ecosystem, we suggest that the transformation of complementary partners should be considered in DT. Therefore, we suggest using co-evolution theory (Lewin/Volberda, 1999) to examine the simultaneous and reciprocal transformation of an organization and its partners in an ecosystem.

Second, a holistic analysis of current and ongoing transformation activities in different industries is still lacking. For such an analysis, it would be important to view DT from a macro-perspective, such as an ecosystem (Puschmann, 2017). In this context, more case studies that cover failed DT initiatives are necessary to learn about DT from a micro-perspective. However, the success factors generated from single case studies are highly context-specific with limited generalizability.

Therefore, as a third avenue, we suggest the use of configurational methods to examine the interplay of environmental and organizational factors via the method of fuzzy-set Qualitative Comparative Analysis (fsQCA) (Ragin, 2008), e.g., to derive patterns for successful DT strategies. This configurative research method is particularly useful to examine DT strategies, as it allows for equifinality, e.g., multiple ways can lead to a successful DT, compared to unifinal methods like regressions.

Fourth, we suggest incorporating the phenomenon of DT in the development of an ecosystem theory (Jacobides et al., 2018), particularly because digital innovations can lead to the emergence of new ecosystems (e.g., blockchain) or the transformation of established ecosystems (e.g., the transformation of the financial industry via Fintechs).

Fifth, particular IS studies may learn from prior management and organization science literature by accounting more for the identity, cognition, and sensemaking, and the transformational leadership school of thought of DT. In contrast, management and organization science could learn from IS literature to account for the specifics of digital technologies in OT, as the technological foundations may significantly influence the possibilities of organizational identity, operation, governance, and learning. This is particularly important when designing an organizational setup that empowers DT.

6. Conclusions

By discussing the 12 different and heterogeneous schools of thought underlying DT and related prior OT, our study contributes to management, organization science, and IS by clarifying the notion of DT. First, we demonstrated that DT is a novel phenomenon compared to prior OT, particularly by incorporating the notion of digital innovation. Second, we provided 12 schools of thought to discuss the phenomenon of DT adequately and among different literature streams. These schools of thought help synthesize articles on DT and allow comparisons to prior OT. Therefore, this study helps compare articles about DT and shows that not all articles that claim to investigate DT are actually studying this particular phenomenon. Finally, we hope that our work contributes to a consistent terminology and that our proposed avenues for future research will be embraced and will help consolidate this research area as well as move it forward.

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Appendix H: Publication P2

Co-evolution in Business Ecosystems: Findings from Literature

Tobias Riasanow[1], Rob Jago Flötgen[2], Michael Greineder[3], Dominik Möslein[4], Markus Böhm[5] and Helmut Krcmar[6]

Abstract: The innovative use of digital technologies has led to a disruption of well-established business models in many industries. To prevent from being disrupted, organizations must transform. However, studies about digital transformation have primarily focused on intra-organizational dynamics, including processes, structures, and business models. Digital transformation, however, substantially changes inter-organizational behavior, sometimes the entire ecosystem. To examine this phenomenon, we draw on co-evolution theory, which states that changes occur among all interacting organizations, permitting transformations to be driven by both direct interactions and ecosystem feedbacks. Thus, goal of this paper is to provide a structured overview of literature about the co-evolution of ecosystems in management, organizational science, and IS literature. Following the six properties of co-evolution, we develop a framework for the co-evolution in ecosystems, comprising 23 configurations, based on the analysis of 44 articles. Ultimately, we suggest avenues for future research.

Keywords: ecosystem, co-evolution, literature review, digital transformation

1 Motivation

Digital platforms having the capacity to combine and deploy innovative technologies create the potential to radically change the way organizations do business in their respective ecosystems. This sometimes leads to a disruption of well-established business models [RT14]. We refer to the organizational transformation to prevent a disruption through the innovative use of digital technologies as digital transformation [WW15, Ri19]. Studies about digital transformation have been primarily concerned with an intra-organizational perspectives, including processes, products, services, organizational structures, and business models [see, e.g., KW15, KHH15]. Digital transformations substantially influence inter-organizational partnerships, particularly in business

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ecosystems, where value is co-created among multiple stakeholders [Sa12, Ce14, Ri18b]. Thus, partnerships are increasingly important, because the market for information technology (IT) is constantly evolving and giving rise to a variety of innovations, e.g., cloud computing, in-memory databases, blockchains, and distributed ledgers [Os18]. These are often provided in platform ecosystems, comprising specific digital platforms and applications and their stakeholders, owners, and complementors [Ti14, Ri18a]. In such ecosystems, we understand that platform owners represent the legal entity owning the platform [Ti14]. Complementors contribute additional value to the platform in the form of applications [Ti14]. Furthermore, platform owners rely on partners to gain access to customers or complementary resources and capabilities [Sa12, LN15]. To study the ongoing digital transformation from an ecosystem perspective, we view the problem through the lens of co-evolutionary theory. This theory assumes that changes can occur at all interacting organizations, permitting transformation to be driven by both direct interactions and positive feedback [LV99, MHG14]. Thus, we analyze the extant literature on co-evolution in IS, management, and organization science literature to build a comprehensive understanding for co-evolution in ecosystems. Second, based on the six propositions of Montealegre et al. [MHG14], we suggest a framework for the co-evolution in ecosystems, including 23 configurations for these propositions. Ultimately, we suggest avenues for future research. This paper is structured as follows. First, we present our conceptual background and research method. Second, we provide an overview of co-evolution theory in literature, particularly in ecosystems. Third, based on the literature review, we propose a framework for co-evolution in ecosystems and suggest avenues for future research. After discussing our results, we conclude with limitations and implications.

2 Digital Transformation in Business Ecosystems

Many digital transformation articles have built upon transformations caused by digital technologies [e.g., Fi14]. Following Yoo, Henfridsson and Lyytinen [YHL10], a new organizational logic is necessary to cope with digital innovations [YHL10]. The case of Kodak shows that new organizational logic is very difficult to achieve, particularly when an organization’s business model has been successful for more than a century [LG09]. Using digital technologies, potential co-creation in ecosystems has become easier via the supply of boundary resources [GK12]. As an example, Apple provided a digital platform to distribute iOS applications. Because most of these applications were developed by third parties, developers were forced to learn a specific programming languages and co-evolve their development processes with Apple [Ea15]. Apple supported third-party developers heavily via the supply of boundary resources [Ea15]. Apple relies heavily on co-creation in its ecosystem, which plays a major role in successful digital transformation [Sa12]. However, whereas Apple’s partners gained access to a huge customer base, they were critically affected by the digital transformation. Therefore, if digital transformation implies the introduction of a digital platform, the business models of co-creating partners are affected. Riasanow, Galic and Böhm [RGB17] demonstrated that emerging players who build mobility service platforms induced a substantial transformation of the automotive ecosystem. For ecosystems, three terminologies are commonly used, dividing the field into three broad streams, as found by Jacobides et al. [JCG18]. These terms are business ecosystems, innovation ecosystems, and platform ecosystems. The three streams differ in their foci, but they share the common understanding of ecosystems as a group of interdependent firms. In a hierarchical sense, business ecosystem can be seen as the root, being explored first, with innovation and platform ecosystems derived thereafter. According to Moore [Mo93], business ecosystems comprise entities with co-evolving capabilities around new innovations in a cooperative and competitive way. These entities represent an economic community supported by a foundation of interacting organizations and individuals that produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders [Mo93]. An innovation ecosystem is a business ecosystem that focuses on the solution for the end customer. A concise definition for innovation ecosystems is the "collaborative arrangements through which firms combine their offerings into a coherent customer-facing solution" [Ad06]. In some articles about business ecosystems, the term "platform" is already mentioned, as in the conceptualization of Autio and Thomas [AT14]. Business ecosystems are more generic, of which platforms are the common instantiation. Many business ecosystems, such as Apple iOS ecosystem, have, at their core, a platform that structures and orchestrates complementors and partners [Ea15]. In this work, we use the terms, "business ecosystem" and "platform or innovation ecosystems" as specific instantiations of business ecosystems. Following Jacobides et al. [JCG18], there is broad knowledge on what ecosystems are. However, we still have limited knowledge about their digital transformation. Co-evolution, first recognized in the field of biology, occurs when two or more species reciprocally affect one another's evolution [CHL91, VW13]. When a system evolves to ensure its best fit, its environment also changes, and those changes are likely to result in further system changes, resulting in continuous system change [VW13]. Therefore, we draw on the theoretical lens of co-evolution to examine this phenomenon.

3 Research Approach

Our work follows a four-step research approach. To identify existing literature contributing to the co-evolution in business ecosystems, we conduct a structured literature review following Webster and Watson [WW02]. In the first step, we focus on leading outlets of IS, management, and organization science, (i.e., the AIS Senior Scholars' Basket of Journals and FT50 journals). Using the EBSCOhost and Scopus databases, we apply the following search terms to the titles, abstracts, and keywords: ("co-evolution" OR "co-evolution") AND ("ecosystem" OR "network"). The search was conducted between May and August 2018. Following Okoli and Schabram [OS10], we reviewed the articles manually and filtered them according to an iterative set of exclusion criteria. Thus, articles not addressing co-evolution in ecosystems, such as Helfat and Raubitschek [HR00], were removed, resulting in 27 selected articles. For the second step, we extended our search to conferences to include recent contributions since 2000. This yielded another 17 articles, resulting in 44. See Table 1.

Outlet		**Hits**	**Selected articles**
IS Journals	Information Systems Research	6	[RT14, GGA11, TRV10, TKB10, VW09, Sa10]
	Journal of the Association for Information Systems	3	[MHG14, VW13, Pu10]
	Journal of Management Information Systems	1	[FN09]
Management and Organization Science Journals	Research Policy	6	[AC01, CV08, HBH04, Ku01, Mu02, Ma13, Mi07]
	Organization Science	6	[An99, DA99, KL99, Mc99, PYH18, SCK10]
	Long Range Planning	3	[Am09, HGB18, Li10]
	Organization Studies	1	[En12]
	Technological Forecasting and Social Change	1	[KTR13]
Top Conferences	International Conference on Information Systems	9	[AC16, AVH17, CA15, HLY17, Hu17, UY16, BPA15a, Ng17, TL17]
	Hawaii International Conference on System Sciences	3	[ST17, SWS18, AZC17]
	European Conference on Information Systems	3	[BAP15b, DC15, WU16]
	Americas Conference on Information Systems	2	[Ja17, HSS16]
Grand Total		**44**	

Tab. 1: Selected Articles on the Co-evolution in Ecosystems

In the third step, we draw upon the six properties of co-evolution identified by Montealegre et al. [MHG14]. Three experienced raters independently coded the selected articles. Before the raters began coding the articles, they coded several other articles to become familiar with the scheme. Then, they calibrated their procedure. All authors validated the coding of each article and discussed the discrepancies until consensus was reached. This helped eliminate disparities [BT90].

4 Literature on Co-evolution in Business Ecosystems

Montealegre et al. [MHG14] identified six properties of co-evolution theory, which we used to structure our findings.

4.1 Multilevel Effects

Co-evolutionary effects vary across a range of multiple levels of analysis [KL99, LL99]. Each level offers a different perspective on co-evolution. We found nine different levels in the articles. Five were intra-organizational levels, including business process, structure, leadership, culture, and business model. Four were inter-organizational levels, including partners, customers, regulatory environment, and other industries. Vidgen and Wang [VW06] found that co-evolution in agile software development between the business process and structure level can be successful if organizations match the co-evolutionary change rate, maximize self-organization, and balance exploration and exploitation. Lin et al. [Li10] characterized the co-evolution in ecosystems based on exchanges of technology via institutional ties. In a single longitudinal case study of a professional service network in the public accounting industry, a network was intentionally created and formally organized to pursue co-evolving effects for the member organization [KL99]. Co-evolution was also successful at another level, as Höyssä et al. [HBH04] showed in an investigation into the level of interaction between the city and its national and international region, focusing on the city's industrial policy as the mediator industry.

4.2 Multidirectional Causalities

Montealegre et al. [MHG14] understood co-evolutionary effects not as a simple cause–effect logia of linear relations between independent and dependent variables. Instead, they ascertained that co-evolutionary process could have many causes [DV09]. A co-evolutionary effect can, in turn, cause many co-evolutionary effects [Li10]. We refer to multidirectional causality between two configurations (i.e., cooperation and competition). In the studied articles, cooperation was understood as voluntary, for which two or more entities could co-evolve in a mutually beneficial exchange instead of competition. Cooperation in the context of co-evolution can happen where resources adequately exist for both parties or are created by their interaction [RT14, Mu02, JD17]. Based on our findings, competition was observed as a rivalry of competencies, resources, profits, market shares, quality, service, rights, knowledge, partnerships, and IT [KL99, Mc99, AC16, AVH17]. Some scholars argued that co-evolutionary processes could combine the configurations of both competition and cooperation [PYH18, HGB18, Li10].

4.3 Nonlinearity

Cause and effect of change in co-evolutionary relationships often did not follow a simple linear logic. However, dependent variables were often influenced by complex interactions of influencing variables. A small change in the initial variables could lead to very significant changes of outputs and even chaotic consequences [VP95]. We suggest a configurations of "diffusion nonlinearity", "hierarchical nonlinearity", and "network nonlinearity" for the co-evolution of business ecosystems and networks in a context characterized by uncertainty following the study of Rogers [Ro95]. Hierarchical nonlinearity occurs when co-evolutionary dynamics follow a vertical direction through an organization or ecosystem. Volberda and Lewin [VL03] defined “hierarchical renewal” as an engine of co-evolution in multi-unit organizations, where the changes cascade down from the top management. In the opposite direction, McKelvey [Mc99] argued that change could be hierarchically propagated from the bottom as chain of competences toward the top throughout the organization. Lin et al. [Li10] found that bottom-up technologies and top-down institutions drove collaboration between organizations, leading to an inter-network and a co-evolution. The co-evolution of complex adaptive systems occurs via nested hierarchies containing more sub-systems, subject to evolutionary dynamics [An99]. Top-down dynamics are observable in governmental organizations, based on a study of disaster-relief ecosystems [ST17] and another on the sphere of healthcare in the hierarchical structure of hospitals [GGA11].

We refer to network nonlinearity for nonlinear-but-orchestrated developments among ecosystem entities. Co-evolutionary dynamics in inter-organizational networks act in nonlinear ways (e.g., jolts, step functions, and oscillations [MGC05]. However, network structures between organizations can emerge in the absence of an authoritative entity. Their creation and development are generally influenced by the actions of an orchestrating entity [PH13]. In the context of a professional services organization network, co-evolution is orchestrated from a headquarters entity that coordinates and facilitates the network exchange [KL99]. It can also be led from the context of innovation policy making the orchestration role less required [Ku01]. From the context of ecosystems, nonlinear diffusion is observed in the form of the diffusion process of technology standards among network members [En12]. Similarly, innovations are diffused in ecosystems among suppliers, end users, and new entrants [HGB18], and they are sparked by spillover effects [Mu02]. Similarly, Bhattacharya et al. [BPA15] analyzed diffusion processes of content postings in social-media networks, where diffusion was mentioned in a different sense, as a formalized process for technology transfer out of the organization [AC01] or as an institution for that specific purpose [CV08]. Some argued nonlinear dynamics went beyond the three identified configurations. A spiral process of co-evolution was detected by van den Ende et al. [VP95]. Kuhlmann [Ku01] uncovered a revolution of innovation. Further, nonlinearity was also used to explain why organizations were unable to renew their offerings in a radical, big-bang approach, in the context of a digital ecosystems of small and medium enterprises (SME) [CA15].

4.4 Mechanisms for Positive Feedback

Positive feedback was described by Lewin and Volberda [VL03] as actions and interactions between entities undergoing recursive co-evolution, leading to recursive interdependencies [Mo93]. A rich variety of positive feedback mechanisms was identified in the selected articles, which we organized into three configurations: “capabilities”, “architectural decisions”, and “managerial actions”. Organizational capabilities can enable co-evolution, including capabilities for customization and standardization of IT to create and appropriate value in co-evolutionary processes [AC16]. In the context of cross-border organizational integration, mechanisms for the co-evolution of capabilities with the organizational structure were depicted by Ambos et al. [Am09], including an integration action plan, an introduction of routines for alignment and standardization, and the development of a knowledge broker for bidirectional knowledge transfer. Positive feedback was also operationalized via architectural decisions of the platforms in ecosystems [KL99]. For software platforms, the decisions on platform openness, architectural decomposition, and modularity were the central levers alongside governance and decision rights mechanisms shaping their co-evolutionary growth dynamics [TKB10]. For the co-evolution of SMEs and their respective ecosystems and environments, Dehbokry and Chew [DC15] suggested a reference architecture that incorporated different views covering strategy, capabilities, and knowledge alongside contingencies with other institutions and the macro environment. Another mechanism used to strengthen the co-evolution was managerial actions, including exclusive agreements for ecosystem members, who legally govern the collaboration and co-evolution of the organizations [AVH17]. Holgersson et al. [HGB18] found that, in the context of an intellectual property strategy, mechanisms for supporting co-evolution included the coordination of working-group networks, cross-licensing agreements for technology accessibility across organizational boundaries, and technical standardization as a governance tool [VW09].

4.5 Path and History Dependencies

The circumstances and conditions in which co-evolutionary processes occur are determined by unexpected events with uncertain outcomes [En12]. Addressing these conditions in a co-evolutionary environment requires following a path having a history of dependencies [MHG14]. Circumstances causing or helping co-evolutionary conditions can be both exogenous and endogenous to the industry, individual organizations, and the ecosystem [KL99]. Therefore, decisions regarding a path-dependent course will influence future actions, strategies, and objectives [Am09] to offer compliance with changes in the ecosystem [Gr12]. The changes in circumstances over time create a history of dependency, shaped by the changing conditions of the evolutionary path and the legacy actions and decisions used to address them [VW13], i.e., ‘legacy’. Because of the individual history and path dependencies among the co-evolving organizations, they develop their own individual capabilities to differentiate their historical evolution paths [TRV10]. Lin et al. [Li10] postulated that the co-evolution between two networks included general environmental shifts and endogenous communications needed to build inter-dependencies and mutual transformations. These dependencies could also be influenced by an extant community with inter-organization collaborations influenced by their prior capabilities [RT14] or networks shaping choices and paths [Mu02]. Specific path dependencies, over time, can develop a beneficial outcome for an organization and ecosystem [Am09], supplemented by organizational socio-technical capabilities [DC15, LL99]. However, organizations with no legacy start-ups may conduct co-evolution as a “greenfield” approach.

4.6 Technology

Montealegre et al. [MHG14] described technology as both an external and internal force, influencing decision making within a business ecosystem or environment. Extending this notion, we found three configurations of technology in co-evolution: disregarded, supported, and enabled. In some articles, technology was not detectable as a driver for co-evolution and was disregarded [e.g., DA99]. As a supportive technology role, Hukal [Hu17] argued that the introduction of new technologies acted as a proxy for co-evolution. Technology can also help to mobilize the transformation of customers in the ecosystem [HLY17]. Digital platform technologies can also support the transformation of end-users to value-co-creators [SWS18]. Um and Yoo [UY16] introduced the most recent property of technology as an "enabler", leveraging characteristics to be changed without restraining the use of existing technologies. Instead, it could enhance the use of different fields by promoting the construction of novel growth patterns in a focal platform system. This was also shown by Janze [Ja17], where blockchain technology enabled the co-evolution of darknet platforms through the usage of cryptocurrencies.

<table>
<tr><th>Property</th><th colspan="60">Configuration</th></tr>
<tr><td rowspan="4">Multilevel effects</td><td colspan="60">Intra-organizational levels</td></tr>
<tr><td colspan="12">Business processes</td><td colspan="12">Structures</td><td colspan="12">Leaderships</td><td colspan="12">Cultures</td><td colspan="12">Business models</td></tr>
<tr><td colspan="60">Inter-organizational levels</td></tr>
<tr><td colspan="15">Partners</td><td colspan="15">Customers</td><td colspan="15">Regulatory environment</td><td colspan="15">other industries</td></tr>
<tr><td>Multi-directional causality</td><td colspan="30">Cooperation</td><td colspan="30">Competition</td></tr>
<tr><td>Nonlinearity</td><td colspan="15">Diffusion</td><td colspan="15">Hierarchical</td><td colspan="15">Network</td><td colspan="15">Big bang</td></tr>
<tr><td>Mechanism for positive feedback</td><td colspan="20">Capabilities</td><td colspan="20">Architectural decisions</td><td colspan="20">Managerial activities</td></tr>
<tr><td>Path and history dependency</td><td colspan="30">Greenfield</td><td colspan="30">Legacy</td></tr>
<tr><td>Technology</td><td colspan="20">Disregarded</td><td colspan="20">Support</td><td colspan="20">Enabler</td></tr>
</table>

Tab. 2: Properties and Configurations of Co-evolution in Business Ecosystems

5 Discussion and Future Research

Through our review of IS, management, and organization science literature on co-evolution processes in ecosystems, our work provided a structured overview of the field from a transdisciplinary perspective. Second, we developed a framework for co-evolution in business ecosystems based on the six properties offered by Montealegre et al. [MHG14], comprising multilevel effects, multidirectional causalities, nonlinearities, mechanisms of positive feedback, paths, and historical dependencies. Furthermore, we extended Montealegre et al. [MHG14] using the property technology, identifying 23 configurations. Second, based on our discussion of the properties and configurations of co-evolution, we provided avenues for future research.

This study has limitations. First, the identified articles are limited to our search terms and the selected articles. Second, this work is limited by the coding of the articles to their respective co-evolution properties and configurations. To mitigate these limitations, three experienced raters coded the articles independently. We ensured that a broad amount of co-evolution articles was included by opening the search to conference articles.

Based on this study, four theoretical contributions came to light. First, the findings of our structured literature review about the identified configurations showed that co-evolution materialized in different ways in different business ecosystems. Therefore, the study enlarged the literature of Lewin and Volberda [LV99] and Montealegre [MHG14]. Second, we fused insights from IS, management, and organizational science and built upon the proposition of Jacobides [JCG18] to contribute a theory about ecosystem transformation by suggesting the notion of co-evolution. Third, our findings showed that co-evolution in business ecosystems was dependent of new properties, which are particularly evident because of the emerging role of technology. Fourth, we showed that co-evolution was a suitable lens for examining digital transformation from an inter-organizational perspective.

This study provided two practical contributions. First, we invited practitioners and scholars to apply the identified configurations to the properties of co-evolution when discussing digital transformation in business ecosystems. Moreover, we provided 23 configurations for the six properties. Second, managers obtained insights about co-evolution novelties in business ecosystems with respect to digital transformations. For example, co-evolution in business ecosystems can be driven by enabling digital technologies, which are the core of digital platforms.

Based on our discussions of the findings, we suggest five avenues for future research. First, as we annotated for the existing literature on co-evolution processes, we were surprised by the limited occurrence of platforms, particularly digital platforms lying at the center of value creation. Thus, we suggest the use of co-evolution theory to examine platform ecosystems. Second, regarding technologies enabling co-evolution, we suggest the analysis of boundary resources, such as application programming interfaces (API) [Ea15, UY16]. Um and Yoo [UY16] understood APIs as the key role of managing the tension between control and generativity of a platform. We suggest that we should also study the effect of changing APIs over time on the business model of complementors or service offerings in platform ecosystems. Co-evolution may be also helpful for determining the effect of API changes on value capturing or value co-creation. Third, regarding multi-directional causality in platform ecosystems, there is a gap in how cooperation or competition can be leveraged. Thus, competition via different platform ecosystems (e.g., Android or iOS) should be examined. Fourth, the nonlinearity configurations of diffusion, hierarchy, network, or big bang could be used to design longitudinal studies for examining co-evolution. Further, we suggest that researchers seek to detect managerial co-evolution mechanisms driving positive feedback in platform ecosystems. Thus, scholars could shed light on co-evolutionary mechanisms for platform owners to enable the co-evolution of complementary partners. Mechanisms used to manage the evolution of platforms should also be evaluated.

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Appendix I: Publication P3

DIGITAL TRANSFORMATION IN THE AUTOMOTIVE INDUSTRY: TOWARDS A GENERIC VALUE NETWORK

Research in Progress

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Abstract

The emergence of digital innovations is accelerating and intervening existing business models by delivering opportunities for new services. Drawing on the automotive industry, leading trends like self-driving cars, connectivity and car sharing are creating new business models. These are simultaneously giving rise for innovative market entrants, which begin to transform the automotive industry. However, literature does not provide a generic value network of the automotive industry, including new market players. The paper aims to visualize the current automotive ecosystem, by evolving a generic value network using the e³-value method. We define different roles, which are operating in the automotive industry by analyzing 650 companies reported in the Crunchbase database and present the value streams within the ecosystem. To validate the proposed generic value network we conducted five preliminary interviews with experts from the automotive industry. Our results show the central role of mobility service platforms, emerging disruptive technology providers and the dissemination of industries, e.g., as OEMs collaborate with mobile payment providers. Scholars in this field can apply the developed generic value network for further research, while car manufacturers may apply the model to position themselves in their market and to identify possible disruptive actors or potential business opportunities.

Keywords: digital transformation, automotive industry, generic value network, e3-value method

1 Introduction

New technologies accelerate digital innovations, which fundamentally transform the daily lives of consumers, companies and the structure of entire ecosystems (Fichman et al., 2014). Today, the digital transformation is even changing the value creation of industries where value is generated exclusively through physical materiality (Yoo et al., 2010), most visible in the automotive industry. Recent digital innovations like self-driving cars, connectivity, big data, and social networks are fundamentally revolutionizing the automotive industry (Wijnen, 2013; Simonji-Elias et al., 2014; Hanelt et al., 2015; Gao et al., 2016). Companies need to be aware of these technologies' disruptive character and adjust their business models to deal with new actors in the ecosystem (Letiche et al., 2008; Perrott, 2008; Möller et al., 2011).

With the emergence of these technologies, platforms and innovative digital services are offered by a plethora of new market entrants, like Tesla, Uber, or ZipCar which threaten the established ecosystem of the automotive industry (Gao et al., 2016). Uber, for instance, which represents the most popular P2P ride sharing platform and was already in 2015 valuated higher than 80 % of the S&P 500 organizations, including General Motors and Ford Motor Company (Verhage, 2015). Due to the rising number of new market entrants, original equipment manufacturers (OEMs) are no more alone in the market and have to align their strategies to compete with these new market entrants, which provide customer-centric mobility for their customers and substantially intervene the current value network (Berman and Bell, 2011; Matt et al., 2015; Gao et al., 2016). Digital transformation strategies are important, because they "reflect the pervasiveness of changes induced by digital technologies throughout an organization" (Chanias and Hess, 2016). Hence, organizations have to change traditional business models, which have been robust for many decades, and transform their organizations to adapt these trends, e.g., car sharing platforms, or new telematics services (Fitzgerald et al., 2013; Lucas et al., 2013).

Currently, OEMs are heavily investing to adapt to these trends. Hence, a business model disruption in the automotive industry is somewhat likely within the next five years (Simonji-Elias et al., 2014). However, it remains unclear which technologies will prevail, leading to tensions in the automotive industry, as OEMs do not want to give up their leadership in product and technology (Simonji-Elias et al., 2014).

However, the transformative impact on industrial-age physical products, especially of the automotive industry, has remained unnoticed in the Information System literature for years (Yoo et al., 2010). Some research has been conducted in the last two years. For instance, Hanelt et al. (2015) identified four business model change types: business model extension, revision, termination, and creation, in the automotive industry. Building on these insights, Remane et al. (2016) detect 27 business model types that were implemented by startups from the mobility sector in the last ten years. However, research is still missing a holistic analysis of the current and ongoing transformation of the automotive industry (Hanelt et al., 2015), as existing studies solely focus on organizations' business models. Therefore, we analyze the digital transformation of the automotive industry from the holistic perspective of its value network. The central advantage of the representation as a value network compared to a business model canvas is to analyze the value streams between all actors in the network. As a first step towards this goal, and to trigger further research, this paper aims to answer the following research questions: *Which generic roles exist and emerge in the value network of the automotive industry? How does the generic value network of the automotive industry look like?* Therefore, we aim towards a generic e^3-value network model based on 15 generic roles we derived from analyzing 650 companies extracted from Crunchbase, a comprehensive database for existing companies and startups.

The remainder of this paper is structured as follows. First, we analyze the underlying literature of digital innovations in the automotive industry, which have been conducted in this field of research. Second, we describe our methodology. As third, the generic roles and the generic value network is presented. Afterwards, we discuss the results and briefly present the implications and outlook.

2 Related Work

Service-dominant logic (S-D Logic) suggests, servitization is one of the key trends in an increasing digitized and interconnected world (Vargo and Lusch, 2004; Lusch and Nambisan, 2015). The theory implies, that services are generated in service ecosystems (actor-to-actor networks), which represent the central theme of S-D Logic. In service ecosystems, value is no longer created by one actor, but increasingly created through cocreation (Lusch and Nambisan, 2015). Therefore, it is crucial to understand the underlying value network of ecosystems.

2.1 From Value Chains to Value Networks

Service ecosystems have their roots in the literature of value chains. The value chain concept was used for the last decades to understand and analyze industries (Stabell and Fjeldstad, 1998). The most established value chain approach is presented by Porter (1985). Traditionally, in the manufacturing industry, value chains are used for visualizing the chained linkage of physical activities (Porter, 1985). The value chain method is applied to analyze competitors and new market entrants (Peppard and Rylander, 2006; Böhm et al., 2010). On account of that, Porter created an extended value chain, namely a value system, which includes the value chains of the firm, of the suppliers, the customers and the end customer, which create interdependencies between the actors of the value system. Value systems are crucial for firms, as by optimization or coordination of the linkages between the actors a firm can create competitive advantage (Connolly and Matarazzo, 2009). But, in a globalized and dynamic world, the explanatory behavior of value chains is limited. Thus, a more complex method is required, which led to value networks (Biem and Caswell, 2008). According to Peppard and Rylander (2006) a value network is a "set of relatively autonomous units that can be managed independently, but operate together in a framework of common principles and service level agreements (SLAs)". Each actor contributes an incremental value to the network (Bovet and Martha, 2000), but concentrates only on their core competencies (Stabell and Fjeldstad, 1998). Due to the increased connected economy and connected inter-organizational relationships, a value network is an adequate method to visualize inter-organizational exchanges and relationships (Biem and Caswell, 2008). The value network presents functions and activities, which are performed simultaneously. The advantage of a value network is an adequate display of cooperation relationships and alliances. Due to the rising complexity of firm relationships, evoked by digitalization, industries can no longer be classified as suppliers, customers and competitors (Peppard and Rylander, 2006; Pil and Holweg, 2006; Biem and Caswell, 2008; Böhm et al., 2010). Today, digitalization is changing value networks and affecting physical products. Therefore, the value network concept is now used for service oriented and non-physical industries (Peppard and Rylander, 2006). Due to digitalization the digital and physical world are merging (Hanelt et al., 2015). Particularly relevant for this paper, we use the holistic value network approach because the most popular digital innovations and changes can be currently observed in the automotive industry (Berman and Bell, 2011; Gao et al., 2016).

2.2 Digital Transformation in the Automotive Industry

For the automotive industry, literature focused on different aspects of the digital transformation, starting from an overview of the different business model changes types (Hanelt et al., 2015) for specific transformation strategies. Hanelt et al. (2015) combine the phenomena of digital and physical world and explore the impact of digital trends on the business model of the automotive industry. Their findings show four different business model change types: extension, revision, termination and creation. Examples for business model extension are interactive elements with customers, e.g., through social media. Business model revision is required through self-driving cars, which reflects a combination of physical and digital components. Termination of business models may occur through virtualization, e.g. virtual showrooms for sales distribution may terminate the business of car dealers. Finally, business model creation can be achieved through new driver services and new data services. Investigating the strategy for digital transformation, Chanias and Hess (2016) examined existing challenges of the digital transformation in the automotive industry. Therefore, they conducted a case study for the formation of strategies due to digital transformation according to the activity-based process model (Chanias and Hess, 2016). Their findings show, digital transformation primarily begins through a multitude of organizational activities from a bottom up perspective, even before top management initiated a holistic strategy. Hildebrandt et al. (2015) found that digital technology-related merger and acquisitions (M&As) have a positive impact on digital business model innovations. OEMs have to acquire external knowledge by M&As to capture the potential of digital innovations (Henfridsson and Lind, 2014). The emerging digital ecosystem, an OEM is surrounded by, is a "key success factor of IT-enabled business models" (Hildebrandt et al., 2015). Their results show, that openness towards external market players and knowledge will support the digital innovations (Hildebrandt et al., 2015). According to the theory of disruptive innovations, digital innovations increase business performance and result in better user experience (Keller and Hüsig, 2009). As external knowledge plays therefore an important role it is crucial to analyze the entire ecosystem of the automotive industry. Piccinini et al. (2015) conducted a Delphi study with industry experts to grasp the emerging challenges which come in line with digital transformation of the physical automotive industry. For digital ecosystems, among these are: competing with an expanding range of new rivals and non-industry rivals and entrants; building complementary partnerships among different ecosystem players (business and IT) to design new business models; bridging gaps between previously separated business units and ecosystem players to create new digital value; improving information flows and exchange between business ecosystem partners to enable a seamless customer experience (Piccinini et al., 2015). Drawing on organizational ambidexterity, they show organizations need to simultaneously exploit current resources while exploring promising capabilities (Gregory et al., 2015). Most recently, Remane et al. (2016) analyzed the business models of emerging and current startups in the mobility sector . They used Crunchbase data to classify startups by business model types according to Weill et al. (2005). They identified 27 different business model types, and organized them in four clusters: creator, distributor, landlord and broker. However, research is missing a detailed actor-to-actor analysis of the current and ongoing transformation of the automotive industry (Hanelt et al., 2015), as existing studies solely focus on organizations' business models. Thus, we analyze the digital transformation of the automotive industry from the holistic perspective of its value network. To achieve this, we aim to identify generic roles and the value streams between them.

3 Research Approach

We conducted a three-step research approach. First, we identified the roles and values streams between them. Second, we visualized the generic value network based on the identified roles and value streams. Third, we validated the model with preliminary semi-structured expert interviews.

For the first step, we decided to use Crunchbase data in order to derive the roles in the value network. Crunchbase possesses a comprehensive database for existing companies and startups (Marra et al., 2015) including a description of organizations' value propositions. Crunchbase contains startups at all funding stages, which enables researchers to capture new business model innovations in emerging markets (Marra et al., 2015; Perotti and Yu, 2015). We extracted all organizations listed on October 20, 2016. To collect all organizations of the automotive industry as well as related technologies, we filtered the Crunchbase category list by the search term "automotive", which led to a sample size of 728 funded companies, which includes 77 initial public offerings (IPOs). This led us to capture established and emerging organizations, which are representative for the current automotive industry. We excluded 15 companies, which have been "closed" so far, for example WhipCar, a London-based car sharing service. Furthermore, we had to exclude three organizations from our coding, as the listed website did not exist anymore. Screening the data, we found companies, which had no relationship to the automotive industry, e.g., Eni, an energy company that engages in oil and natural gas exploration. Hence, we shortened the data set by 60 companies. With the remaining 650 organizations we conducted in a first step a structured content analysis, including an inductive category development based on Mayring (2010) and Miles and Huberman (1994). With this method, we identified a set of 15 generic roles. We established inter-coder reliability to ensure consistent coding. Two experienced raters independently coded the 650 organizations. Before the raters started coding the organizations from Crunchbase, both raters coded several organizations to become familiar with the coding scheme and then compared their coding for calibration purposes. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached a consensus; this helped to eliminate individual disparities (Bullock and Tubbs, 1990). For example, we coded Vroom based on its description *"Vroom is an online direct car retailer that makes car-buying and -selling fast and easy"* as car dealer. We used the same approach for the identification of the value streams, but combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles or annual reports. For example, we coded the value streams between OEMs and tier suppliers as exchange of technology (hardware and software) and money based on the quote *"Continental's five largest OEM customers (Daimler, Fiat-Chrysler, Ford, General Motors, and VW) generated approximately 43% of the Continental Corporation's sales in 2016"* in Continental's recent annual report (Continental AG, 2016). After both raters completed the coding, we used Krippendorff's (2004) Alpha to determine inter-coder reliability. The results indicated an Alpha of 0.87, reflecting an acceptable inter-coder reliability (Krippendorff, 2004).

In the second step, we use the e³-value method to visualize the value network of the automotive industry based on the identified generic roles and the value streams between the generic roles. The e³-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an eco-system perspective. It is used to evaluate economic sustainability of value networks by modelling the exchange of things of economic value between actors (Gordijn and Akkermans, 2003).

In the third step, we conducted five preliminary interviews with experts from the automotive industry to validate the generic value network. We used a semi-structured technique (Myers and Newman, 2007) to interview two CEOs of value added partners, a CEO of an OEM's technology subgroup, a department manager of another OEM, and a senior consultant with a major in IS applications for the automotive industry. Each of the experts has a minimum of ten years' experience in the automotive industry and in new digital technologies. The interviewees are either working in a leading strategic position or information technology related function (Goldberg et al., 2016), who have privileged access to information and knowledge on the subject (Bogner et al., 2009). This allowed drawing from a broad knowledge on long-time market experience and different customer insights from various companies. We conducted the interviews between December and March 2017. The interviews were recorded and transcribed afterwards took 41 minutes on average. To validate the generic roles and value streams, we discussed the roles and value streams of the proposed generic value network with the experts.

4 Towards a Generic Value Network for the Automotive Industry

Due to digital innovations, the automotive industry is transforming and is giving rise to a set of new market players in the resulting value network. Following the approach of Böhm et al. (2010), we abstract the definition of market players and actors, which offer similar services and products to customers, and define generic roles based on the structured content analysis of the Crunchbase data of 650 organizations, see Table 1.

Role	**Description**	**Example(s)**
OEM	The original equipment manufacturer (OEM) produces cars. We assume an OEM manufactures traditional combustion engines as well as electro vehicles (EV). The value proposition of OEMs can include direct sales, R&D, manufacturing, after sales, and services (Kang et al., 2009).	Ferrari, Tesla, Cadillac, BMW, Daimler, Bolt Motorbikes
Consumer	Consumers request mobility, which can be fulfilled in many forms like driving an own car, lending or sharing a car as well as using public transportation or a specific mobility service like Uber. Customers may use products or services before, during or after transportation. In some contexts, a consumer is a *Prosumer*, by simultaneously using and creating a service. An example is sharing personal data via smartphone with Google Maps while using the aggregated real-time traffic information of other users for navigation. Consumers can pay for services with money, data or a combination of both.	
Tier 1-3 Supplier	The traditional automotive industry is characterized by a one-sided supplier-buyer relation (Turnbull et al., 1992). Vehicle manufacturers rely heavily on *first tier* suppliers, which approximately supply 85 percent of the parts. First tier supplier may offer product development, design and technology and many depend on subcontractors, namely *second tier* suppliers. These in turn can depend on *third tier* contractors, which e.g., supply press, cutting, welding, forging or casting work.	Bosch, Continental, Faurecia, China Automotive Systems, Hyundai Mobis, ABC Group
Public Transportation Provider	This role represents the traditional public transportation, including underground station, busses, city bikes and trains (Hoffmann et al., 2016).	New York MTA, citibike
Car Rental Provider	A car rental provider offers different models for renting a car (Moeller and Wittkowski, 2010).	Sixt, Hertz
Car (parts) Dealer	Apart from directly purchasing from OEMs, consumers can purchase from car (or car parts) dealers. Cars and spare parts can be also sold via online platforms of the respective dealers (Applegate, 2001).	LUEG, Amazon (Fiat), carparts.com
Disruptive Technology Provider	Disruptive technology providers offer disruptive innovations to OEMs in form of software and hardware, such as sensors for assisted driving. Following Christensen (1997), disruptive technologies may be inferior to established technologies in the beginning. However, disruptive technologies move up market relentlessly, leading to the elimination or replacement of established technologies (Christensen, 1997).	Savari, Intel, Mobileye,
Mobility Service Platform	We distinguish between different mobility service platforms, such as private or commercial car sharing, P2P-Lending, or service platforms from	Uber, VRide, DriveNow, Tesloop, Taxify, Car2Go

	OEMs (Lee et al., 2016). Mobility services can be accessed and distributed via these platforms, e.g. Uber provides the platform that allows drivers to provide their mobility service to registered users.	
Mobility Service Aggregator	This role aggregates different mobility services, including public transport services and car sharing platforms, which may also imply intermodal mobility services (Plummer and Kenney, 2009).	Moovel, Flare
Intelligent Infrastructure Provider	This role represents the connection of physical and digital infrastructure. Due to connectivity and new technologies, e.g., sensors and electric vehicles (EV), the infrastructure, e.g., including traffic signs or parking lots can be connected to cars and consumers. Electric vehicle charging stations (EVCS) is such an intelligent infrastructure. Providers allow to access if they are currently used or free, for example.	ChargeNow, CarCharging, Chargerlink
Cloud Infrastructure Provider	A cloud infrastructure provider (IaaS), consists of a shared pool of Internet-based configurable computing resources (e.g. servers, storage, applications and services), which can be rapidly provisioned and released with minimal management effort (Youseff et al., 2008).	Amazon Elastic Compute Cloud (Amazon EC2)
Cloud Platform Provider	The cloud platform provider (PaaS) offers a digital marketplace of various cloud infrastructure services. The key objective is to connect customers and service providers. The former can search for suitable value added services, telematics services and in-car apps while the value added provider can advertise its services. The platform is built on underlying cloud infrastructure (Youseff et al., 2008).	Google Cloud Platform, Microsoft Azure
Value Added Service Provider	Value added services can be accessed before, during, or after transportation. Two types of value added service providers (SaaS) exist. First are telematics services, or technical information about the vehicle, safety features or intelligent driver assistance software. Second are services, which offer complex digital services to the customer, e.g., entertainment, security, location based information services or concierge services. These services can be access via cloud platforms (Youseff et al., 2008).	Spotify, Data Crossover, Autolinked, ParkNow, On-Star, BMW Connected Drive
Car Service Provider	Car services include all traditional services, such as maintenance, insurance, or stationary services like car wash (Remane et al., 2016).	Washtec
E-Payment Provider	Provision of payments, which also work for mobile devices or cars.	MercedesPay

Table 1. Generic Roles of the Actors in the Value Network of the Automotive Industry

As our roles are on a more abstract level than business models, on role can refer to different business model types. Further, one company can act in different roles by offering different services to other players.

We compared our identified roles with the business model types of Remane et al. (2016) and found examples for each business model type in our generic roles. For example, we aggregated the business model types ‘digital service provider’ and ‘sensor-enabled service innovator’ in our generic role value added service provider due to similar value streams in the value network. Second, we used the e3-value method to propose a generic value network of the automotive industry, see Figure 1. It depicts the identified roles and the value streams between them, we validated through five preliminary expert interviews.

Roles create value within the value network by providing data, services and physical products (car, rental car, spare parts, and technology). By drawing on publicly accessible information on the companies’ websites, we identified the following value streams regarding services: car as a service (CaaS), software as a service (SaaS) and mobility as a service (MaaS).

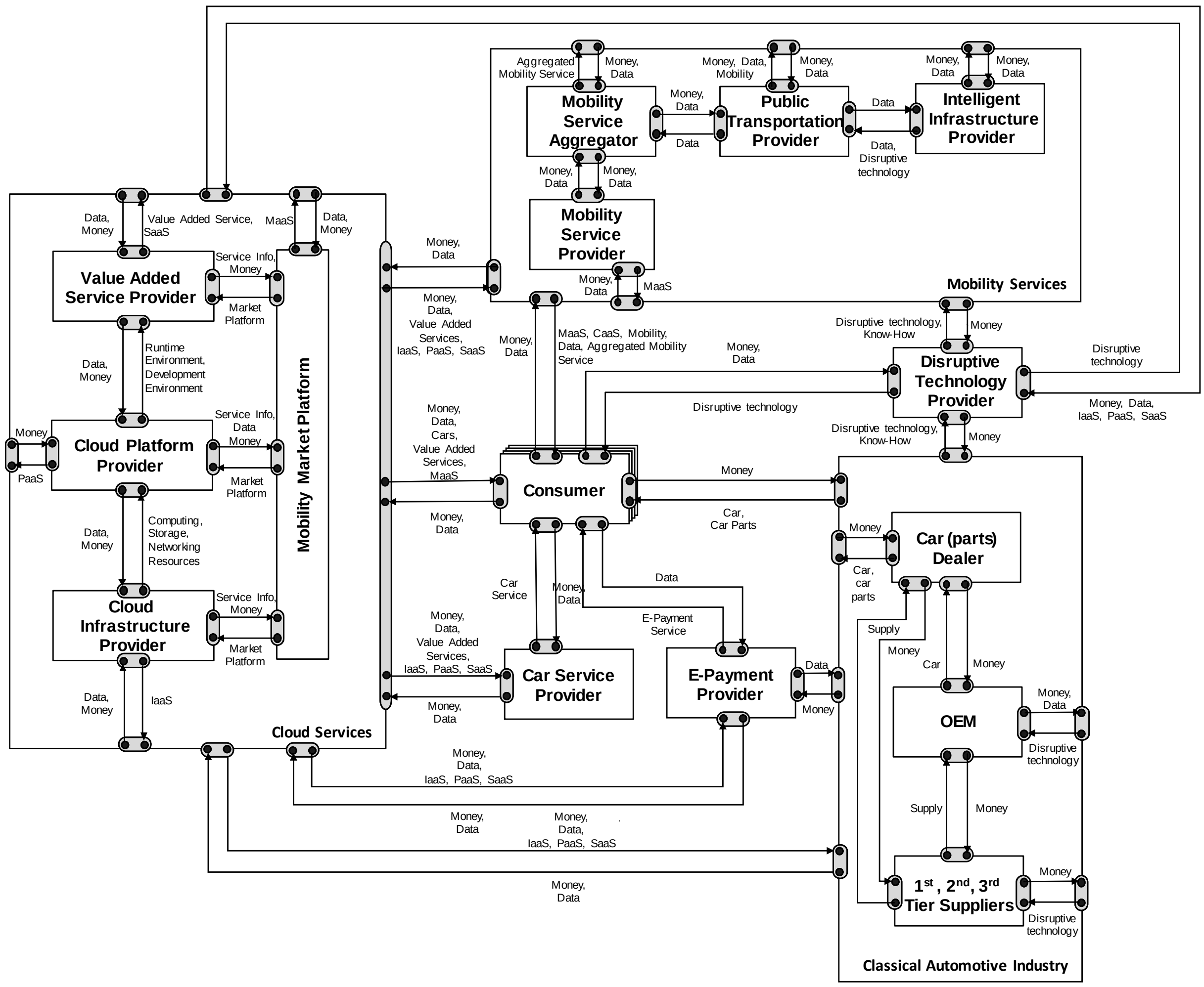

Figure 1. Proposed Generic Value Network for the Automotive Industry

Further, we integrated the cloud computing perspective of Böhm et al. (2010), by accounting for platform as a Service (PaaS), infrastructure as a Service (IaaS). Further, the service layer of cloud computing was framed as value-added services here, e.g. BMW Connected Drive. Naturally, products and services are exchanged in favor of money or data. The center of the value network is the consumer, who demands a MaaS, CaaS, SaaS or buys or rents a physical product (car, rental car, spare parts).

The generic value network shows that the automotive industry transformed to a multi-sided value network, and thus moves away from the traditional one-sided supplier-buyer business model. Thus, we can confirm the conclusion of Remane et al. (2016) that new roles are emerging, for example mobility service platforms, or intelligent infrastructure providers. Based on the findings of the proposed model, emerging roles threaten the value creation of OEMs from two sides. On one hand, the generic value network shows the automotive industry is being intervened through mobility service platforms, like Uber, which directly offer mobility services to the customers. Therefore, OEMs may gradually lose the customer touchpoint. On the other hand, trends like self-driving cars force OEMs to cooperate emerging players. This is represented by the central role of disruptive technology providers between OEMs and mobility services, e.g., Mobileye and Intel in the case of BMW. Therefore, OEMs have to be open to new market entrants and need to gain external knowledge to foster innovation (Hildebrandt et al., 2015). This is particularly helpful in order to enhance the user experience (Keller and Hüsig, 2009). The generic value network also highlights the creation of new data-driven roles due to digital innovations, e.g., as intelligent infrastructure providers share real-time traffic information with self-driving cars. Finally, the expert interviews showed the increasing diffusion of mobility services through digital technology as one expert suggested to incorporate the role e-payment providers in the value network. For example, Daimler acquired an electronic payment provider for mobile payments which is now implemented as 'MercedesPay' for mobility services, such as Car2Go or as virtual wallet for customers' smartphones (Daimler AG, 2017).

5 Conclusion and Outlook

This paper presents a generic value network for the automotive industry based on 15 generic roles identified by a structured content analysis of the Crunchbase data of 650 automotive organizations. Preliminary findings are that digital transformation creates new roles for value creation in the automotive industry. The value network shows that mobility service platforms and disruptive technology providers penetrate the market and therefore threaten the value creation of OEMs from two sides simultaneously.

The model is limited by the information provided by the Crunchbase database and our coding of the generic roles. Drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles or annual reports. Further, we conducted five preliminary semi-structured interviews with experts from the automotive industry to validate the proposed generic value network based on the identified roles and value streams. However, a deeper analysis of the value streams should be conducted which also relies on quantitative information, such as the Crunchbase database.

Scholars can apply the developed generic value network for further research, particularly for understanding digital transformation. Practitioners, e.g., OEMs can apply the model to identify potential threats to their current market position and potential opportunities to adapt to trends or shifts in customer needs. As example, innovative OEMs introduced car-sharing platforms early, like BMW with Drive Now, or more recently, Mercedes acquired a mobile payment provider to enhance their digital portfolio (Daimler AG, 2017). Hence, companies can use the generic value network to analyze their position in the automotive industry and their linkages to competitors or partners. However, according to Böhm et al. (2010) it is not necessarily important to know, which generic role might take the largest share within the value network, but to develop a unique value proposition based on core competencies.

Due to its novelty, future research should investigate the intelligent infrastructure provider and monitor roles, reflecting them in practice to potentially extend the generic value network. Moreover, a complete case study of the transformation of an OEM would be particularly helpful to understand the full extent of digital transformation.

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Appendix J: Publication P4

The Generic Ecosystem and Innovation Patterns of the Digital Transformation in the Financial Industry

Completed Research Paper

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Abstract

The emergence of financial technology companies (Fintechs) through the easy access of digital technologies is transforming the entire financial industry, heralding a new era of business models. With digital technologies like mobile payments, robo advisors, and distributed ledgers or blockchain, Fintechs are challenging the prevailing position of traditional financial institutions. However, literature does not provide a structured overview of the digital transformation in the financial industry, including inter-organizational innovation patterns. By analyzing 792 Fintechs, this paper visualizes the 22 generic roles and value streams within the financial ecosystem using the e^3-value method. Moreover, we identify and discuss seven inter-organizational innovation patterns of the digital transformation in the financial industry. We contribute to literature by examining digital transformation in the financial industry from an inter-organizational perspective. Practitioners may apply the model to position themselves and to identify disruptive actors or potential business opportunities. We also analyze the influence of blockchain technology.

Keywords: *Digital Transformation, Financial Industry, Fintechs, Inter-Organizational Innovation Patterns, Ecosystem, e^3-value model*

Introduction

When asked why he launched Alipay in 2004, Jack Ma, the founder and chairperson of Alibaba replied "*at that time, I went to a bank, and the bank said 'we can't do that [online] (...)'. So I decided to do it, and threw everything into it*" (Custer 2015). In 2016, Alipay had more than 450 million of the 1 billion internet users registered and already accounted for 52% of the Chinese online payments, which represents more than $ 2,500 billion in transaction volume (Meeker 2017; Statista 2018).

The case of Alipay in the Chinese market shows that pure technology companies are continuously penetrating the business model of traditional financial institutions. One reason is that the market for digital technologies is easily accessible and constantly innovating. Digital technologies, like e.g., mobile payments, robo-advisors, crowdfunding or -sourcing, or blockchain (Cearley et al. 2017), are some of the main drivers in the financial industry.

Digital platforms that have the capacity to combine and deploy innovative technologies create new business models that fundamentally transform the way business is done (Lucas and Goh 2009; Tiwana 2015). We refer to this organizational transformation as digital transformation following Fitzgerald et al. (2013). Digital transformation is defined as “the use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements (such as enhancing customer experience, streamlining operations or creating new business models)” (Fitzgerald et al. 2013, p. 2). The transformative influence on industrial-age products has remained unnoticed in the Information Systems literature for years (Yoo et al. 2010). However, due to the easy access and the decreasing cost of innovative digital technologies many startups are challenging the value creation of established organizations.

In the financial industry, these startups are referred to as Fintechs, which is essentially a combination of “finance” and “technology” (Zavolokina et al. 2016). Fintechs use innovative digital technology to create novel financial products or services that either improve existing processes or create new business models, such as robo-advisors or cryptocurrencies (Zavolokina et al. 2016). According to Puschmann (2017), Fintechs reflect the IT-induced transformation of the financial industry. Central advantages of Fintechs are costs efficiency, flexibility, speed, and scalability (Deutsche Bank AG 2014). However, Fintechs either change or improve established processes, products, or services, or create competition or eventually disrupt established business models (Puschmann 2017; Zavolokina et al. 2016).

Due to the rising number of new market entrants, traditional financial institutions such as banks are no more alone in the market. Hence, established organizations have to align their strategies to compete with these new market entrants, which provide customer-centric financial services for their customers (Matt et al. 2015; Puschmann 2017; Riasanow et al. 2018). Currently, traditional financial institutions invest heavily into Fintechs (Puschmann 2017). Yet, existing studies solely focus on the business model of Fintechs or the transformation of the business model of established financial institutions (Puschmann 2017). However, following Puschmann (2017), literature does not provide an inter-organizational and macro-economic overview of the current and ongoing transformation of the financial industry, particularly through Fintechs. Further, innovation patterns of the digital transformation through Fintechs are particularly missing (Puschmann 2017). Towards this goal, and to trigger further research, this paper aims to answer the following research question: *What is the generic ecosystem of the digital transformation in the financial industry and which inter-organizational innovation patterns can be observed?* Therefore, we first use qualitative content analysis of Mayring (2010) and Miles and Huberman (1994) to identify 22 generic roles we derived from analyzing 792 companies. We extracted the company data from the Crunchbase database, a comprehensive, socially curated database for established companies and startups. Further, we use the e^3-value method to develop a generic ecosystem of the digital transformation in the financial industry including Fintechs based on these 22 roles. Following Puschmann (2017), we discuss seven inter-organizational innovation patterns to structure the digital transformation in the financial industry, such as the elimination of intermediaries.

The paper is organized as follows. First, based on digital transformation literature we analyze related background on the digital transformation in the financial industry through Fintechs. Second, we describe our methodology. As third, the 22 generic roles and the generic ecosystem are presented. Further, we suggest seven innovation patterns of the digital transformation in the financial industry. Next, we discuss the results, implications and future research. The final section is the conclusion.

Digital Transformation in the Financial Industry through Fintechs

Digital transformation is currently one of those topics practitioners and researchers hardly can avoid when talking about IS or business strategy making. Digital transformation is an industry level phenomenon (see, for example da Silva Freitas et al. 2016; Downes and Nunes 2013) which changes the way organizations within and across industries compete. Therefore, digital transformations “affect large parts of companies and even go beyond their borders, by impacting products, business processes, sales channels, and supply chains” (Matt et al. 2015, p. 339).

Following Horlacher et al. (2016), inherent to digital transformation is the development of technology enabled business models that are new to the organization that has initiated the transformation. This is particularly relevant for the financial industry, as a magnitude of emerging technology-enabled players penetrate the market (Puschmann 2017). These organizations, so called Fintechs, use innovative digital technology to create novel financial services or products that either improve existing processes or create new business models, such as robo-advisors (Zavolokina et al. 2016). According to Deutsche Bank AG (2014), central advantages of Fintechs are costs efficiency, flexibility, speed, and scalability. The changing role of IT, changing customer behavior, changing ecosystems, and changing regulation are the main drivers for the success of Fintechs (Puschmann 2017).

Moreover, digital transformation means changing the way value is delivered to customers (Piccinini et al. 2015), which is also observable in the financial industry. Hence, Fintechs revolutionize the financial industry in several ways. They may improve established processes, products, or services, create competition through innovative products or services, or eventually disrupt established business models (Puschmann 2017; Zavolokina et al. 2016). To be successful, the evolution of a company's business model needs to be complemented by a co-evolution on the customer side (Riasanow et al. 2017). In particular, Haffke et al. (2016, p. 2) emphasize the effects on "sales and communication channels, which provide novel ways to interact and engage with customers" and a "firm's offerings (products and services)", which replace or augment physical offerings. Drawing on the software industry, Apple's App Store shows DT is not just affecting the organization with its internal value creation processes. Apple heavily invested into resources (e.g., the software development kit for iOS) that helped the organization to establish an ecosystem of connected developers and customers. Today the magnitude of applications is created by external companies or independent developers (Eaton et al. 2015).

Recognizing this interdependence, researchers have analyzed digital transformation with an intra-organizational perspective (see, for example Bley et al. 2016; Haffke et al. 2016; Matt et al. 2015; Piccinini et al. 2015). However, research is missing a detailed inter-organizational, macroeconomic analysis of the current and ongoing digital transformation in the financial industry (Puschmann 2017) as existing studies solely focus on organizations' business models. Thus, we analyze the digital transformation in the financial industry from the holistic perspective of its ecosystem.

Research Approach

We conducted a five-step research approach based on Riasanow et al. (2017). To develop the generic ecosystem of the financial industry, we first identified the roles of the actors in the industry and the value streams between them. Second, we presented the generic ecosystem based on the prior identified roles and value streams. Third, we validated the model with four semi-structured expert interviews. Afterwards, we identified innovation patterns of the digital transformation in the financial industry using qualitative content analysis.

For the first step, we decided to use Crunchbase data[1] in order to derive the roles in the ecosystem. Crunchbase possesses a comprehensive database for existing companies and startups (Marra et al. 2015) including a description of organizations' value propositions. Crunchbase contains startups at all funding stages, which enables researchers to capture business model innovations in emerging markets (Marra et al. 2015; Perotti and Yu 2015).

We extracted all organizations listed on October 02, 2017. To collect all organizations of the financial industry as well as related technologies, we filtered the Crunchbase category list by the search term "fintech", which led to a sample size of 1000 European funded companies. This led us to capture established and emerging organizations, which are representative for the current financial industry. We excluded eleven companies, which have been "closed" so far, for example Kiria, a Berlin-based mobile financial assistant. Furthermore, we had to exclude three organizations from our coding, as the listed website did not exist anymore. Screening the data, we found companies, which had no relationship to

[1] The Crunchbase database is accessible via www.crunchbase.com. We used a premium account for data collection.

the financial industry, e.g., DigitalMR, a company that uses artificial intelligence for customer insights. Hence, we shortened the data set by further 247 companies.

With the remaining 742 organizations we conducted in a first step a structured content analysis, including an inductive category development based on Mayring (2010) and Miles and Huberman (1994). With this method, we identified a set of 22 generic roles. We established inter-coder reliability to ensure consistent coding. Two experienced raters independently coded the 742 organizations. Further, to prevent restriction to the European market, we randomly extracted 50 further non-European organizations from Crunchbase and coded them accordingly, leading to 792 organizations in total. However, we could not derive new roles from this additional data set. This implies our data sample is a comprehensive representation of the international financial industry.

Before the raters started coding the organizations from Crunchbase, both raters coded several organizations to become familiar with the coding scheme and then compared their coding for calibration purposes. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached a consensus; this helped to eliminate individual disparities (Bullock and Tubbs 1990). For example, we coded Klarna as "alternative payment solution" based on its description *"Klarna provides e-commerce payment solutions for merchants and shoppers"*. We used the same approach for the identification of the value streams, but combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles or annual reports. For example, we coded the value streams between "loans" and "customers" as exchange of money (payment and fees) and loans or leasing based on the quote "*RateSetter is a P2P lending website allowing users to lend and borrow money directly with each other according to their own interest rates*" (RateSetter 2018). After both raters completed the coding, we used Krippendorff's (2004) Alpha to determine inter-coder reliability. The results indicated an Alpha of 0.85, reflecting an acceptable inter-coder reliability (Krippendorff 2004).

In the second step, we use the e³-value method to visualize the ecosystem of the financial industry based on the identified generic roles and the value streams between the generic roles. The e³-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective. It is used to evaluate economic sustainability of ecosystem by modelling the exchange of things of economic value between actors (Gordijn and Akkermans 2003). Further, we compared the prior generic ecosystem to the generic ecosystem including Fintechs.

In the third step, drawing on qualitative content analysis following Mayring (2010) and Miles and Huberman (1994), we derive inter-organizational innovation patterns of the digital transformation in the financial industry. Therefore, we analyzed emerging roles that either corporate or compete with existing roles in the ecosystem.

Fourth, we conducted four interviews with experts from the financial industry or founders of Fintechs to validate the generic ecosystem. We used a semi-structured technique (Myers and Newman 2007) to interview a venture fund representative, a senior analyst at a major German investment bank, and two founders of European Fintechs. Each of the experts has substantial experience in the financial industry and in new digital technologies. The interviewees are either working in a leading strategic position or information technology related function (Goldberg et al. 2016), who have privileged access to information and knowledge on the subject (Bogner et al. 2009). We conducted the interviews between January and February 2018. The interviews were recorded and transcribed afterwards. Each interview took 41 minutes on average. To validate the generic roles, value streams and innovation patterns, we discussed the roles and value streams of the proposed generic ecosystem with the experts.

Fifth, we draw on Puschmann (2017) to identify the inter-organizational innovation patterns. We derive the innovation patterns by comparing the traditional ecosystem with the digitally transformed ecosystem due to Fintechs.

The Generic Ecosystem of the Financial Industry including Fintechs

Due to the emergence of innovative digital technologies, the financial industry is transforming. This is particularly due to new market entrants like Fintechs. To model the ecosystem of the financial industry, we follow the approach of Riasanow et al. (2017).

Hence, we first derive the roles of the actors in the ecosystem by drawing on data from 792 companies derived from the Crunchbase database. Actors, which offer similar services and products to the customer are abstracted to one role based on a structured content analysis following Mayring (2010). As our roles are on a more abstract level than business models, one role can refer to different business model types. Further, one company can act in different roles by offering different services to other players. In table 1, we first present the generic roles of the traditional actors in the financial industry.

Table 1. Generic Roles of the Traditional Actors in the Financial Industry

Role	**Description**	**Example(s)**
Consumer	The consumer requests, among other applications, financial services for business or private use. In some cases, the consumer is a *prosumer* through simultaneously using and creating a service. This is particularly the case for crowdsourced services, where users may simultaneously provide and use the service. Consumers pay for services with money, data, or cryptocurrency.	
Savings Accounts	A savings account is a deposit account that pays interest but cannot be used directly as payment solution in the narrow sense of a medium of exchange. Sometimes customers can compare different plans among several European partner banks. The service is often completely digital and may be activated through a digital identity provider (Ho 2017).	Wells Fargo Saving Accounts
Loans	A loan is a debt provided to another entity at an interest rate, and evidenced by a promissory note, which specifies, among other things, the principal amount of money borrowed, the interest rate the lender is charging, and date of repayment. A loan entails the reallocation of the subject asset(s) for a period of time, between the lender and the borrower. Fintechs in this segment, in cooperation with a partner bank, extend credit to customers without recourse to the crowd. They offer innovative factoring solutions, such as selling claims online or offering factoring solutions without a minimum requirement. Companies with this role automate many of their processes, thereby enabling cost-effective, fast and efficient services (Dorfleitner et al. 2017).	Fannie Mae, Schwäbisch Hall, Monetise, Finanzarel, Capitalise,
Fraud Detection	Fraud detection targets to protect customer and enterprise information, assets, accounts and transactions through analysis of activities by users and other defined entities. It uses background server-based processes that examine users' and other defined entities' access and behavior patterns, and typically compares this information to a profile of what's expected. Fraud detection is not intrusive to a user unless the user's activity is suspect (Griffin 2012; Phua et al. 2010).	Featurespace, Fraugster
Risk Management	Risk Management providers use big data analyses to offer more personalized products and services, e.g. to reduce currency risk in institutional portfolios (Puschmann 2017).	Risklab, Riskopy
Stock Market	A stock market portal offers customers central access platform to all cash market services concerning listing, trading and clearing (Hull 2009).	NASDAQ, XETRA
Portfolio Management / Robo-advice	Portfolio management systems and robo-advisors provide algorithm-based and largely automated investment advice (European Supervisory Authorities 2015). These providers are generally based on passive investing and diversification strategies	Blackrock iShares ETFs, Easyfolio,

	(Sironi 2016). They consider investor's risk tolerance, the preferred duration of the investment, as well as other goals (Fein 2015). We distinguish between "automated investment advice" in which a one-off investment recommendation is given, and "automated financial portfolio management," which is characterized by ongoing recommendations (BaFin 2018). Since these two services often overlap, they are conflated in this paper.	Scalable Capital
Personal Financial Management	Personal financial management (PFM) includes Fintechs that offer private financial planning, administration, and presentation of financial data, using digital services. PFMs are typically connected to other financial institutions, using Application Programming Interfaces (APIs). In many PFM systems, a manual entry of the account data is still required (Glushko et al. 1999; Nienaber 2016).	Bean
Money Transfer	Companies that offer e-wallets are money transfer services. An e-wallet is a system in which both digital currencies (not cryptocurrencies) and payment information for various payment systems are stored. The payment information can be used during an online payment process without re-entering it. This enables very fast and user-friendly transactions (Mallat 2007). Other solutions offer peer-to-peer transactions. The money is transferred online and thus faster than via traditional financial institutions (Merritt 2010).	TransferWise, Western Union
Regulatory Authority	Regulatory authorities supervise the solvency of banks, insurers and financial service providers. Their market supervision facilitates fair and transparent market conditions and protects consumers. The tasks of regulatory authorities include to prevent money laundering, terrorist financing (Dewispelaere 2017).	Securities and Exchange Commission (SEC)

Second, we propose the generic ecosystem of the traditional financial industry, see Figure 1.

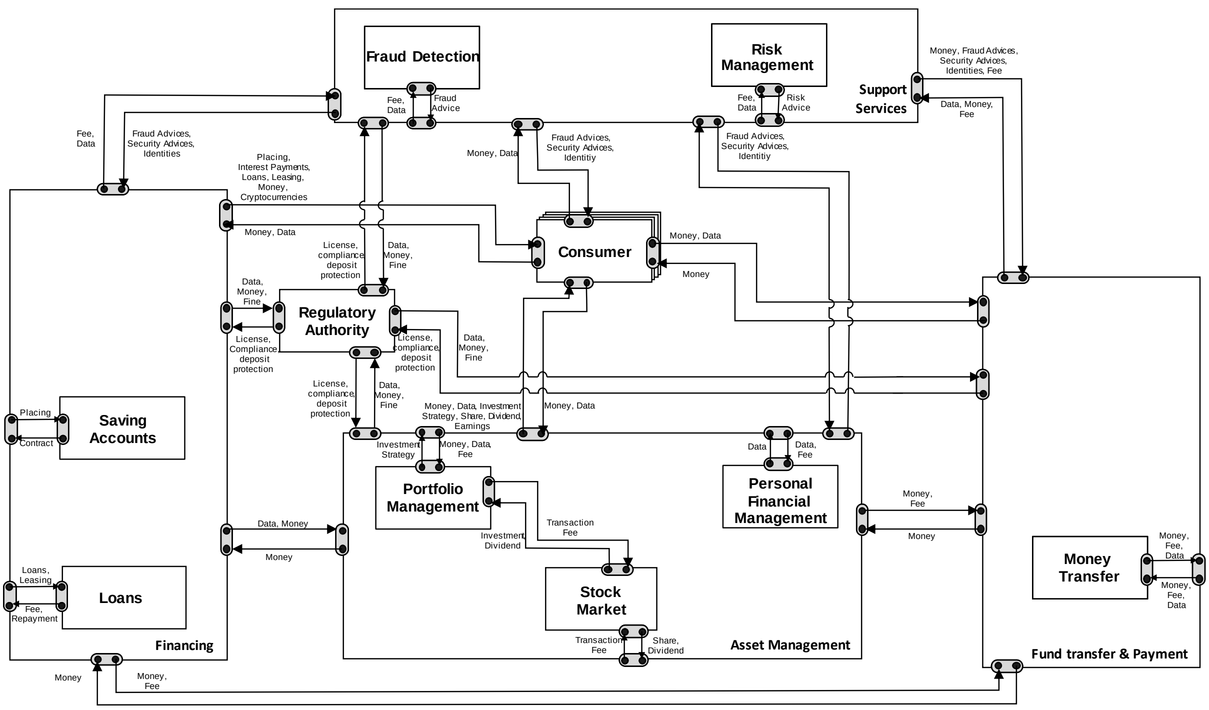

Figure 1. Generic ecosystem of the traditional financial industry

Drawing on the e^3-value method, it depicts the identified roles and the value streams between them. As our roles are on a more abstract level than business models, on role can refer to different business model types. Further, one company can act in different roles by offering different services to other players. Following Dorfleitner et al. (2017), products and services in the financial industry can be divided into three categories: financing, asset management, and payment.

Third, we show the generic roles of the actors emerging actors that are exclusively based on Fintechs in table 2. Further, following the generic ecosystem for cloud computing, we included the four roles of Böhm et al (2010): cloud infrastructure provider, cloud platform provider, cloud application provider, and cloud market platform.

Table 2. Generic Roles of the Emerging Actors due to Fintechs in the Financial Industry

Role	**Description**	**Example(s)**
Crowdfunding	Crowdfunding involves an open call for the provision of financial resources either in the form of donations or in exchange for the future product or some form of reward to support initiatives for specific purposes and achieve a common goal (Klöhn and Hornuf 2012). Crowdfunding platforms enable the matchmaking between potential complementors (Belleflamme et al. 2014).	Kickstarter, indiegogo
Crowdlending	Crowdlending describes platforms that enable customers to secure loans from the crowd. In return for the provision of the loan, lenders receive a predetermined interest (Bradford 2012).	LendingClub, Auxmoney
Cryptocurrency wallet	Cryptocurrency wallets are platforms, which are accessible from web or mobile devices and store containers for private keys, usually implemented as structured files or simple databases. Cryptocurrency wallets contain only the keys, not cryptocurrency coins. The coins are stored on the blockchain in the form of transaction-outputs. Wallets are key-chains containing pairs of private/public keys. Users sign transactions with the keys, thereby proving they own the coins (EvryLabs 2015; Mougayar 2016).	Coyno, MyEther-Wallet
Digital Identity Provider	Digital identity providers offer identity on demand services to verify individuals for financial services digitally. Besides verification, identity and access management is managed, with all identity information collected in one access point, in addition to electronic signatures and certificates. Its aim is to prove who you are, online and in person (Puschmann 2017).	Yoti, AimBrain, OneVisage
Cryptocurrency exchange	Cryptocurrency exchange provider are digital platforms, which are accessible from web or mobile devices. The purpose of an exchange platform is to transact cryptocurrency securely, through a clean, intuitive user-interface. Banks are not required to serve as intermediaries for the transaction. Core features are a built-in security center that helps the user to secure his account, backup funds and prevent unauthorized access, as well as the provision of partnerships with trusted exchanges. This facilitates buying and selling cryptocurrencies from the platform. The user pays a transaction fee each time cryptocurrency moves in or out of the wallet. The amount of the fee is based on the size of the transaction and the level of network activity at the time (EvryLabs 2015; Schlatt et al. 2016).	Coinbase, Kraken, Bitfinex

Multi Banking-Aggregator	Aggregators imply the administration and presentation of financial data using digital services. Aggregators enable customers to visualize multiple assets they have deposited with different financial institutions in one user interface. It often requires a one-off or annual fee from users. Examples for multi banking-aggregators are remote deposit capturing apps for mobile phones which allow users to optimize their payment processes by simply photographing a bill instead of typing the data into their online banking system (Glushko et al. 1999; Nienaber 2016).	Feelix, finq, Just Spent
Social Trading	Social trading is a form of investment in which consumer (or follower) observe, discuss, and copy the investment strategies or portfolios of other members of a social network (Liu et al. 2014). Individuals benefit from the collective wisdom of a large number of traders. Consumers can be charged for spreads, order costs, or percentages of the amount invested (Pentland 2013).	Wikifolio, etoro
Alternative Payment solution	"Alternative payment solutions" is an umbrella role that applies to Fintechs whose applications and services concern payment and mobile payment transactions. The term "mobile payment" generally encompasses various functionalities that are handled via mobile phones (Mallat 2007). The payments often include the use of the mobile devices, such as smart phones.	PayPal, ApplePay, AliPay
Cloud Market Platform	This role represents a marketplace where cloud services of different providers are offered. The main objective of the market platform is to bring customers and service providers together. The former can search for suitable cloud computing services while the latter can advertise its services (Böhm et al. 2010).	Univention AppCenter
Cloud Infrastructure Provider	A cloud infrastructure provider, consists of a shared pool of Internet-based configurable computing resources (e.g. servers, storage, applications and services), which can be rapidly provisioned and released with minimal management effort (Youseff et al. 2008).	Amazon Elastic Compute Cloud (EC2)
Cloud Platform Provider	The cloud platform provider offer an environment to develop, run, and test applications. From a technical perspective an operating environment, application programming interfaces (APIs), programming languages are provided. Developers are shielded from technical, infrastructure related details. Programs are executed over datacenters, not concerning developers with matters of resource allocation (Böhm et al. 2010).	SAP Cloud Platform, Microsoft Azure Cloud Platform
Cloud Application Provider	The cloud application provider hosts and operates applications, in contrast to the traditional software model, in an own or outsourced datacenter. Cloud applications are accessible for customers via the internet. The application provider has to ensure a smooth operation of the applications, including monitoring, asset/resource management and failure/problem management (Böhm et al. 2010).	Salesforce CRM, Dropbox

Third, we used the e^3-value method to develop a generic ecosystem of the digital transformation in financial industry including Fintechs. It extends the ecosystem in figure 1 by the Fintechs, we found by drawing on the identified generic roles for Fintechs.

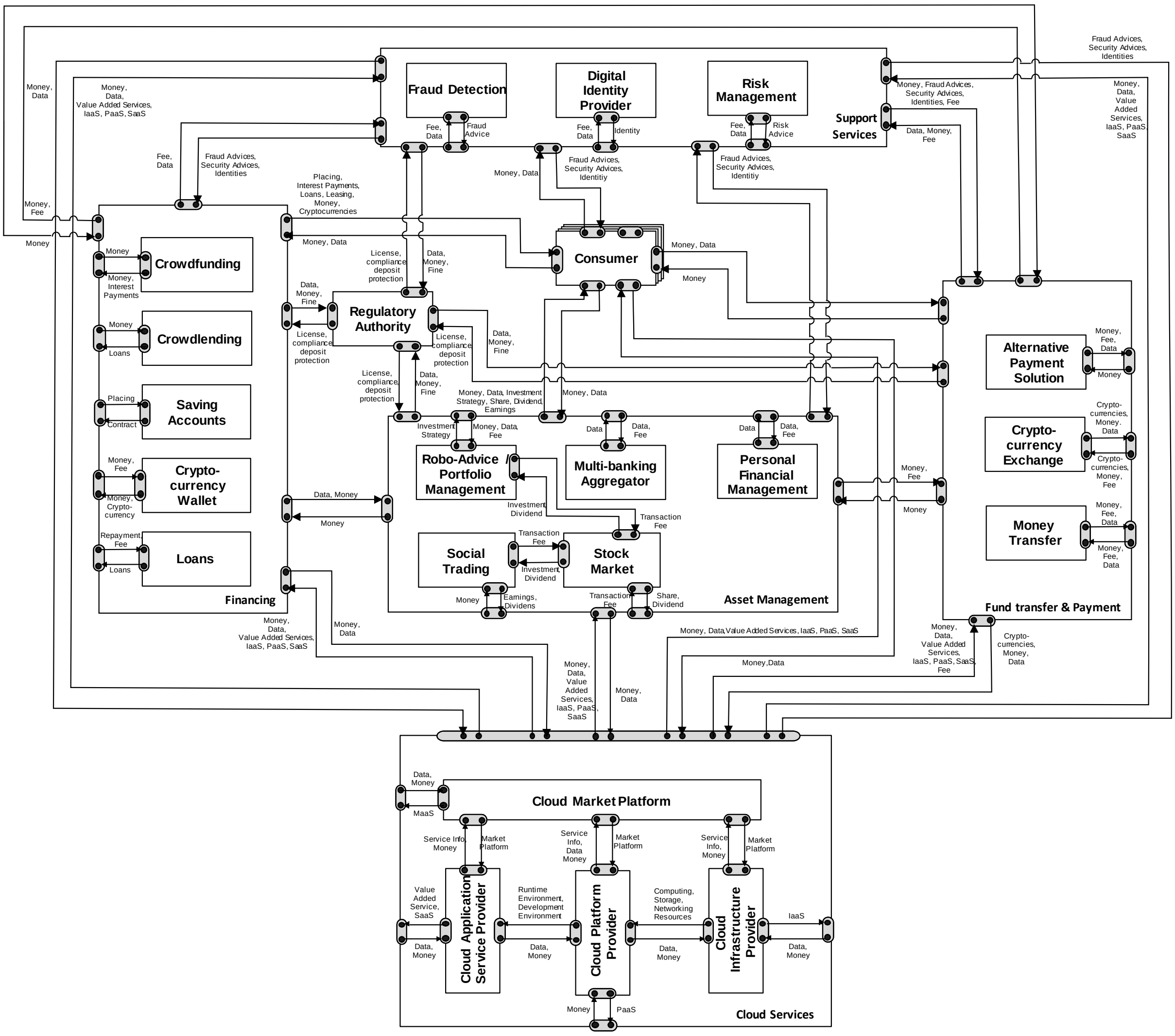

Figure 2. Generic ecosystem of the financial industry including Fintechs

Innovation Patterns of the Digital Transformation in the Financial Industry

Based on the analysis of the digital transformation in the generic ecosystem, e.g., compare figure 1 with figure 2, we identified seven innovation patterns of the digital transformation in the financial industry. These innovation patterns are inter-organizational, as they affect the relationship of at least two roles in the proposed generic ecosystem of the financial industry.

The first innovation pattern is the **elimination of intermediaries**. In this pattern, Fintechs are ruling out products or services of traditional financial institutions. One example is PayPal, where customers send or receive money without the necessity of traditional saving accounts. Another example can be found in the case of crowdlending. In the traditional financial industry, customers only had the chance to get loans from banks if they fulfilled the requirements of the bank. Crowdlending eliminates the necessity of a bank for the distribution of loans. Crowdfunding is the practice of funding a project or venture by raising many small amounts of money from a large number of people, typically online (Belleflamme et al. 2014). Crowdfunding is a form of crowdsourcing and of alternative finance. Crowdfunding has been used to fund a wide range of for-profit entrepreneurial ventures such as artistic and creative projects, medical expenses, travel, or community-oriented social entrepreneurship projects (Barnett 2015).

The second innovation pattern, **enhance transparency**, refers primarily to the generic roles in the security segment. There, the generic roles fraud detection, digital identity provider, and risk management are intended to generate transparency in payments, asset management, and financing. The pure online bank Starling Bank built a mobile platform to increase transparency. Their service “gives their customers the ability to instantly check their spending habits, apply overdraft controls directly from their app, and eliminate all fees when traveling abroad” (Biermann 2017).

Most of the emerging roles in the financial ecosystem follow the third innovation pattern **cloud-based services**. These services are built on a modular cloud infrastructure that enables quick scalability and, therefore, eliminates the boundaries of traditional financial products or services that are bound to the capacities of the financial institution. Here, the scalability is bound to the computing power of the cloud infrastructure provider (Youseff et al. 2008). However, Fintechs like TransferWise are increasingly building on established cloud infrastructure providers, such as Amazon Web Services (Biermann 2017).

Service aggregation is the fourth innovation pattern in the financial industry. There, the service provider aggregates a plethora of services and makes it accessible in one solution. The Moscow-based Advisa App with its “mobile portfolio management which covers all your banks in one app, it also converts all banking SMS and text notifications into single push inbox” (Advisa.ru 2018) is a typical example for this innovation pattern.

Fifth innovation pattern is **service integration**. This innovation pattern emerges particularly due to the roles of robo advisors or crypto currency exchanges. Robo advisors, such as Munich-based Scalable Capital, Germany’s leading online asset manager that administers more than € 600 million of customer funds, integrate a multitude of external services. There, customers may invest in various securities, ranging from government or corporate bonds, passively managed exchange traded funds (ETFs), or commodities to real estate trusts. The different securities are integrated from a multitude of service providers, such as Blackrock’s iShares ETFs or services from ING-DiBa (Scalable Capital 2018). Hence, portfolio managers, stock market, or saving accounts provide the external services.

As sixth innovation pattern of the digital transformation in the financial industry, we identified **prosumption**. In some cases a consumer simultaneously uses and creates a service, we refer to as prosumption. We borrowed this term from the software industry, e.g., when a user is sharing personal data via smartphone with Google Maps while using the aggregated real-time traffic information of other users for navigation (Riasanow et al. 2017). In the financial industry, one may participate in crowdfunding rounds, such as Lending Club. Due to the participation the network increases, which makes it easier to lend funds in the future. We observe the same innovation pattern in the case of blockchain. In case of minable cryptocurrencies, an increase in the number of nodes in the network simultaneously increases the value of the cryptocurrency, which allows the miner to participate indirectly from the value increase of the mined tokens (Tapscott and Tapscott 2016).

The seventh innovation pattern of the digital transformation in the financial industry is the creation of a **parallel universe**. This is particular the case for blockchain technology. Based on blockchain, more than 1,500 cryptocurrencies like Bitcoin, Ethereum, Ripple, IOTA, Monero, or Litecoin emerged (Coinmarketcap.com 2018). It is therefore hardly surprising that the technology, known above all as the basis of the cryptocurrency Bitcoin (Nakamoto 2008), has the potential to change entire sectors of the economy like the financial industry. Most of the products are services can be substituted or replaced through automated programmable contracts (smart contracts) that are executed without human intervention or any intermediary (Tapscott and Tapscott 2016). Historically, cryptocurrencies as a means of payment were the first application of blockchain technology. It was attributed with the potential to fundamentally transform the financial industry. For example, through the elimination of intermediaries (e.g., clearing houses in securities trading), as well as the speed of transaction, transactions can be carried out more efficiently (EvryLabs 2015). Some startups try to use the potential of the technology to improve the efficiency of existing processes; others propagate a "new economy" without intermediaries in the financial system, such as central banks, e.g., based on the cryptocurrency bitcoin. But, a large number of financial institutions already experiment with blockchain applications for securities trading, lending or contracts (Schlatt et al. 2016). For example, in the case of securities trading, a limit order could be executed automatically upon reaching the limit and immediately the securities exchanged for money through the blockchain. Currently, the transfer of securities takes between two and five days (Havard Business Review 2017).

Discussion

Based on this work five theoretical contributions arise. First, based on our analysis of 792 companies, we contribute to literature on Fintechs, as existing studies solely focus on the business model of Fintechs or the transformation of the business model of established financial institutions (Puschmann 2017). Second, by developing the generic, inter-organizational, e^3-value model of the financial industry including Fintechs, we provide a macro-economic overview of the current and ongoing transformation of the financial industry. We identified 22 generic roles for traditional and emerging players in the financial industry. Third, this study shows that digital transformation is more than an intra-organizational phenomenon as it affects the whole ecosystem. Thus, we extend Fitzgerald et al. (2013), who understand digital transformation primarily as intra-organizational phenomenon. Fourth, based on the comparison of the traditional actors and the emerging Fintechs, we identified seven inter-organizational innovation patters. These patterns that drive the digital transformation in the financial industry through Fintechs were particularly missing (Puschmann 2017). Fifth, we confirm the generic cloud computing ecosystem of Böhm et al. (2010) by showing that most of the innovation in the financial industry is driven by cloud-based services.

Six practical contributions arise. First, decision makers, e.g., from traditional financial institutions can apply the model to identify potential threats to their current market position, potential opportunities to adapt to trends, or shifts in customer needs. Second, we show that additional layers of services emerge, such as the recombination of financial services in the service integrator role, or the intelligent combination of existing services to generate a new service in the service aggregator role. The roles show, typical for digital transformation, that the way value is delivered to the customer is changing (Piccinini et al. 2015). Third, the inter-organizational innovation patterns differ in magnitude and effect. The innovation pattern *prosumption* shows that this is also true for the financial industry, as consumers are co-creating value with financial service providers. Fourth, blockchain as disruptive technology may be understood as the most threatening digital technology for traditional financial institutions. In all categories of financial products and services – payment, asset management, and financing – we found blockchain-related Fintechs. Fifth, from an ecosystem perspective, blockchain has the potential to substitute many of the existing products and services, e.g. in the case of payments or financing. However, plenty of the traditional financial institutions and regulatory authorities are increasingly experimenting with this innovative technology. Sixth, we see that blockchain is not necessarily a *parallel universe* in this context. Nevertheless, many products and services are under strict regulation due to governmental authorities. Therefore, it remains uncertain how large the impact of blockchain on traditional financial institutions is.

Limitations and Future Research

Our study is subject to limitations. First, the model is limited by the information provided by the Crunchbase database and our coding of the generic roles. Second, drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles or annual reports. However, we established inter-coder reliability among two independent coders with an Alpha of 0.85. Third, we conducted four semi-structured interviews with experts from the financial industry or Fintech founders to validate the proposed generic ecosystem and the identified innovation patterns.

Following Puschmann (2017), we suggest future research to detect intra-organizational, micro-economic innovation patterns. Second, we would be curious to examine if the identified innovation patters are observable in further industries, such as the automotive industry where the digital transformation is less mature. Third, many Fintechs are offering their services on digital platforms (Zavolokina et al. 2016), however, the success factors for digital platforms in the digital transformation process of the financial industry remain uncovered. Fourth, we invite scholars – not only due to the novelty of the technology – to examine the transformational impact of blockchain in qualitative and quantitative nature.

Conclusion

This paper presents the generic ecosystem for the financial industry based on 22 generic roles of traditional financial institutions and Fintechs, we identified by a structured content analysis of the Crunchbase data of 792 financial organizations. Digital transformation creates new roles for value creation in the financial industry and thus affects the whole ecosystem. The ecosystem shows that robo advisors, cryptocurrencies, or alternative payment providers penetrate the market and therefore threaten the value creation of traditional financial institutions. To discuss this, we derived seven inter-organizational patterns of the digital transformation in the financial industry, such as the elimination of intermediaries or the creation of a parallel universe. Our work contributes to Fintech literature and to the growing body of knowledge on digital transformation. We encourage traditional financial institutions to actively experiment with innovative technologies or to collaborate with emerging players in the market, just as Jack Ma did by introducing Alipay.

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Appendix K: Publication P5

The Generic Blockchain Ecosystem and its Strategic Implications

Completed Research

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Abstract

The emergence of blockchain technology, most known due to the hype around Bitcoin, has the potential to transform entire industries, such as banking, insurance, or the Internet of Things (IoT). Yet, parallel ecosystems like cryptocurrencies that substitute products and services of traditional financial institutions emerged. However, literature does not provide a structured overview of the blockchain ecosystem. By analyzing 479 blockchain companies reported in the Crunchbase database, this paper visualizes the current blockchain ecosystem using the e^3-value method consisting of eleven generic roles. Moreover, we identify three strategic implications where blockchain is fundamentally different from prior approaches: governance, trust, and openness. Scholars can apply the generic ecosystem for future research, while practitioners can use the model to identify possible disruptive actors or potential business opportunities.

Keywords

Blockchain, digital transformation, ecosystem, value network, e^3-value model.

Introduction

Blockchain, currently at the top of the Gartner hype cycle (Cearley et al. 2017), follows the blueprint process for a technology hype. Blockchain is known above all as the basis of the cryptocurrency Bitcoin (Nakamoto 2008). As of February 2018, more than 1,500 cryptocurrencies have a market capitalization in excess of $ 400 billion, with Bitcoin accounting for more than $ 150 billion with a more than eightfold rise over the last year (Coinmarketcap.com 2018). Some countries already accept cryptocurrencies as a means of payment. Hence, it is hardly surprising that many believe the technology has the potential to disrupt entire branches of the economy (Tapscott and Tapscott 2016).

While some understand it as technological innovation, some argue blockchain to be the technological basis for a new economy (Swan 2015). Drawing on the recent hype, Vitalik Buterin, founder of Ethereum, states, "whereas most technologies tend to automate workers on the periphery doing menial tasks, blockchains automate away the center. Instead of putting the taxi driver out of a job, blockchain puts Uber out of a job and lets the taxi drivers work with the consumer directly" (Tapscott and Tapscott 2016). Traditional banks, insurances, or the interaction of machines through the Internet of Things (IoT) can be replaced or automated through programmable contracts that are executed without human intervention or middleman, so-called smart contracts (Swan 2015; Tapscott and Tapscott 2016).

The case of cryptocurrency shows that innovative technology is continuously penetrating or substituting the business model of established organizations. One reason is that the market for digital technologies, such as blockchain is easily accessible and constantly innovating. Organizations that have the capacity to combine and deploy digital technologies create new business models that fundamentally transform the way business is done (Lucas et al. 2013). Yet, existing studies solely focus on the business model of organizations or the transformation of the business model of established financial institutions (Puschmann 2017). To visualize the blockchain ecosystem, blockchain landscapes were developed (e.g., Mougayar 2015). However, none of the landscapes presented their coding process. Consequently, literature does not provide a structured inter-organizational overview of the emerging blockchain ecosystem (Puschmann 2017).

Towards this goal, and to trigger further research, this paper aims to answer the following research questions: *Which generic roles and value exchanges exist in the blockchain ecosystem? How does the generic blockchain ecosystem look like?* Therefore, we first use the e3-value method to model the blockchain ecosystem based on eleven generic roles we derived from analyzing 479 companies. We extracted the company data from the Crunchbase database, a comprehensive, socially curated database for established companies and startups.

The paper is organized as follows. First, we briefly present related work on blockchain. Second, we describe our research methodology. As third, we identify eleven generic roles and present the blockchain ecosystem. Next, we discuss the results, strategic implications and future research. The final section is the conclusion.

Related Work

Due to the early stage of development no general definition of blockchain technology has been established (Swan 2015). Condos et al. (2016) define a blockchain as an electronic ledger for digital records, events, or transactions managed by the participants of a distributed computer network. Previously, most trade repositories, e.g. for example, for lending or sale of securities, were not publicly available. The opening of transaction registers for all interested parties is an important innovation of the blockchain technology, so that all previous transactions can be viewed in the system (Harvard Business Review 2017). However, this does not necessarily indicate who carried out the transactions, e.g. in the case of Bitcoin, the users remain anonymous or pseudo-anonymous, since only the identification tag of the digital wallets is required for a transaction.

Furthermore, a blockchain is a distributed system without a central control point or authority (Glaser and Bezzenberger 2015; Tapscott and Tapscott 2016). Central control points or authorities are not necessary in a blockchain because the distributed network verifies the transactions being performed. This is considered a key innovation of the blockchain technology (Harvard Business Review 2017). If a transaction between two parties is to be made in the network, the nodes in the distributed network compete to solve a mathematical puzzle and also store that transaction in the trade repository (Nakamoto 2008). A transaction can then no longer be deleted from the trade repository or ever returned. The elimination of a central instance in the distributed network implies a radical shift to direct transactions between non-intermediaries or intermediary services (Tapscott and Tapscott 2016). The data structure of a blockchain corresponds to a database that groups entries into blocks that are linked in chronological order via a cryptographic signature (Walport 2015). The blocks contain a copy of the last transactions since the last block was added (Bogart and Rice 2015). The management system of a blockchain corresponds to a distributed consensus system. Since a blockchain has no central authority, there must always be consensus among the actors in the system about the valid state of the blockchain. For the verification of the blockchain different consensus mechanisms can be used, which are based on peer-to-peer mechanisms and encryption (Glaser and Bezzenberger 2015). Blockchain was originally created as an approach to cryptographic-based payment transactions to provide an alternative mechanism of trust between two transaction parties: Bitcoin (Nakamoto 2008). In classical transactions, the parties have to rely on a trusted third party, such as a bank. In the case of Bitcoin, the necessary trust is now completely substituted by the blockchain, as it allows for a collective trade repository operated by many decentralized registers (Nakamoto 2008). A consensus mechanism based on mathematical functions (in the case of bitcoin: hash functions) coordinates the network nodes and can validate and approve or reject the status of a transaction (Nakamoto 2008).

Frederik Voss, Vice President of Nasdaq, states “Blockchain is a technology that only works at its full potential in a network. You need to have a complete ecosystem on the blockchain for it to offer maximum value to all its participants” (Nasdaq 2016). However, literature does not provide a structured inter-organizational overview of the emerging blockchain ecosystem (Puschmann 2017). To visualize the blockchain ecosystem, some blockchain landscapes were developed for practitioners (e.g., Mougayar 2015). Mougayar (2015) clustered 268 companies that are involved in crypto-tech computing, decentralized services, or cryptocurrencies into four major categories with over 20 sub-categories. However, the category development and the coding process is not published. Thus, we target to following a structured approach to identify the generic roles in the blockchain ecosystem and the value streams between them.

Research Approach

We conduct a three-step research approach based on Riasanow et al. (2017). To get an inter-organizational overview, we develop the generic ecosystem of the blockchain industry. We first identify the roles of the actors in the industry and the values streams between them. Second, we present the generic ecosystem based on the prior identified roles and value streams. Third, we validate the model with five semi-structured expert interviews.

For the first step, we decided to use Crunchbase data[1] in order to derive the roles in the ecosystem. Crunchbase possesses a comprehensive database for existing companies and startups (Marra et al. 2015) including a description of organizations' value propositions. Crunchbase contains startups at all funding stages, which enables researchers to capture new business model innovations in emerging markets (Marra et al. 2015; Perotti and Yu 2015). The information reported in the database consists of the company size class, its location, its primary role (firms, group, investor), its status (operating, acquired, IPO, or closed), its founding date, and the dates on which the record was created and updated.

We extracted all organizations listed on December 11, 2017. To collect all organizations of the blockchain industry, we filtered the Crunchbase category list by the search term "blockchain", which led to a sample size of 500 funded companies. This led us to capture established and emerging organizations, which are representative for the current blockchain industry. We excluded six companies, which have been "closed" or "acquired" so far, for example KapeIQ, a Blockchain-based intelligent fraud detection service. Furthermore, we had to exclude 15 organizations from our coding, as the listed website did not exist anymore, e.g., DigitalMR, a company that uses artificial intelligence for consumer insights. Hence, we shortened the data set by 21 companies. With the remaining 479 organizations we conducted in a first step a structured content analysis, including an inductive category development based on Mayring (2010). With this method, we identified a set of nine generic roles.

We established inter-coder reliability to ensure consistent coding. Two experienced raters independently coded the 479 organizations. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached a consensus. For example, we coded Axoni as "blockchain infrastructure provider" based on its description *"New York-based provider of distributed-ledger technology for financial firms"*. We used the same approach for the identification of the value streams, but combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles or annual reports. After both raters completed the coding, we used Krippendorff's (2004) Alpha to determine inter-coder reliability. The results indicated an Alpha of 0.87, reflecting an acceptable inter-coder reliability (Krippendorff 2004).

In the second step, we use the e^3-value method to visualize the ecosystem of the blockchain industry based on the identified generic roles and the value streams between the generic roles. The e^3-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective. It is used to evaluate economic sustainability of ecosystem by modelling the exchange of things of economic value between actors (Gordijn and Akkermans 2003; Riasanow et al. 2017).

In the third step, we conducted five interviews with experts from the financial industry to validate the generic ecosystem. We used a semi-structured technique (Myers and Newman 2007) to interview a COO and co-founder of blockchain startup, a senior developer of a blockchain startup, two senior managers working in the blockchain lab of one of the big four accounting firms, and an independent blockchain consultant with a major in IS applications. The interviewees are either working in a leading strategic position or information technology related function, who have privileged access to information and knowledge on the subject (Bogner et al. 2009). This allowed us to draw from a broad knowledge and different insights from various companies. We conducted the interviews between December and March 2018. The interviews were recorded and transcribed afterwards took 48 minutes on average. To validate

[1] The Crunchbase database is accessible via www.crunchbase.com. We used a premium account for data collection.

the generic roles and value streams, we discussed the roles and value streams of the proposed generic ecosystem with the experts. This step yielded another two generic roles: the blockchain community and the token-based community platform provider, ultimately leading to eleven generic roles.

Development of the Generic Blockchain Ecosystem

To model the generic blockchain ecosystem, we follow the approach of Riasanow et al. (2017). Hence, we first derive the roles of the actors in the ecosystem by drawing on data from 479 companies derived from the Crunchbase database. Actors, which offer similar services and products to the consumer are abstracted to one role based on the structured content analysis following Mayring (2010). One company can act in different roles by offering different services to other players. In table 1, we first present the generic roles of the blockchain ecosystem.

Role	**Description**	**Example(s)**
Consumer	The consumer requests on- and off-chain and hybrid applications as well as cloud mining services. In some contexts, a consumer is a *Prosumer*, by simultaneously using and creating a service, as it is the case when running an own node or creating an own token on the Ethereum blockchain. When participating in a token-based community platform, the consumer is a *Participant*, contributing knowledge and content with the intention of being rewarded by the auction mechanism. Since in many cases a consumer participates through investing in a blockchain or blockchain application, he can also be called an *Investor*. Besides that, consumers benefit from the analyses and statistics offered by ancillary service providers and is part of the public dialogue with blockchain alliances. A consumer pays for value adding activities with money or cryptocurrency.	
Blockchain Infrastructure Provider	Blockchain infrastructure provider supply users and developers with a set of infrastructure capabilities including the conceptual framework, the underlying decentralized ledger technology (DLT) and cryptocurrencies (Mougayar 2016; Swan 2015). Corresponding information as permission rules, block sizes etc. are defined here. They provide the foundational elements for any further blockchain service development or delivery utilized by platform or application providers. Further capabilities of blockchains are the P2P network, consensus algorithms, a virtual machine, historical records, and state balances (Mougayar 2016).	Ethereum, Bitcoin, BigChainDB, MultiChain, Corda, Hyperledger
Blockchain Platform Provider	Platform providers offer the technical basis in the form of software and services that are on top of the infrastructure. They build an environment to develop, run and test applications, and extend the functionality of infrastructure elements (Mougayar 2016). This includes smart contract languages and scripts, testing tools, sandbox environments, integrated development environments and rapid application development frameworks as well as other software capabilities on higher stack levels than blockchain protocols (Tapscott and Tapscott 2016). Through providing smart contracts with implemented token settings, voting systems as well as auction and reward mechanisms, blockchain platform providers offer the technical basis for token-based community platforms. Cloud-based development environments are offered as Blockchain as a Service (BaaS). Blockchain platform providers allocate APIs, including a transaction scripting language, a P2P nodes communication API, and a client API to check transactions on the network (Mougayar	Elemetric, Monax, Multichain, Setl.io, Etherparty, Smart Contract Solutions, ShapeShift, ChromaWay, RiddleAndCode, Neuroware,io, Tierion, BlockApps, IBM BlueMix

	2016). The software offered by technical platform provider is compatible with one or more types of blockchains.	
Blockchain Application Provider	Application providers offer applications that are linked to on-chain and off-chain services and technically differ as following. On-chain services as identity management, voting, tokenization, messaging, assets linkages and naming registration are provided by decentralized applications, called dapps (Mougayar 2016). The back-end of dapps is executed on blockchain nodes, whereas the front-end either runs on a third-party-server, a user owned software or a decentralized storage owner such as Inter-Planetary File Systems (IPFS). On the other hand, services such as reputation, storage, exchange services and payments gateways belong to off-chain services, where the value is moved outside of the blockchain. The back-end of such traditional applications is not executed on a blockchain but rather on cloud computing services like Amazon Web Services. Besides offering dapps and off-chain applications, application provider also mix up applications with an existing web application and create a so-called hybrid blockchain application. By taking advantages of the decentralized character of blockchain, those providers create P2P marketplaces for users by developing appropriate applications (Mougayar 2016). Areas of application are diverse and can possibly be found in every existing industry. A large proportion of studied application providers are wallet providers. A wallet stores the access to currency by saving the private keys that demonstrate ownership of a public key, which in turn can be used to access currency addresses. Currently, three distinct categories of wallets are available for storing currency: software-, hardware- or paper-based wallets (Dale 2018). The applications are hosted and operated by the application provider and are built on top of technical platforms and the appropriate blockchain infrastructure (Mougayar 2016). Thus, applications represent the end-user products, which are accessible via the internet. One of the main duties of the application provider is to ensure a smooth operation of the application through constant monitoring as well as resource and problem management. Accordingly, the service provider must be aware of the state of his system at any time (Böhm et al. 2010).	Databroker DAO, BlockScience, Storj.io, Power Ledger, Crowdz, Propy, OwlTing, Binded, FunFair, Scorum, TAO Network
Token-Based Community Platform Provider	A token-based community platform is built on internal token distribution reward systems for establishing and evaluating content (Steem 2017). It serves a dual purpose of being a digital token processing systems and a platform having a specific purpose, such as Steemit, a social media platform. Actors on such platforms do not compete over raw computing power, as miners do, but over incentives that in turn add value to the network. An example is Numerai, which proposes Numeraire, a cryptographic token executed on the Ethereum blockchain that can be used in an auction mechanism. As it is the purpose of token-systems, data scientists participating in Numerai projects reveal their knowledge of their models' abilities to generalize to new, unseen data for the purpose of maximizing winnings through the auction mechanism (Craib et al. 2017). Such platforms propose tokens appropriate to the blockchain they are executed on. In the case of Steemit, they are generated at a fixed rate of one block every three seconds. These tokens are represented as smart contracts, which in turn dictate the maximum number of coins mined the rules for distributing tokens and the initiation of sending and destroying tokens. In many cases, they are	Numerai, Steemit

	based on Ethereum's ERC-20 tokens, accompanied by certain built-in "Proof-of-Brain" properties, which is the token rewards algorithm that aligns incentives between application owners and community members. The reward pool is a pool of tokens dedicated to incentivizing content creation. It then distributes these tokens to various participants based on the defined rules.	
Miner / Mining Pool	Miners execute the decentralized computational process of confirming transactions trustfully in public blockchains (BitcoinMining 2018). Thus, they are responsible for adding transaction records to the ledger of past transactions. Miners use special soft- and hardware to solve the given mathematical problem and are issued with the appropriate cryptocurrency of the blockchain they did the mining for as a reward. Since in the case of Bitcoin the difficulty for mining increased, miners started to pool their resources together and share their hashing power while splitting the reward equally according to the amount of shares they contributed to solving a block (Blockchain.info 2018). This collaboration is called *Mining Pool*. Nevertheless, whether miners are involved in a blockchain or not depends on the type of blockchain that an application or platform is executed on and the appropriate trust and permission layer and consensus algorithm.	Antpool, Slush Pool, BTC.top, Bitfury
Mining Solution and Equipment Provider	Mining solution providers offer hardware and software that is required for executing the process of mining. This includes equipment sales, maintenance and repair services. Since normal processors or graphics cards do not withstand the required computing power anymore, miners use special hardware, which computes hashes with application-specific integrated circuits (ASICs) and appears to be noticeably faster (Schulz 2017; Swan 2015). Besides distributing mining hardware, they provide cloud-mining solutions for private individuals who are not interested in physically hosting machines. This service is called Mining as a Service (MaaS). Another service offered by mining solution providers is consulting in setting up and operating mining farms.	Giga Watt, Canaan, MinersGate Technology, Riot Blockchain, Bitmain Technologies Ltd., Genesis Mining
Blockchain Ancillary Service Provider	Provider of ancillary services for blockchain technology undertake a wide variety of tasks. This is for example the provision of assistance before, during and after the launch of a crowd sale, including securing funding and providing acceleration services such as connecting with experts to co-develop white papers or to comply with global regulations and legal and business administration. Ancillary service providers offer monitoring services with appropriate statistics and analysis. Moreover, they publish the latest blockchain and cryptocurrency news and developments, inform and educate people interested in blockchain and offer workshops and trainings for developers and managers (Mougayar 2015).	Sweetbridge, SettleMint Blockchain Academy, Byte Academy, BTC Media
Blockchain Alliances	Blockchain alliances are founded as associations for boosting the public dialogue between the different participants of the blockchain ecosystem. Those alliances can be collaborations between industry experts to explore the potential of DLT within their industry for the benefit of all stakeholders in the value chain. They try to fulfill the need for education and certification of industry professionals, as well as to solve legal issues, set up standards and establish a regulatory framework. Alliances bridge the gap between blockchain-focused organizations and national and international governmental agencies and regulatory authorities (WallstreetBlockchainAlliance 2017).	WSBA, Enterprise Ethereum Alliance, Hyperledger, R3, B3i, EWF

Blockchain Community	The blockchain community is a strong and crucial force in driving the blockchain technology further. Consisting of individuals with a great affinity with blockchain (e.g., open source developers or blockchain and crypto professionals), the community discusses whether a new currency, application, crowd sale, etc. is accepted or not. This step is crucial for the breakthrough and establishment on the general market.	Reddit, Slack, Blockchain Community IEEE, CryptoFriends, Commonlounge
Blockchain Consulting Services	When a company decides to leverage blockchain technology within their organization, they often request consulting companies for their expertise in blockchain-centric software, customized blockchain development, or prototyping. Additional services might a proof of concept, a cost benefit and risk evaluation to evaluate the business case, as well as the assessment of security issues regarding the implementation of such a technology. Particularly service providers might make use of consulting services. Infrastructure and mining service provider demand consulting services to solve technical and security problems, to evaluate service offerings.	DigitalX, BlockGemini Technology, e-BIT Inc., Blockchain Partners, Deloitte Consulting, Datarella GmbH

Table 1. Generic Roles of the Blockchain Ecosystem

Second, we used the e3-value method to propose a generic blockchain ecosystem, see Figure 1. It depicts the identified roles and the value streams between them. As our roles are on a more abstract level than business models, on role can refer to different business model types. Further, one company can act in different roles by offering different services to other players.

Drawing on the developed generic ecosystem, we identify three strategic implications in which emerging blockchain companies fundamentally differ from established companies: governance, trust, and openness.

Governance can be characterised by the allocation of decision rights, control and ownership (Tiwana 2010). In contrast, blockchain allows the creation of decentralised marketplaces that can be governed by a community. This empowers users to directly influence the direction of a project. For instance, the project District0x offers a creation platform that allows its users to design and set up new marketplaces, called districts. As users stake tokens to a project, they gain voting rights. These rights can not only be used to participate in the change of the design and the functionality of a district, but also to specify how the generated revenue of a marketplace is used or distributed (Lestan et al. 2017).

Trust lays the foundation of the willingness of users to participate in and execute transactions (Riasanow et al. 2015). With blockchain a single central authority as trust mediator becomes unnecessary (Beck et al. 2016; Tapscott and Tapscott 2016). As example, Provenance enables companies to track the paths of products within the supply chain, allowing verification of ownership, attributes and origin. Thereby, blockchain enables product journeys to be more transparent (Provenance 2018). An integration into the marketplace would allow consumers to avoid plagiarism and parallel imports. Through the integration of external reputation platforms, a global web of trust could be built that is founded on immutable and verified data stored on blockchains. Furthermore, participants with no available reputation data can improve their reputation score by staking tokens into their accounts that serve as additional security deposits in the case of a conflict (Liu and Fraser 2018).

Openness is associated with the degree of accessibility, and it can even involve relinquishing control over a platform (Boudreau 2010). In the context of blockchain organizations, openness is of particular importance, as many of these projects are open source. Today, many organizations grant access to their platforms by providing boundary resources in the form of documented APIs (Eaton et al. 2015). Blockchain goes beyond that. For example, Syscoin makes its core and API-server available as open-source (Wasyluk 2018). As a result, an open ecosystem is established that allows developers to create their own frontend applications or even participate in the core development.

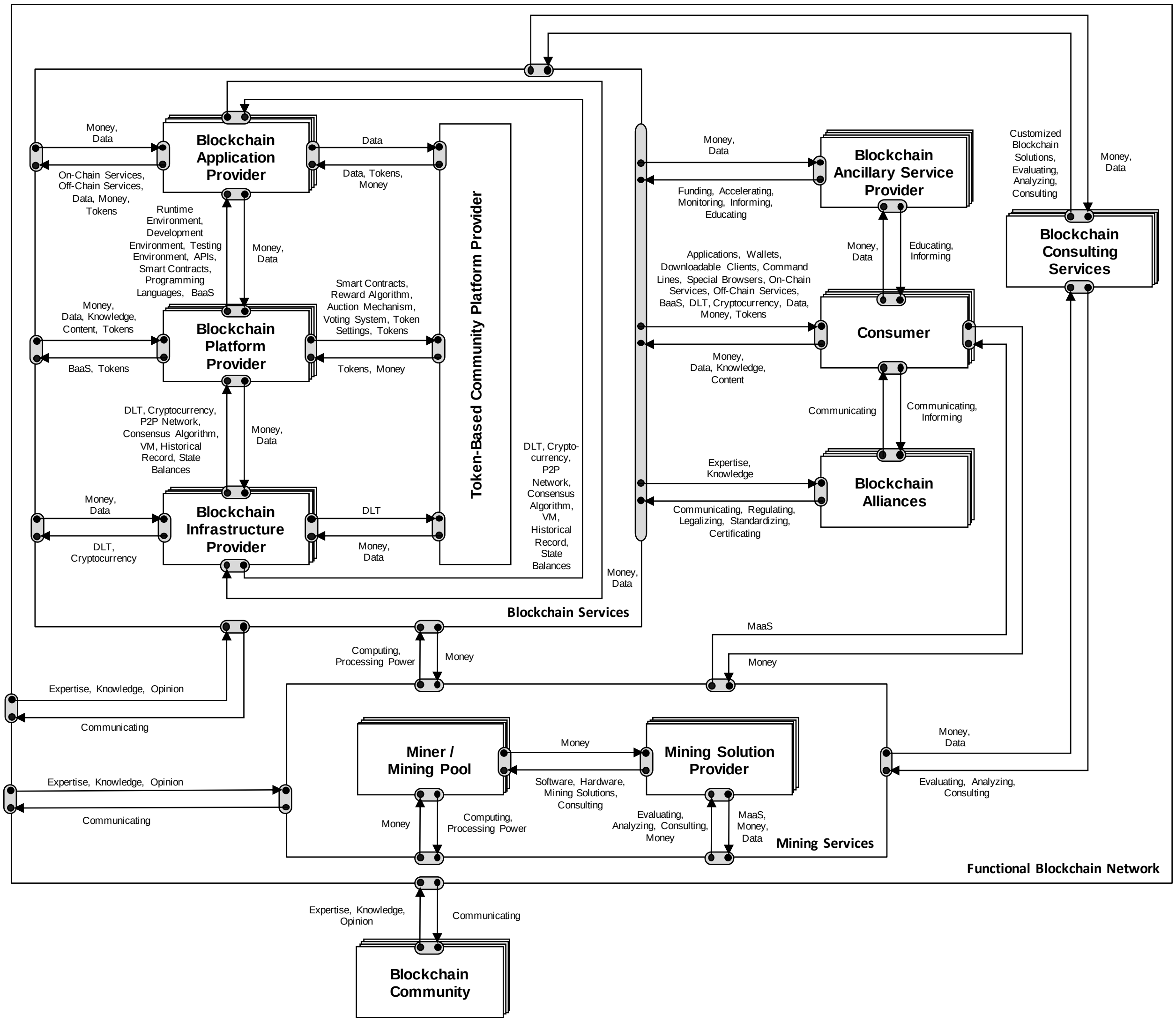

Figure 1. Generic Blockchain Ecosystem

Discussion

The model is limited by the information provided by the Crunchbase database and our coding of the generic roles. However, we reached an Alpha of 0.87, reflecting an acceptable inter-coder reliability for the coding of the generic roles. Drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles or annual reports. Further, we conducted five semi-structured interviews with blockchain experts to validate the proposed generic ecosystem.

Scholars can apply the developed generic ecosystem for further research, particularly for understanding digital transformation in the financial industry. We contribute to literature on blockchain, as existing studies solely focus on the transformation of the business model (Puschmann 2017). By developing the generic, inter-organizational, e^3-value model of the blockchain ecosystem, we provide a macro-economic overview of an ecosystem that seeks to substitute the financial industry. There, we identified eleven generic roles. Based on the ecosystem, we identified three strategic implications in which blockchain fundamentally differs from prior approaches: governance, trust, and openness. On an ecosystem perspective, blockchain has the potential to substitute many of the existing products and services, e.g. in the case of payments or financing. However, plenty of the traditional financial institutions and regulatory authorities are increasingly experimenting with this innovative technology.

We suggest future research to determine the impact of blockchain on other ecosystems, such as the IoT. Blockchain could contribute to the interoperability of heterogeneous services and objects, which can be achieved through common standards and a platform (Mattila 2016). The unique identification of things or objects is of central relevance to the IoT. Blockchain-based identity management for items, services, and their transactions could break the concept.

Practitioners, e.g., from financial institutions can apply the model to identify potential threats to their current market position and potential opportunities to adapt to trends or shifts in consumer needs. According to Böhm et al. (2010) it is not necessarily important to know, which generic role might take the largest share within the ecosystem, but to develop a unique value proposition based on core competencies.

Conclusion

This paper presents the generic blockchain ecosystem, we identified by a structured content analysis of 479 blockchain organizations. The generic e^3-value model shows the complexity of the blockchain ecosystem, consisting of eleven generic roles. Among them are miners, community roles and various application providers. However, many of the services are based on the cloud computing ecosystem (Böhm et al. 2010). To discuss three strategic implications in which blockchain differs fundamentally from prior organizations: governance, trust, and openness. Moreover, we encourage organizations to actively experiment with innovative technologies or to collaborate with emerging players in the blockchain ecosystem.

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Appendix L: Publication P6

The Generic InsurTech Ecosystem and its Strategic Implications for the Digital Transformation of the Insurance Industry

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Abstract: The emergence of insurance technology companies (InsurTechs) through the easy access of digital technologies is transforming the entire insurance industry and heralding a new era of business models. With digital technologies such as big data analytics, robo advisors, and mobile distribution models or blockchain, InsurTechs are challenging the prevailing position of traditional insurance institutions. However, the literature does not provide a structured overview of digital transformation (DT) in the insurance industry, including strategic implications and inter-organizational innovation patterns. By analyzing 956 InsurTechs, this paper visualizes the 34 generic roles and value streams within the insurance ecosystem using the e3-value method. Moreover, through semi-structured interviews with industry experts, we identify and discuss five strategic implications following seven inter-organizational innovation patterns of DT in the insurance industry. We contribute to the literature by examining DT in the insurance industry from an inter-organizational perspective. Practitioners may apply the model to position themselves in a digital insurance ecosystem and to identify disruptive actors or potential business opportunities.

Keywords: Ecosystem, Insurance Industry, InsurTech, Digital Transformation, Innovation Pattern, e3-value model

1 Motivation

Disruptive technologies are the engine of digital transformation (DT). They transform industries, society, and governments by introducing the digital lifestyle and eliminating well-established business models [Bh13, Ri19]. Recent developments and adaptations, such as mobile payments, robo advisors, peer-to-peer, and blockchain [Os18], are some of the most promising drivers in the insurance industry.

The combination of new and innovative technologies and the development of new digital platforms fundamentally change the value creation of existing companies and how business is executed [LG09, Ti15]. The transformative impact on pre-digital products, especially in the insurance industry, has remained unnoticed in the information systems

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(IS) literature for years [YHL10]. However, companies are forced to overthink and redefine their business models to stay competitive against recently founded startups that are more agile given their IT-enabled digital business models [Lu13, Ve94]. In this context, the term InsurTech is often used for startup companies that deliver innovative or disruptive solutions to the market [Pu17, BC95]. Established insurance companies and insurance brokers are forced to compete with a rising number of new market entrants that provide customer-centric solutions for their customers and substantially engage in the current ecosystem [MHB15]. The industry is facing new trends, such as pay on demand insurance, data science for preventive health care, and insurance compare platforms, and new market entrants in this changing environment are shaping DT in the industry [Lu13, Ri19].

However, the existing literature does not provide an inter-organizational and strategic overview of the current and ongoing industry transformation, particularly through InsurTechs [Pu17]. Further, strategic implications for the industry through InsurTechs are particularly missing [Pu17]. Therefore, this paper aims to answer the following overall research question: What is the generic ecosystem of the DT in the insurance industry and which strategic implications can be observed?

We follow the research approach of Riasanow et al. [Ri18a] to identify 34 generic roles derived from analyzing 956 companies. We extracted company data from the Crunchbase database and used the e3-value method to develop a generic ecosystem of the DT in the insurance industry, including InsurTechs based on these 34 roles. Following Riasanow [Ri18a], we discuss five strategic implications following seven inter-organizational innovation patterns of the DT in the insurance industry, such as the aggregation of intermediaries.

The paper is organized as follows. First, based on the literature on DT, we analyze the related background on the DT in the insurance industry through InsurTechs. Second, we describe our methodology. Third, the 34 generic roles and the generic ecosystem are presented. Further, we provide a framework for five strategic implications following seven innovation patterns of DT in the insurance industry. Next, we discuss the results, implications, and future research. The final section presents the conclusion.

2 Digital Transformation in the Insurance Industry and the Role of InsurTechs

DT is currently one of those topics that practitioners and researchers can hardly avoid when talking about IS or developing business strategies. DT is an industry level phenomenon (see, for example, da Silva Freitas et al. [Si16], Downes and Nunes [DN13]) that changes the way organizations compete within and across industries. Therefore, DT "affect large parts of companies and even go beyond their borders, by impacting products, business processes, sales channels, and supply chains" [MHB15].

Following Horlacher et al. [Ho16], inherent to DT is the development of technology-enabled business models that are new to the organization that has initiated the transformation. This development is particularly relevant for the insurance industry as a number of emerging technology-enabled players penetrate the market [Pu17]. These organizations, the so-called InsurTechs, use innovative digital technology to create novel insurance services or products that either improve existing processes or create new business models, such as robo advisors [ZDS16]. According to Zeier et al. [Ze18], the central advantages of InsurTechs are cost efficiency, flexibility, speed, and scalability. Changes in the role of IT, customer behavior, ecosystems, and regulations are the main drivers for the success of InsurTechs [Pu17, ZDS16]. Moreover, DT means changing the manner in which value is delivered to customers , which is also observable in the insurance industry. Hence, InsurTechs revolutionize the insurance industry in several ways. They may improve established processes, products, or services, create competition through innovative products or services, or eventually disrupt established business models [Pu17, ZDS16]. To be successful, the evolution of a company's business model needs to be complemented by a co-evolution on the customer side [Ri19]. In particular, Haffke et al. [HKB16] emphasized the effects on "sales and communication channels, which provide novel ways to interact and engage with customers" and a "firm's offerings (products and services)" that replace or augment physical offerings. Recognizing this interdependence, researchers have analyzed DT through an intra-organizational perspective (see, for example, Bley et al. [BLS16]; Haffke et al. [HKB16]; Matt et al. [MHB15]; Piccinini et al.). However, research is missing the strategic implications for the industry and a detailed inter-organizational, macroeconomic analysis of the current and ongoing DT in the insurance industry [Pu17] given existing studies' sole focus on organizations' business models. Thus, we analyze the DT in the insurance industry from the perspective of its ecosystem.

3 Research Approach

We conducted a five-step research approach based on Riasanow et al. [Ri18a]. To develop the insurance industry's generic ecosystem, we first decided to use data from Crunchbase, a comprehensive database of existing companies and startups, to derive the roles in the ecosystem [Ma15]. To collect all organizations of the insurance industry and the related technologies, we filtered the Crunchbase category list by the search terms "InsurTechs" and "FinTechs and Insurance," resulting in a sample size of 1,424 worldwide funded companies. Screening the data, we found companies with no relationship to the insurance industry. Hence, we shortened the data set by a further 454 companies. Second, we presented the generic ecosystem based on the previously identified 34 roles and value streams. Third, we validated the model through seven semi-structured expert interviews. Subsequently, we identified strategic implications and followed and modified the discovered innovation pattern of Riasanow et al. [Ri18a] of the DT in the financial industry using qualitative content analysis.

4 Generic Ecosystem of the Insurance Industry including InsurTechs

Given the emergence of innovative digital technologies, the insurance industry is transforming, particularly as a result of new market entrants such as InsurTechs.

We first derive the roles of the actors in the ecosystem by drawing on data from 956 companies derived from the Crunchbase database. Actors, which offer similar services and products to the customer, are abstracted to one role based on a structured content analysis following Mayring [Ma10]. Because our roles are on a more abstract level than business models, one role can refer to different types of business models. Further, one company can act in different roles by offering different services to other players. In Table 1, we present the generic roles of the traditional actors in the insurance industry.

Role	**Description**	**Example(s)**
Consumer	Consumers request, among other applications, insurance services for business or private use. In some cases, the consumer is a prosumer by simultaneously using and creating a service.	Private, business client
Product Development	Develops and modifies products for new or changing customer needs and aims to create new products for an optimal customer journey with short development cycles [Go15].	Allianz, AIG, AXA
Underwriting	A primary insurer's or reinsurer's process to check applications, assess risks, and finalize them. Underwriting assumes real significance for businesses with industrial or general risks and for reinsurance [Go15, Fa06].	Allianz, AIG, AXA
Distribution Management	Translates an insurance company's strategic goals into sales targets that can be implemented operationally [Go15].	Allianz, AIG, AXA
Policy Service	The basic function of insurance administration that only indirectly serves the actual purpose of the operation and ensures that operations run smoothly by looking after client-related requests and issues [Go15].	Allianz, AIG, AXA
Billing & Collection	Because insurance companies handle large money streams, a large aspect of administration is billing and collecting insurance premiums [Go15, Fa06].	Allianz, AIG, AXA
Claims & Payment	Administration, assessment, and settlement of insurance claims and life insurance refunds are handled by a specified division in every insurance line [Go15, Fa06].	Allianz, AIG, AXA
Asset	Assesses and predicts future cash flows and adjusts	Allianz Global

Management	investment strategy accordingly to provide enough cash flow for claims payments and life insurance refunds [Go15, RM08].	Investor, AIG-Global Capital, AXA Assets
Global Agent	Coordinates the distribution of multinational clients and provides them with needed insurance coverage. In the respective markets, these agents have exclusive partnerships with insurance companies, which may differ between the insurance lines and countries [Go15].	Aeon, Willis Tower Watson
Independent Broker	Anyone who commercially handles the brokerage or conclusion of insurance contracts for the principal without being entrusted by an insurer or insurance agent.	FondsFinanz, Euroassekuranz
Fraud Detection	Aims to protect customer and enterprise information, assets, accounts, and transactions by analyzing activities. Fraud detection is not intrusive to a user unless the user's activity is suspect [Gr12, Ph10].	Trulioo, Fraugster
Business Service	Services handled by an external service provider in all aspects of the insurance industry, including Consulting, Human Resource Management, and Debt Collection services.	Aeon, Price Waterhouse Cooper, InkassoDirect
Claims Partner	Policyholders and insurers turn to claims partners as professionals with claims-relevant expertise and onsite capacity to handle claims. Claims partners support the parties in the event of a claim, especially during the claims settlement process [Go15].	Cognotekt, MotionsCloud, McLaren
IT-Service Provider	Related to the use of information technology and supports the insurance industry partner's business processes and digital identity management [Pu17].	Capgemini, Yoti, AimBrain, OneVisage
Service Insurance	Uses personal contacts with customers and a wide branch agent and broker network.	Allianz, AXA, Zurich
Direct Insurance	Offers comparison and purchase possibilities without meeting with agents or brokers. The customer receives advice only via Internet chat, e-mail, or a telephone hotline.	DirectCar, HUK 24, AllSecur
Reinsurance	Insurance for insurance corporations that transfers part of the risks assumed by a direct insurer to policyholders under insurance contracts or via statutory provisions, or transfers risk to a second insurer—the reinsurer—that is not directly related to the customer [Go15].	Munich RE, Swiss RE
Regulatory	Supervises the solvency of insurers and other	SEC, EIOPA,

Authority	financial service providers. Its market supervision facilitates fair and transparent market conditions and protects consumers.	BaFin

Table 1: Generic roles in the traditional insurance industry

Second, in Figure 1, we propose a generic ecosystem of the traditional insurance industry. Drawing on the e3-value method, the ecosystem depicts the identified roles and the value streams among them.

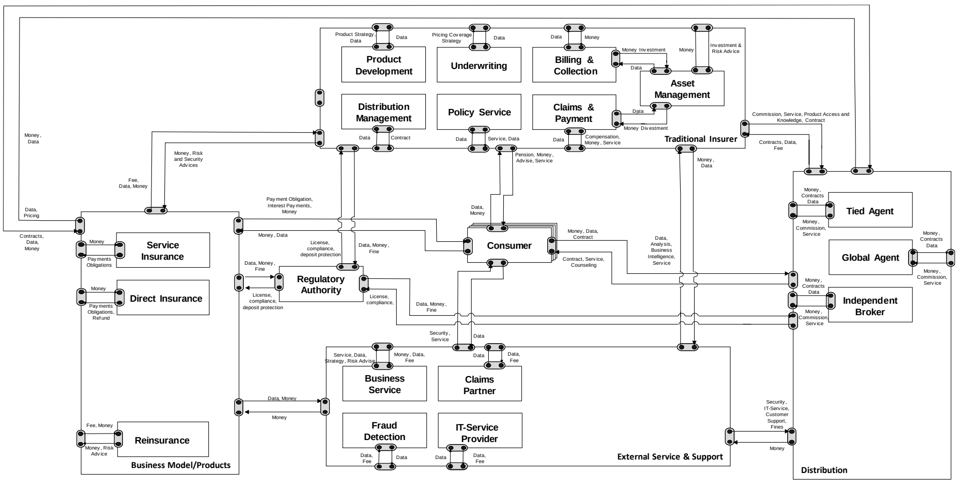

Figure 1: Generic ecosystem of the traditional insurance industry

Third, in Table 2, we show the generic roles of the emerging actors that are exclusively based on InsurTechs. Further, following the generic ecosystem for cloud computing, we included the four roles of cloud infrastructure provider, cloud platform provider, cloud application provider, and cloud market platform, as extracted from Böhm et al [Bö10].

Role	**Description**	**Example(s)**
Comparison Platform	Comparison platforms enable customers to form adequate decisions regarding different products and providers.	getinsured, impacthealth, comfortplan.de
Digital Broker/Robo Adviser	Digital brokers are intermediaries that offer insurance brokerage services by incorporating digital technologies, such as artificial intelligence, web-based platforms, and mobile applications.	Knip, Clark
Cross-Seller	Cross-sellers target the potential of insurance in a digital environment by focusing on e-commerce solutions for online shops that combine the traditional	Simplesurance, Check24

	insurance business with new digital online shopping through a one-click solution.	
Big Data Analytics/Predictives	Big data analytics and predictives provide services and solutions for risk takers to manage data and take advantage of large data collections for extensive analytics, such as analyses of target customers, calculations of quotes, decreases in claims-related expenses, fraud detection, frequent risk assessments, and stress-test simulations.	Laptetus, Fraugster, Cognotect
Smart Contract/Blockchain	Blockchain technology is a secure technology incorporated by InsurTechs to automate processes in claims regulation, payment management, and data and platform handling.	Black, safeshare
Instant Insurance	Instant insurance is a product for a selected period, in contrast to conventional insurance products that provide coverage at any time.	Trōv
Peer-to-Peer Insurance	Peer-to-peer insurance supplies competitively priced insurance products financed by eliminating moral hazard and profit margins through reinsurance contracts.	Friendsurance, Lemonade
E-Payment Provider	The term “e-payment” generally encompasses various functionalities that are handled via mobile phones [Ma07]. Provision of payments includes the use of mobile devices, such as smartphones.	PayPal, ApplePay, AliPay

Table 2: Generic roles of InsurTechs

Third, we used the e3-value method to develop a generic ecosystem of DT in the insurance industry, including InsurTechs. This method extends the ecosystem of InsurTechs in Figure 1 that we determined by drawing on the identified generic roles for InsurTechs; see Figure 2.

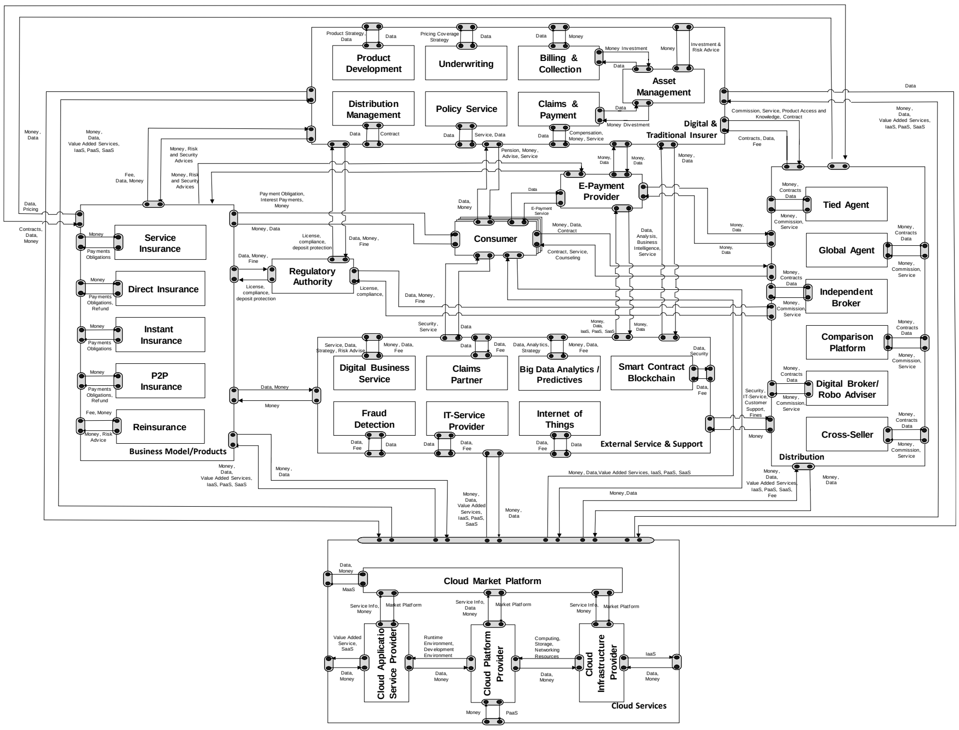

Figure 2: Generic ecosystem of the insurance industry including InsurTechs

5 Strategic Implications and Innovation Patterns in Insurance Industry

Based on the analysis of the DT in the generic ecosystem, such as comparing Figure 1 with Figure 2 and the interviews with seven industry experts, we extend and modify the research of Riasanow et al. [Ri18a] through strategic impactions and inter-organizational innovation patterns.

Strategic Implication	**Innovation Pattern**
Customer centricity	Aggregation of Intermediaries
Create coverage for customer ecosystem	Enhanced Transparency
	Service Aggregation
	Prosumption
Restructuring the organization to enable DT	

	Cloud-based Services
Leverage in-house collaboration	
Integrate partners with complementary services in the ecosystem	Service Integration
	Parallel Universe

Table 3: Strategic implications and innovation patterns

The first strategic implication is to provide *customer centricity*, which is independent of location and time, and is a key enabler of DT [HKB16, LV16]. Given accelerating media and channel fragmentation and evolving new customer expectations, omni-channel management has become more complicated for the insurer. Moreover, customer-to-customer interactions through simultaneously using and creating a service are creating significant challenges and opportunities for the insurer. Customer experiences are more social in nature, and peer customers also influence experiences. Overall, insurers also have much less control over the customer experience and the customer journey [LV16]. In reaction, insurers need to develop a new base of "digital only" clients and launch and support a new direct-to-customer channel, which is also shown in the *aggregation of intermediaries* by InsurTechs' roles as comparison platforms or robo advisers. They provide appropriate expertise such as personalized and digital app-based interactions with the customer by also integrating new customer services, such as robo advisors or smart contract interactions.

Creating coverage for customer ecosystems is the second strategic implication and is also related to transparency. *Enhancing transparency* refers primarily to the generic roles in the areas of distribution, coverage reliability, and product design, and is the second innovation pattern in the industry. There, the generic roles in distribution channels, fraud detection, asset management, and product development are intended to generate transparency in claims management, fund management, and the overall understanding of insurance products. This development provides a more customer-focused systems view in the industry, in contrast to the traditional focus on insurance services that only included a single insurance provider and a customer. We define the digital ecosystem as a conglomerate of all interactions that an insurer has with its customers within all of the ranges of products and services that the insurer provides to them. The need to identify customers' hidden interest in insurance coverage without an insurance stimulus on the customer side is critical for the insurer in this context. Therefore, *service aggregation* is the third innovation pattern in the insurance industry. There, the service provider aggregates a plethora of services and makes them accessible through a single solution, such as in the dimensions of customer-ecosystems in Smart Home, Connected Health, Life, and Mobility. These dimensions also introduce our fourth innovation pattern *prosumption*, enabled through cloud-based services [Bö10] and the integration of advanced big data analytics in which the customer simultaneously uses and creates a service (e.g., such as when a user shares personal data with Google Maps when navigating with the aggregated real-time traffic information of other users) [RGB17, Ri18a].

This innovation pattern needs to be integrated within the organizational processes and structure that set the third strategic implications of *restructuring the organization to enable DT*. Because of the mentioned change in customer demands, new competitors such as InsurTechs, and increasing pressure from digitalization, insurers need to reorganize and close the “digital gap.” Providing a flexible and comprehensive IT infrastructure enables new ways to enhance efficiency. Handling business tasks without human interaction is critical in the insurance industry to increase efficiency and profitability. The field of application ranges from manually setting up workarounds to complex software on a virtual machine. Providing IT services in an appropriate environment of *cloud-based services* is the fifth innovation pattern [Bö10]. These services are built on a modular cloud infrastructure that enables quick scalability and, therefore, eliminates the boundaries of traditional insurance administration, products, or services that are bound to the capacities of the insurance institution. Here, the scalability is bound to the computing power of the cloud infrastructure provider [YBS08]. In an environment of constantly increasing demands coupled with enormous cost pressure, cloud-based services, big data analytics, and process automation can deliver high-quality work results on a flexible schedule and offer new business opportunities, thus strengthening the position in the ecosystem.

Fourth, insurers should *leverage in-house collaboration* and human resources. Most insurers are functionally and regionally organized with standardized processes. For a company in a changing and agile market environment and given new digital technologies, company employees must be able to position themselves differently and adopt a stronger entrepreneurial focus. New types of collaboration empowered through cloud-based services and the use of new forms of organization and working methods encounter different cultures, visions, goals, and strategies. In particular, cross-company collaboration and design are needed, as are cultivating an entrepreneurial attitude and promoting it among all managers and employees. This collaboration and design also include modern ways of working and other ways to consciously take risks and establish the associated culture of error, which also contributes to positive cultural development. Within the organization, specific individuals can be engaged with this role to evaluate action-oriented future opportunities and, as a consultant in a structured approach, make these opportunities transparent and conduct business development. Insurance companies should establish Smart Circles across functionalities, regions, and silos to support a culture of continuous collaboration between different roles such as underwriting, product development, asset management, claims, and distribution. The purpose of these circles is to develop a joint understanding of current business performance and to identify areas of opportunity and action that are both aligned and understood by all different roles.

The insurance industry belongs to the network economy and is shaped by complementary network effects. Thus, the industry behaves like a massively interconnected network of organizations, technologies, consumers, and products. Hence, our final strategic implication is to *integrate partners with complementary services in the ecosystem*. The insurance industry and its value proposition for customers was the result of independent developments of standardized products driven by a regulatory background. The execution focus was on developing customer insights, building core competencies, and beating the competition in price and efficiency. Thus, companies devoted less attention to external companies that were neither competitors nor customers. However, in the insurance industry, this centralized and vertical perspective has changed significantly. The management of dependencies on a multitude of external complementary companies is relevant to success in strengthening the position in the ecosystem. For the right position in the ecosystem, suitable partners are an important factor [Ri18a, Ba04], such that an insurer and its partners create value for the customer through additional services, which is the seventh innovation pattern of *service integration*. Therefore, the success of an insurance company depends not only on its own quality but also on its ability to manage a landscape of multiple partners to meet the customer's desire for a comprehensive product and service offer. Furthermore, the integration of partnerships for data generation and analysis is critical for business success. Additionally, the emergence and creation of a *parallel universe*—the sixth innovation pattern—is particular to the case for blockchain technology [Ri18b] and peer-to-peer insurance. The case of Trov shows that insurance products or services can be substituted by connecting customers to new platform setups and incentives.

6 Discussion

Based on this work, five theoretical contributions arise. First, based on our analysis of 956 companies, we contribute to the literature on InsurTechs given that existing studies solely focus on the business model of InsurTechs or the transformation of the business model of established financial institutions [Pu17]. Second, by developing the generic, inter-organizational e3-value model of the insurance industry, including InsurTechs, we provide a macroeconomic overview of the current and ongoing transformation of the insurance industry. We identified 34 generic roles for traditional and emerging players in the insurance industry. Third, this study shows that DT is more than an intra-organizational phenomenon because it affects the entire ecosystem. Thus, we extend Fitzgerald et al. [Fi13], who understands DT primarily as an intra-organizational phenomenon. Fourth, based on the comparison of the traditional actors and the emerging InsurTechs and industry insights derived from interviews, we identified five strategic implications following seven inter-organizational innovation patterns. In particular, these patterns that drive the DT in the insurance industry through InsurTechs were missing [Pu17]. Fifth, we confirm the generic cloud computing ecosystem of Böhm et al. [Bö10] by showing that most of the innovation in the insurance industry is driven by cloud-based services.

Six practical contributions arise. First, decision makers, such as from traditional insurance institutions, can apply the model to identify potential threats to their current market positions, potential opportunities to adapt to trends, or shifts in customer needs. Second, we show that the different layers of innovation patterns influence and drive strategic implications for the DT of insurance companies. Third, we prove that the innovation pattern of the financial industry discovered by Riasanow et al. [Ri18a] is also valid in the insurance industry, such as the recombination of insurance services in the service integrator role or the intelligent combination of existing services to generate a new service in the service aggregator role. As is typical for DT, the roles show that the way that value is delivered to the customer is changing [Pi15]. Fourth, the inter-organizational innovation patterns differ in magnitude and effect. The innovation prosumption pattern shows that this is also true for the insurance industry because consumers are co-creating value with insurance service providers. Fifth, blockchain as a disruptive technology may be understood as the most promising digital technology for traditional insurance institutions. In all categories of insurance products and services and payment, asset management, and financing, we found insurance-related or process-optimizing InsurTechs using blockchain technology. Sixth, from an ecosystem perspective, InsurTechs do not possess a significant market share, and a crowding out effect or disruption is not visible. However, a number of traditional insurance institutions and regulatory authorities are increasingly experimenting with new and innovative technology. Seventh, we see that new business models as peer-to-peer insurance do not necessarily represent a parallel universe in this context. Nevertheless, many products and services are under strict regulations from governmental authorities. Therefore, the extent of the impact of new technologies, such as blockchain or new business models, on traditional insurance institutions is unknown.

7 Limitations and Future Research

Our study is subject to limitations. First, the model is limited by the information provided by the Crunchbase database and our coding of the generic roles. Second, drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles, and annual reports. However, we established intercoder reliability among two independent coders with an alpha of 0.87. Third, we conducted seven semi-structured interviews with experts from the insurance industry or InsurTech founders to validate the proposed generic ecosystem and the presented strategic implications and innovation patterns [Ri18a]. Following Puschmann [Pu17], we suggest that future research detect intra-organizational, microeconomic innovation patterns. Second, we are curious to further investigate the developed strategic implications. Third, many InsurTechs offer their services on digital platforms [ZDS16]; however, we invite scholars to investigate the success factors for the digital platforms in the DT process of the industry that remain uncovered.

8 Conclusion

This paper presents the generic ecosystem for the insurance industry based on 34 generic roles of traditional financial institutions and InsurTechs identified by a structured content analysis of the Crunchbase data of 956 financial organizations. DT creates new roles for value creation in the insurance industry and, thus, affects the entire ecosystem. The ecosystem shows that robo advisors, big data, or short-term insurance providers penetrate the market and, thus, threaten the value creation of traditional insurance institutions. To discuss this phenomenon, we developed five strategic implications following seven inter-organizational patterns of the DT [Ri18a] in the insurance industry, such as the development of a customer-centric voice through the aggregation of intermediaries or the integration of new services in the creation of customer ecosystems. Our work contributes to the literature on InsurTech and to the growing body of knowledge on DT. We encourage traditional insurance institutions to actively experiment with innovative technologies or to collaborate with emerging new players in the market.

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