Case Studies on Digital Transformation: Research on the Impact of Digital Technologies and Digital Platforms on the Economy

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Preamble

Digital transformation is one of the major challenges these days for both economy and society. Hence, I consider myself happy that I could dedicate my research activities to a field so emergent, important, and dynamic. The results of my endeavors in the recent years culminate in this thesis, which aims to considerably contribute to the knowledge of digital transformation in IS research. However, I would never have been able to write this thesis in its present form on my own. Hence, this is to say thank you to all those who have contributed to my journey, personally and professionally.

Special thanks go to Prof. Dr. Key Pousttchi, who contributed to this work not only as co-author and supervisor who spent much time on seemingly endless research discussions – but also as a mentor who roused my passion for digital transformation and opened the door to the world of research for me; as a teacher who broadened my horizons both academically and professionally; and as an adamant leader who believed in my strengths and brought out the best in me.

Particular thanks go to all my other co-authors – Benedikt, Frederick, Konrad, Maik, Marco, and Stefanie – who accepted their challenges passionately and unrepiningly, and thus valuably co-contributed to the included papers of this thesis.

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Finally, a heartfelt thank you goes to my family – my mother Monika, and Bettina, Dietrich, and Elenica – as a safe haven, who have always accepted me as I was, supported me and believed in me; and to my one and only, Vivienne, for being my most critical critic, my most supportive supporter, and the shining light in my life.

Abstract

Digital transformation (DT) has not only been a major challenge in recent years, it is also supposed to continue to enormously impact our society and economy in the forthcoming decade. On the one hand, digital technologies have emerged, diffusing and determining our private and professional lives. On the other hand, digital platforms have leveraged the potentials of digital technologies to provide new business models. These dynamics have a massive effect on individuals, companies, and entire ecosystems. Digital technologies and platforms have changed the way persons consume or interact with each other. Moreover, they offer companies new opportunities to conduct their business in terms of value creation (e.g., business processes), value proposition (e.g., business models), or customer interaction (e.g., communication channels), i.e., the three dimensions of DT. However, they also can become a threat for a company's competitiveness or even survival. Eventually, the emergence, diffusion, and employment of digital technologies and platforms bear the potential to transform entire markets and ecosystems.

Against this background, IS research has explored and theorized the phenomena in the context of DT in the past decade, but not to its full extent. This is not surprising, given the complexity and pervasiveness of DT, which still requires far more research to further understand DT with its interdependencies in its entirety *and* in greater detail, particularly through the IS perspective at the confluence of technology, economy, and society. Consequently, the IS research discipline has determined and emphasized several relevant research gaps for exploring and understanding DT, including empirical data, theories as well as knowledge of the dynamic and transformative capabilities of digital technologies and platforms for both organizations and entire industries.

Hence, this thesis aims to address these research gaps on the IS research agenda and consists of two streams. The first stream of this thesis includes four papers that investigate the impact of *digital technologies* on organizations. In particular, these papers study the effects of new technologies on firms (paper II.1) and their innovative capabilities (II.2), the nature and characteristics of data-driven business models (II.3), and current developments in research and practice regarding on-demand healthcare (II.4). Consequently, the papers provide novel insights on the dynamic capabilities of digital technologies along the three dimensions of DT. Furthermore, they offer companies some opportunities to systematically explore, employ, and evaluate digital technologies to modify or redesign their organizations or business models.

The second stream comprises three papers that explore and theorize the impact of *digital platforms* on traditional companies, markets, and the economy and society at large. At this, paper III.1 examines the implications for the business of traditional insurance companies through the emergence and diffusion of multi-sided platforms, particularly in terms of value creation, value proposition, and customer interaction. Paper III.2 approaches the platform impact more holistically and investigates how the ongoing digital transformation and "platformization" in healthcare lastingly transform value creation in the healthcare market. Paper III.3 moves on from the level of single businesses or markets to the regulatory problems that result from the platform economy for economy and society, and proposes appropriate regulatory approaches for addressing these problems. Hence, these papers bring new

insights on the table about the transformative capabilities of digital platforms for incumbent companies in particular and entire ecosystems in general.

Altogether, this thesis contributes to the understanding of the impact of DT on organizations and markets through the conduction of multiple-case study analyses that are systematically reflected with the current state of the art in research. On this empirical basis, the thesis also provides conceptual models, taxonomies, and frameworks that help describing, explaining, or predicting the impact of digital technologies and digital platforms on companies, markets and the economy or society at large from an interdisciplinary viewpoint.

Zusammenfassung

Die Digitale Transformation (DT) war in den letzten Jahren eine große Herausforderung und wird auch im kommenden Jahrzehnt unsere Gesellschaft und Wirtschaft weiterhin enorm beeinflussen. Neue digitale Technologien durchdringen unseren Alltag, beeinflussen unser Leben maßgeblich und werden es zunehmend mitbestimmen. Gleichzeitig haben digitale Plattformen die Potenziale digitaler Technologien genutzt, um neue Geschäftsmodelle zu entwickeln und zu etablieren, mit tiefgreifenden Auswirkungen auf Einzelpersonen, Unternehmen und ganze Ökosysteme. Digitale Technologien und Plattformen haben das Konsum- und Kommunikationsverhalten der Menschen in den letzten Jahren erheblich und nachhaltig verändert. Einerseits bieten digitale Technologien Unternehmen verschiedener Branchen neue Gestaltungsmöglichkeiten in allen drei Dimension der DT, nämlich dem Leistungserstellungsmodell (z. B. bessere Geschäftsprozesse), dem Leistungsangebotsmodell (z. B. neue Geschäftsmodelle) und dem Kundeninteraktionsmodell (z. B. zeitgemäße Kommunikationskanäle). Anderseits besitzen digitale Technologien und Plattformen das Potenzial, ganze Ökosysteme zu verändern, und können daher auch zu einer Bedrohung für die Wettbewerbsfähigkeit – oder gar das Überleben – einzelner Unternehmen oder ganzer Märkte werden.

Vor diesem Hintergrund hat die Forschung der Wirtschaftsinformatik und Information Systems (WI/IS) die Phänomene im Zusammenhang mit der DT in den letzten Jahren erforscht und in Theorien überführt, jedoch angesichts des Ausmaßes, der Dynamik und Komplexität der DT noch nicht vollumfänglich erschlossen. Folglich bedarf es noch weiterer Forschungsanstrengungen, um die DT einschließlich der Interdependenzen in ihrer Gesamtheit und im Detail besser zu verstehen, insbesondere durch die WI/IS-geprägte Perspektive in der Schnittmenge von Technologie, Wirtschaft und Gesellschaft. Folgerichtig wurde in der WI/IS-Disziplin eine Vielzahl bedeutender Forschungslücken diagnostiziert, u. a. den Mangel an empirischen Daten, an Theorien und Konzepten sowie an Wissen über die dynamischen und transformativen Fähigkeiten digitaler Technologien und Plattformen sowohl für einzelne Organisationen als auch für ganze Branchen und Ökosysteme.

Daher zielt diese Arbeit darauf ab, ausgewählte Forschungslücken auf der WI/IS-Forschungsagenda anzugehen. Die Arbeit ist hierzu in zwei Bereiche aufgegliedert. Der erste Bereich dieser Arbeit umfasst vier Beiträge zur Analyse der Auswirkungen *digitaler Technologien* auf Organisationen. Beleuchtet werden hier im Speziellen Einflüsse neuer Technologien auf Unternehmen (Beitrag II.1) und deren Innovationsfähigkeit (II.2), Wesen und Eigenschaften datengetriebener Geschäftsmodelle (II.3) sowie Entwicklungen in Forschung und Praxis zu On-demand Healthcare, d. h. digitalen, patientenzentrierten Ad-hoc-Gesundheitsservices (II.4). Diese Beiträge liefern der Forschung neue Erkenntnisse über die dynamischen Fähigkeiten digitaler Technologien für Unternehmen entlang der drei Dimensionen der DT und zeigen Firmen neue Möglichkeiten auf, digitale Technologien zur Umgestaltung der Organisation oder zur Entwicklung neuer Geschäftsmodelle systematisch zu erkunden, einzusetzen und zu bewerten.

Der zweite Bereich dieser Arbeit beinhaltet drei Beiträge zur Analyse der Auswirkungen *digitaler Plattformen* auf traditionelle Unternehmen und Märkte sowie die Wirtschaft und Gesellschaft als Ganzes. Im Speziellen beleuchtet Beitrag III.1 den Einfluss digitaler Plattformen auf das Geschäft traditioneller Versicherungsunternehmen und demnach, wie sich Wertschöpfung, Leistungsangebot

und Kundeninteraktion in der Folge wandeln. Beitrag III.2 betrachtet den Einfluss digitaler Plattformen ganzheitlicher und untersucht, wie sich die Wertschöpfungsstrukturen im Gesundheitsmarkt infolge der Digitalisierung und "Plattformisierung" nachhaltig verändern. Gegenstand der Betrachtung sind hierbei insbesondere die fünf großen Player: Google, Apple, Facebook, Amazon und Microsoft (GAFAM). Beitrag III.3 verlässt die Ebene einzelner Unternehmen und Märkte und untersucht die regulatorischen Probleme, die infolge der Plattformökonomie für Wirtschaft und Gesellschaft entstehen, und entwickelt entsprechende Lösungsansätze, diese anzugehen. Die Beiträge steuern somit neue Erkenntnisse über die transformativen Auswirkungen digitaler Plattformen auf etablierte Unternehmen im Speziellen und ganze Ökosysteme im Allgemeinen bei.

Die Erkenntnisse aller Beiträge stützen sich im Wesentlichen auf der Analyse von Fallstudien, die im Kontext bestehender Forschung in den einzelnen Bereichen systematisch untersucht werden. Auf dieser empirischen Grundlage werden im Rahmen dieser Arbeit theoretische Modelle, Taxonomien und Frameworks entwickelt, die helfen, diese Auswirkungen aus interdisziplinärer Sicht zu beschreiben, zu erklären oder vorherzusagen. Insgesamt trägt diese Arbeit demzufolge zum weiteren Verständnis der Auswirkungen der DT auf Organisationen, Märkte und die Gesellschaft bei.

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List of Abbreviations

ACM DL	Digital Library of the Association for Computing Machinery
AI	Artificial Intelligence
AISel	Electronic Library of the Association for Information Systems
API	Application Programming Interface
AR	Augmented Reality
AWS	Amazon Web Services
B2A	Business-to-Administration (Market Segment)
B2B	Business-to-Business (Market Segment)
B2B2C	Business-to-Business-to-Consumer (Market Segment)
B2C	Business-to-Consumer (Market Segment)
BI	Business Informatics
BM	Business Model
CAS	Content-Addressed Storage
CEO	Chief Executive Officer
CH	Switzerland
CIM	Customer Interaction Model
CIO	Chief Information Officer
COVID-19	Coronavirus Disease SARS-CoV-2
CPS	Cyber-physical Systems
CRM	Customer Relationship Management
DB	Database
DDBM	Data-driven Business Model
DDS	Data-driven Service
DI	Digital Innovation
DICOM	Digital Imaging and Communications in Medicine
DMA	EU Digital Markets Act
DMS	Data Management System
DP	Digital Platform
DPR	Digital Platform Regulation
DSA	EU Digital Services Act
DSR	Design Science Research
DT	Digital Transformation
EBSCOhost	Library of the Elton B. Stephens Company
EC	European Commission
ECF	Electronic case file
ECG	Electrocardiogram
EHR	Electronic Health Record
ERP	Enterprise Resource Planning
EU	European Union
FAQ	Frequently Asked Questions
FHIR	Fast Healthcare Interoperability Resources
GAFAM	Google, Apple, Facebook, Amazon, Microsoft
GDPR	EU General Data Protection Regulation
GI	German Informatics Society
GPS	Global Positioning System
GUI	Graphical UI
HCI	Human-Computer Interaction
HDMP	Hospital Data Management Platform
HIPAA	Health Insurance Portability and Accountability Act (in the U.S.)
HIS	Health/Hospital Information System
HIT	Health Information Technologies
HL7	Health Level 7
HPI	Hasso-Plattner-Institut
HTML5	Hypertext Markup Language 5
ICT	Information and Communication Technologies
ID	Identification

IEEE Xplore	Library of the Institute of Electrical and Electronics Engineers
IHE	Integrating the Healthcare Enterprise
ILM	Information Lifecycle Management
IoMT	Internet of Medical Things
IoT	Internet of Things
IS	Information System(s)
IT	Information Technologies
JSTOR	Library of the Journal STORage
KPI	Key Performance Indicator
LAN	Local Area Network
LDAP	Lightweight Directory Access Protocol
LIS	Laboratory Information System
M&A	Mergers & Acquisitions
mHealth	Mobile Health
ML	Machine Learning
mOS	mobile OS
MPI	Master Patient Index
MSP	Multi-sided Platform
NAS	Network-Attached Storage
NFC	Nearfield Communication
NLP	Natural Language Processing
NoSQL	Not-only SQL
NYU	New York University
OA	Organizational Ambidexterity
OBD2	On-board Diagnosis Standard
OCR	Optical Character Recognition
ODHC	On-demand Healthcare
OEM	Original Equipment Manufacturer
OS	Operating System
OTC	Over-the-Counter
P2P	Peer-to-Peer
PACS	Picture Archiving and Communication System
PAN	Personal Area Network
PC	Personal Computer
PDF	Portable Document Format
PDMS	Patient Data Management System
PEPP-PT	Pan-European Privacy-Preserving Proximity Tracing
PHR	Personal Health Record
PHTI	Public Health Tech Initiative
PL/SQL	Procedural Language for SQL
PSD2	EU Payment Services Directive II
REST	Representational State Transfer
RFID	Radiofrequency Identification
RIS	Radiology Information System
RoI	Return on Investment
RQ	Research Question
SAN	Storage Area Network
SLR	Structured Literature Review
SME	Small and Medium-sized Enterprise
SMS	Short Message Service
SP	Service Provider
SQL	Structured Query Language
UC	Ubiquitous Computing
UI	User Interface
UK	United Kingdom
US/USA	United States (of America)
UV	Ultraviolet Light
VCM	Value Creation Model
VHB	German Academic Association of Business Research
VPM	Value Proposition Model
VR	Virtual Reality
WAN	Wide Area Network
WHO	World Health Organization
WORM	Write Once, Read Many

List of Publications

Six research papers that are already published as indicated below are included in this document for the purpose of thesis publication:

II.1 Authors: Pousttchi K, Gleiss A, Buzzi B, & Kohlhagen M (2019)
Title: Technology Impact Types for Digital Transformation
Published in: 2019 IEEE 21st Conference on Business Informatics (CBI)
Publisher: IEEE; Link: https://doi.org/10.1109/CBI.2019.00063
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II.2 Authors: Gleiss A, & Lewandowski S (2021)
Title: Removing Barriers for Digital Health through Organizing Ambidexterity in Hospitals
Published in: Journal of Public Health (online first)
Publisher: Springer Nature; Link: https://doi.org/10.1007/s10389-021-01532-y
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II.3 Authors: Dehnert M, Gleiss A, & Reiss F (2021)
Title: What Makes a Data-driven Business Model? A Consolidated Taxonomy
Published in: ECIS 2021 Proceedings (Paper No. 139)
Publisher: AIS; Link: https://aisel.aisnet.org/ecis2021_rp/139/
Copyright © 2021, the authors (https://aisnet.org/page/PoliciesGuidelines)

II.4 Authors: Gleiss A (2020)
Title: The Patient Will See You Now – Towards an Understanding of On-demand Healthcare
Published in: 2020 IEEE 22nd Conference on Business Informatics (CBI)
Publisher: IEEE; Link: https://doi.org/10.1109/CBI49978.2020.00024
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III.1 Authors: Pousttchi K, & Gleiss A (2019)
Title: Surrounded by Middlemen – How Multi-sided Platforms Change the Insurance Industry
Published in: Electronic Markets 29(4):609–629
Publisher: Springer Nature; Link: https://doi.org/10.1007/s12525-019-00363-w
Copyright © 2019, Institute of Applied Informatics at University of Leipzig
Author's secondary publication under Springer Nature license no. 5275920947184

III.2 Authors: Gleiss A, Kohlhagen M, & Pousttchi K (2021)
Title: An Apple a Day – How the Platform Economy Impacts Value Creation in the Healthcare Market
Published in: Electronic Markets 31(4):849–876
Publisher: Springer Nature; Link: https://doi.org/10.1007/s12525-021-00467-2
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I Introduction

I.1 Background and Motivation

Digital transformation (DT) has proven to be a major challenge for the society and economy in recent years and is supposed to keep employing both researchers and practitioners in the forthcoming decade (Hinterhuber et al. 2021; Loebbecke and Picot 2015; Verhoef et al. 2021; Vial 2019). From a societal viewpoint, the ongoing emergence, use, and diffusion of digital technologies continuously affect people's daily routines, thinking, and behavior, with both positive and negative implications for the individuals and our society at large (e.g., Pousttchi and Goeke 2011; Reckwitz 2017; Stolterman and Fors 2004; Zuboff 2015). From an economic viewpoint, the availability of digital technologies provides fresh opportunities for businesses, while the digital ubiquity and impact in turn requires appropriate reactions and strategies from the affected companies to remain competitive (Bilgeri et al. 2017; Eden et al. 2019; Matt et al. 2015; Pousttchi 2017). In the extreme, such dynamics might possibly result into new economic orders (Staab 2019; Zuboff 2019).

In IS research, several definitions and conceptualizations of DT have emerged in recent years (Van Veldhoven and Vanthienen 2021; Vial 2019). Pousttchi refers to DT as "significant changes in everyday life, the economy, and society through the use of digital technologies and techniques as well as their impact" (2017). Regarding organizations, this implies changes in terms of the three DT dimensions value creation model (VCM), value proposition model (VPM), and customer interaction model (CIM) (Figure I.1-1). While the first dimension includes the technological influence on business processes, the general organization of an enterprise, and its workforce, the second dimension implies the influence on the selection of products and services proposed to the market and their according revenue models. The third dimension affects all mechanisms of customer interaction, including the design of the customer relationship and the inclusion of automated communication and modern forms of data analysis. (Pousttchi 2017)

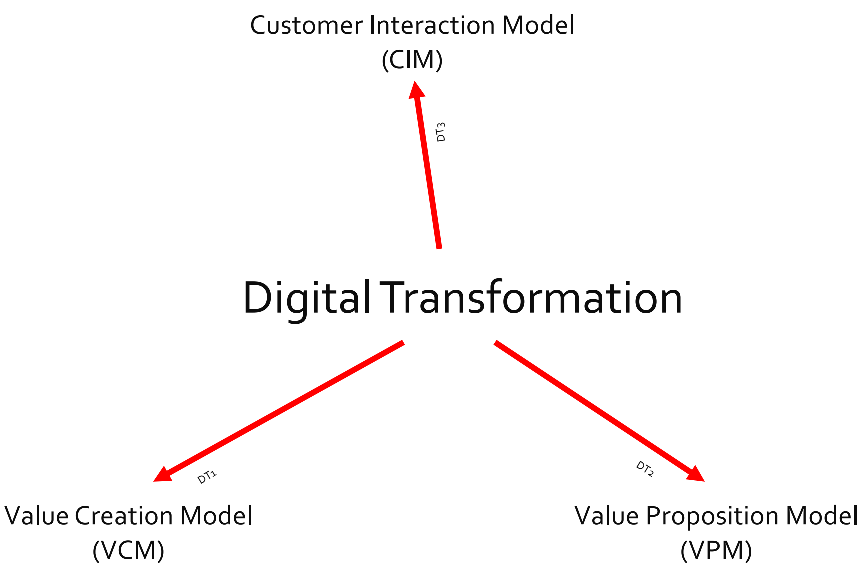

Figure I.1-1: Dimensions of Digital Transformation (adapted from Pousttchi 2017)

According to Pousttchi (2017), DT is based on direct and indirect effects of the application of *digital technologies and techniques* on organizational and economic conditions on the one hand and new products and services on the other hand. Besides constantly increasing computing power and miniaturization of classical IT components, the ubiquitous integration of these components into all types of technology has to be taken into account, especially in conjunction with:

- comprehensive use of sensors and actors including audio and video recordings,
- use of mobile communication technologies for networking and automated communication with very low latency (internet of things),
- elicitation, archiving and processing of very large data sets with the application of big data techniques,
- various techniques of machine learning, and
- advanced forms of human-computer interaction.

Particularly, the combination of these factors leads to new potentials for comprehensive automation of cognitive and mixed mechanical-cognitive tasks. Further definitions approach DT more broadly. For instance, Vial synthesizes DT to "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (2019). Altogether, we experience manifold interdependencies at the confluence of technology, economy, and society (Van Veldhoven and Vanthienen 2021).

Besides the diffusion and impact of digital technologies in general, the thesis puts special emphasis on the nature and impact of *digital platforms.* Digital platforms are different from traditional pipeline businesses, which increases competition complexity and leads to new competition paradigms, which is why they are believed to employ the digital connectivity to transform the economy and society at large (Parker et al. 2016; Zuboff 2015). Baldwin and Woodard (2008) define a platform as a modularized architecture that governs the interactions of its components and participants. Regarding their purpose, three platform types can be distinguished (Abdelkafi et al. 2019). First, Innovation platforms "consist of common technological building blocks that the owner and ecosystem partners can share to create new complementary products and services" (Cusumano et al. 2019), such as open-source collaboration platforms like Wikipedia or Linux. Second, transaction platforms intermediate between sellers and buyers (to exchange goods) or two groups of users (for mutual interaction), such as eBay, WhatsApp, or Tinder. Third, some digital platforms comply with both definitions, e.g., iOS, and are seen as hybrid platforms (Abdelkafi et al. 2019).

Either way, successful platforms are reliant on (efficiently governing) the complementary actors (Parker and Van Alstyne 2008). At best, they are efficient matchmakers that provide and govern infrastructures for *direct interaction* (i.e., transaction or collaborative innovation) among complementary user groups (Caillaud and Jullien 2003; Hein et al. 2019; Rochet and Tirole 2003). Thus, platforms control the transactions' key terms (e.g., pricing of goods, or program language) and govern the mechanisms among the user groups which are *affiliated with the platform* (e.g., fees, registrations) to engage in the interaction (Hagiu and Wright 2015). However, increased interaction and affiliation entail usage and membership externalities (Evans and Schmalensee 2008; Rochet and Tirole 2004) of two kinds. First, *network effects*, which arise from perfectly bringing together similar or complementary user groups (Parker and van Alstyne 2005; Rochet and Tirole 2003). Hence, a platform's usefulness (and therefore value) is subject to the size and fitness of complementary participants (Eisenmann et al. 2006; Shapiro and Varian 1998). Second, *homing and switching costs* incur for participants due to their affiliation, i.e., users are bound to the platform (Armstrong 2006; Evans et al. 2006; Kwon et al. 2017).

Framed by these definitions and concepts, IS research has extensively explored and theorized the phenomena in the context of DT in the past decade (Henriette et al. 2015; Legner et al. 2017), but not to its full extent (Gerster 2017). This is not surprising, given the complexity and pervasiveness of DT, which still requires far more research to further understand DT with its interdependencies in its entirety *and* in greater detail, particularly through the IS perspective at the confluence of technology, economy, and society. Broadly, this implies the contents ("what?") and approaches ("how?") of research in the context of DT (see Table I.1-1).

In terms of *approach*, IS research exposes two major research voids within the DT research landscape, namely, empirical data and proper methods as well as theoretical statements and terminologies that help exploring and understanding the phenomena and interdependencies of DT, and provide a profound basis for further conceptualization, generalization, and falsification (Loebbecke and Picot 2015; Lynne Markus and Rowe 2020; Van Veldhoven and Vanthienen 2021). At this, both de Reuver et al. (2019) and Vial (2019) emphasize the eligibility of value network analyses for understanding digital ecosystems. Altogether, the DT research landscape in IS provides a number of white spots solely in exploring the dynamics and impact of digital technologies and digital platforms on companies, ecosystems, and markets. At the same time, the practical relevance of DT has remained unchanged at a high level within the recent years (Google Trends 2021; Hinterhuber et al. 2021).

In terms of *content*, the IS research community has specified a multi-faceted research agenda with a multitude of addressable research gaps. From an economic view, two prevalent strands have found emphasis across all available IS research missions. First, it is about understanding the dynamics and impact of *digital technologies* on companies. Research gaps in this strand include dynamic capabilities of such technologies and the internal and external influence on companies' processes and structures, resulting shifts in business models and customer demands and participation across different industries (Loebbecke and Picot 2015; Tilson et al. 2010; Van Veldhoven and Vanthienen 2021; Vial 2019). One industry of particular interest is healthcare, where health IT (HIT) and patient empowerment promise tremendous potential to improve healthcare quality and reduce costs (Agarwal et al. 2010). Second, IS needs to further explore the nature and impact of *digital platforms* on the pertaining markets and ecosystems. Research gaps refer to the emergence and dynamics of platform markets, their transformational potential to disjoint traditional value networks, and regulatory perspectives (de Reuver et al. 2018; Gozman et al. 2020; Loebbecke & Picot 2015; Tilson et al. 2010; Van Veldhoven & Vanthienen 2021; Vial 2019).

Table I.1-1: Selected Gaps of the DT Research Landscape in IS

Focus	Field of Action	Research Gap	References
approach ("how")	empirical data & proper methods	- empirical research on drivers and phenomena of DT - design science and network analyses	Van Veldhoven & Vanthienen 2021; Loebbecke & Picot 2015 de Reuver et al. 2018
	new theories & concepts	- lack of theories - development of terminologies - interdisciplinary research approaches	Lynne Markus & Rowe 2020 Van Veldhoven & Vanthienen 2021 Van Veldhoven & Vanthienen 2021
content ("what")	knowledge of impact of digital technologies on organizations	- DT capabilities and impact on firms - DT impact on different sectors, e.g., healthcare (health-IT & patients) - shifting business models - the role of customer demands & value co-creation	Vial 2019; Tilson et al. 2010 Van Veldhoven & Vanthienen 2021; Agarwal et al. 2010 Van Veldhoven & Vanthienen 2021; Loebbecke & Picot 2015; Vial 2019 Van Veldhoven & Vanthienen 2021; Vial 2019; Tilson et al. 2010
	knowledge of impact of digital platforms (DP)	- emergence and dynamics of DP - market transformation through DP - political realm of DP and regulation	Van Veldhoven & Vanthienen 2021; Vial 2019 de Reuver et al. 2018; Vial 2019; Tilson et al. 2010 de Reuver et al. 2018; Vial 2019; Tilson et al. 2010; Loebbecke & Picot 2015; Gozman et al. 2020

I.2 Research Aim and Scope

Against this background, the aim of this thesis is to address these research gaps and contribute to understanding the dynamics and mechanisms of digital technologies and digital platforms in the context of DT at the confluence of technology, economy, and society. Particularly, the included research papers of this thesis zero in on the selected research gaps as per Table I.1-1. What all papers have in common is their exploratory multiple-case study-based approach from publicly available online sources and written material. Case studies are fruitful to explore and understand scarcely explained but complex phenomena and to develop or test theory from empirical evidence (Benbasat et al. 1987). Qualitative approaches are specifically appropriate to identify and understand underlying and causal relationships of social and economic phenomena (Orlikowski and Baroudi 1991; Patton 2014, pp. 39 et seqq.). While this method is interpretive, it is useful for extracting both conscious and unconscious messages within documents (Rothbauer 2008). Based upon the analyses of empirical case data, all papers provide generalized and testable theorizations about the phenomena in question. Consequently, this thesis throughout addresses the two approach-related research gaps of missing empirical data and theories.

However, also content-related gaps of the DT research landscape are tackled. The research papers within this thesis are basically framed by the conceptual model of DT from Pousttchi (2017) including the three dimensions VCM, VPM, and CIM (as per Figure I.1-1). Upon this basis, the research papers specifically target two fields of action (as per Table I.1-1), i.e., broadly, the knowledge of the impact of digital technologies on organizations (Chapter II), and in a narrower range, of the impact of digital platforms (Chapter III; see Figure I.2-1). Consequently, this section aims to provide an overview of the derived and formulated research questions of the thesis.

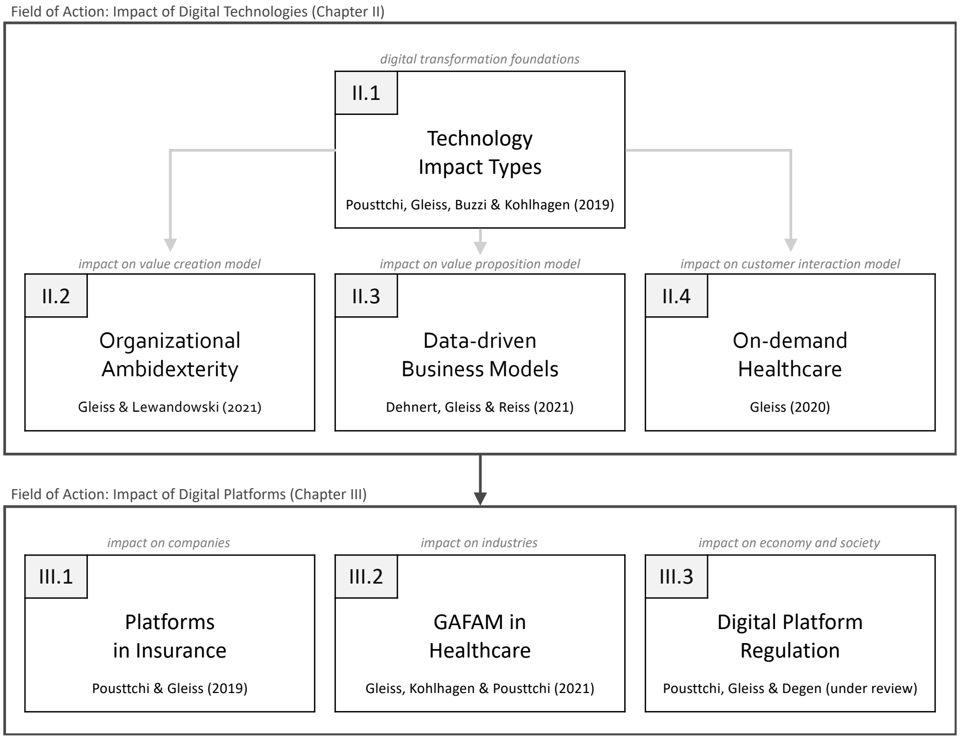

Figure I.2-1: Research Papers in the Context of the Identified Fields of Action

I.2.1 Research Questions on the Impact of Digital Technologies

Technology Impact Types (II.1)

Digital transformation affects many industries as digital technologies increasingly change the way companies create and offer their propositions and interact with their customers (Pousttchi 2017). The combination of new technologies with innovative methods of data processing and analysis not only improves and disrupts existing business processes, but also enables completely new business models and markets (Constantinou and Kallinikos 2015; Seddon et al. 2017). Consequently, companies need to react properly to such digitally induced changes (Gimpel and Röglinger 2015) by developing and pursuing adequate strategies to exploit digital technologies in order to ensure or enhance competitiveness in global markets (Bharadwaj et al. 2013; Matt et al. 2015; Pagani 2013). However, there is still little knowledge of the implications in their entirety and how this is induced by the exploitation of digital technologies. This specifically applies to the dynamic capabilities of digital technologies in organizations and how they contribute to the DT of organizations, if DT is considered as a "process where digital technologies create an impetus for organizations to implement responses to gain or maintain their competitive advantage" (Vial 2019). Consequently, companies need to learn the impact of digital technologies, to seize disruptions, and to reconfigure their business models (Vial 2019). Against this background, the following research question (RQ) can be posed:

RQ1: How can we classify the impact of digital technologies on companies along the three dimensions of digital transformation?

Organizational Ambidexterity (II.2)

Digital transformation massively affects the *value creation model* of organizations of different branches, such as the healthcare sector. Digital technologies diffuse from multiple directions (Chan et al. 2004; Fichman et al. 2011; Gleiss et al. 2021) and might conceivably revolutionize the entire healthcare sector with remarkable consequences for providers, patients and other stakeholders (Christensen et al. 2017). Practical insights indicate that hospitals noticeably struggle with the massive changes around (Dash et al. 2019; Eddy 2020). Hospitals have to manage a plethora of (partly critical) IT systems and applications and need to comply with latest standards and regulations for IT and patient security. Hence, IS research needs to understand the issues around the design, implementation, and meaningful use of health-IT (Agarwal et al. 2010). Moreover, it is necessary to understand IT landscapes in such organizations to ensure their availability and reliability in complex service ecosystems (Tilson et al. 2010). For hospitals, however, it is rather challenging to simultaneously manage the existing IT systems *and* continuously explore new technologies that might improve healthcare quality or internal workflows. To find a remedy for this problem, hospitals might consider to integrate technologies from digital health startups, which are seen as one important driver of technology diffusion in healthcare (Chowdhury 2012; Villegas 2019). Against this background, the following research question can be posed:

RQ2: How can hospitals explore and integrate innovative technologies while maintaining the efficiency, availability, and reliability of their IT ecosystems?

Data-driven Business Models (II.3)

Digital transformation also massively affects the *value proposition model* of organizations of different branches. In particular, the usage of data to modify the existing business models or create new ones has become vital for companies in the 21st century. However, to extract value from data it is important to understand these new types of business models (Loebbecke and Picot 2015). IS research provides empirical and qualitative evidence and approaches for tackling the challenges of creating and conceptualizing data-driven business models (e.g., Engelbrecht et al. 2016; Kühne and Böhmann 2018). Given the increasing relevance of data in contemporary business models and its economic importance, IS research should sharpen the understanding of the core elements of data-driven business models and services (DDBM/DDS). However, there is yet little analytical consolidation of existing DDBM/DDS taxonomies and frameworks. Instead, IS-related research provides several partly contradictory or redundant conceptualizations, which requires a synthesis of the terminology (Van Veldhoven and Vanthienen 2021). Against this background, the following research question can be posed:

RQ3: What makes a data-driven business model and what are its core elements?

On-demand Healthcare (II.4)

Digital transformation also massively affects the *customer interaction model* of organizations of different branches. Consumers increasingly "cede or retain control over devices and services options" (Tilson et al. 2010). Particularly in healthcare, the increasing prevalence and ubiquity of digital technologies is changing the needs and expectations of patients towards healthcare services, extending the traditional realm of health-IT (Agarwal et al. 2010). As a result, a plethora of patient-centered services edges into the healthcare market (Pfannstiel et al. 2017; Bogdan 2018). Since digital technologies bear the potential to surmount barriers in time and space, patients increasingly demand real-time or near-time healthcare services (Varshney 2005). Amongst a cloud of related concepts in the context of digital health, one term increasingly typifies this impulse: *on-demand healthcare*. While this term can be noticeably found in practice (e.g., Colby and Bell 2016), there is barely a theoretical foundation so far. Hence, some effort is required to utilize the right terminologies (Van Veldhoven and Vanthienen 2021). Against this background, the following research question can be posed:

RQ4: What is on-demand healthcare and what are the relevant components?

I.2.2 Research Questions on the Impact of Digital Platforms

Platforms in Insurance (III.1)

The insurance industry is faced with existential challenges such as the ongoing digital transformation (Capgemini/Efma 2018a; Nicoletti 2016). The emergence and development of digital technologies does not only affect the structures and processes of traditional insurance companies (e.g., Allianz, Generali, Ping An, Berkshire Hathaway), but also leads to changing customer needs and behaviors (e.g., Deloitte 2016; Naylor 2017). As a result, digital transformation impacts value creation, value proposition, *and* customer interaction of insurance companies (Pousttchi 2017; Pousttchi et al. 2019a). Although the insurance industry is historically entangled with information and communications technology, large companies struggle to respond adequately to this transformation (e.g., Eling and Lehmann 2018; Scardovi 2017; Naylor 2017). These developments give rise to new players with innovative business models (Capgemini/Efma 2018b; Hook 2018; Moore 2018), particularly to multi-sided platforms (MSP). Despite their growing economic relevance, there is currently little research on insurance-related MSP and their strategic impact on the insurance industry. Specifically, there is little knowledge of how digitally-empowered MSP can transform entire traditional industries (de Reuver et al. 2018). Practical evidence also suggests that the insurance industry might be highly affected by MSP and the rise of new ecosystems within the next years (e.g., Catlin et al. 2018; Noack et al. 2017). Against this background, the following research question can be posed:

RQ5: How and to what extent might MSP change value creation of the future insurance industry?

GAFAM in Healthcare (III.2)

The healthcare sector is of vital importance for both society and economy. Global spending on health amounted to US$ 7.8 trillion in 2017 and continues to rise, partly because of expensive digital technologies (WHO 2019). Recently, the COVID-19 pandemic has yet again elevated the importance of digital health solutions. As a result, advanced digital and data-enabled technologies increasingly diffuse the healthcare market, which undergoes a costly and massive digital transformation (Agarwal et al. 2010; Lapão 2019; Menvielle et al. 2017; Pousttchi et al. 2019b). Both academic and practical literature indicate that digital platforms might decisively contribute to that transformation (Chen 2019; Hermes et al. 2020c; Zenooz and Fox 2019). Big digital platforms have concentrated enormous power and radically changed our work, private and social lives. This particularly accounts for Google, Apple, Facebook, Amazon, and Microsoft (GAFAM), as the most successful platforms and most valuable companies in the world (van der Aalst et al. 2019). These players build upon personal data that consumers produce with their services or products, and employ these data to create personalized services or offer pinpoint advertising space to other companies. Health-related data might become another puzzle piece to complete the big picture, and recent GAFAM activities and statements underpin their ambitions strongly (Kimmell 2019b). Available research has examined digital platforms from various perspectives and disciplinary approaches (Abdelkafi et al. 2019; Sutherland and Jarrahi 2018). However, there is comparatively little knowledge and theoretical conceptualization from a holistic standpoint on how and to what extent big digital platforms redesign entire ecosystems and markets such as healthcare (Agarwal et al. 2010; Asadullah et al. 2018; de Reuver et al. 2018). Against this background, the following research question can be posed:

RQ6: How do GAFAM platforms affect value creation in the future healthcare market?

Digital Platform Regulation (III.3)

Digital platforms have proven to be successful and powerful players in our networked and digitalized economy and society. In recent years, they have radically diffused our work, private and social lives. This way, they can offer companies and governments an exclusive, carefully targeted access point to customers and citizens, acting as a gatekeeper (Pousttchi and Hufenbach 2013), affecting the three dimensions value creation, value proposition, *and* customer interaction (Pousttchi and Gleiss 2019; Gleiss et al. 2021). Particularly Google, Apple, Facebook, Amazon, and Microsoft (GAFAM) – as the most successful platforms and most valuable companies in the world (van der Aalst et al. 2019) – build upon consumer data from their personalized services and products. On the one hand, this makes them perfect matchmakers among the most diverse user groups. On the other hand, it implies enormous economic, political, and societal power, which does not only challenge the authority of national states but also entails unprecedented dependencies. Consequently, public concerns and debates about power and influence of digital platforms have risen, and governments around the world attempt to catch up on their neglects in the past decade to curb platform dominance (Nylen 2020). Given the dynamics of digital and networked markets, we require comprehensive and sustainable regulatory approaches that successfully address the concerns with digital platforms on the one hand, and maintain their matchmaking efficiency on the other hand. The interdisciplinary landscape provides a bouquet of practical and scientific pieces that address digital platform regulation (DPR). Despite the increasing relevance of DPR, there is no contribution that explores the underlying problems with digital platforms systematically and comprehensively. Especially, the IS research community has humbly effaced itself so far from the academic discourse on DPR (Gozman et al. 2020). Against this background, the following research question can be posed:

RQ7: How can we classify negative impact patterns of digital platforms and relate them to appropriate regulatory measures?

I.3 Thesis Structure

Based on the introductory foundations in Chapter I up to this point, this section aims to provide a brief overview of the subsequent chapters and the included research papers. The following *Chapter II* addresses the strategic impact of digital technologies on companies.

Research paper II.1 approaches DT quite fundamentally and aims to explore potential cause-effect relationships between the application of digital technologies and their impact on the enterprise along the three different dimensions of DT. For this purpose, we conduct a concept-oriented multiple-case study analysis of 75 DT projects in different companies across various industries. The outcome is threefold: First, a systematic categorization of digital technologies (technology framework). Second, a set of 10 detailed impact types of DT along with their subgroups. Third, a coherent conceptual model of technologies, causes and impact types along the three dimensions of DT.

Research paper II.2 zeroes in on the value creation model of DT and aims to explore digital innovation (DI) barriers in hospitals to assess how a hospital data management platform (HDMP) architecture might help hospitals to overcome such barriers and extract innovative capabilities. Based on the concept of organizational ambidexterity (OA), we pursue a qualitative mixed-methods approach. First, we explore and consolidate innovation barriers through a structured literature review (SLR), interviews with 20 startup representatives, and a focus group interview with a hospital IT team and the CEO of an HDMP provider. Second, we conduct a case-study analysis of 36 digital health startups to explore and conceptualize the potential impact of DI and apply the morphological method to synthesize our findings from a multi-level perspective. As a result, we provide a classification of typical DI barriers in hospitals, and explain how an HDMP might mitigate such barriers to extract value from DI at both individual and organizational level by means of a multi-level framework.

Research paper II.3 focuses on the value proposition model of DT and aims to understand and synthesize available taxonomies of data-driven business models and services (DDBM/DDS) within IS research. At this, we pursue a two-phase approach. First, we conduct a structured literature review on DDBM and DDS taxonomies, following the guidelines from Webster and Watson (2002) and vom Brocke et al. (2009). Second, we compare and synthesize the identified 26 taxonomies through defining the common building blocks and developing a consolidated taxonomy of DDBM and DDS according to Nickerson et al. (2013). Here, we rely on 30 empirical cases with DDBM to validate and refine our taxonomy. As a result, we derive and define 14 generic building blocks of DDBM to develop a consolidated taxonomy that represents the current state of the art in IS research.

Research paper II.4 targets the customer interaction model of DT and aims to explore the phenomenon of on-demand healthcare through an explorative and qualitative design-oriented approach consisting of two phases. The first (exploration) phase comprises an analysis of closely related definitions, a structured literature review, in-depth expert interviews, and a case-study analysis of digital health applications. In the second (synthesis) phase, we systematically code and aggregate our findings into a coherent conceptual framework and definition of on-demand healthcare.

Building upon these DT foundations, *Chapter III* refers to the strategic impact of digital platforms on companies, markets, and the economy and society at large.

Research paper III.1 investigates the impact of digital platforms on the value creation, value proposition, and customer interaction of traditional insurance companies. For this purpose, we analyze the state of the art in research and practice in order to develop a reference model of the value network for the insurance industry. On this basis, we conduct a case-study analysis with a special focus on platforms to discover and analyze roles, which are occupied or even newly created by multi-sided platforms (MSP) in the network. As a final step, we categorize MSP with regard to their relation to traditional insurance companies. The outcome of the paper is threefold: a role-based reference model of the insurance value network; the identification and analysis of insurance-related MSP configurations through an MSP-impacted insurance value network; a taxonomy resulting into the derivation of four MSP standard types in the insurance industry.

Research paper III.2 addresses the impact of digital platforms on value creation in the healthcare market, with a particular focus on Google, Apple, Facebook, Amazon, and Microsoft (GAFAM). We rely on multiple case study and value network analysis to examine both the conventional and platform-induced healthcare market to demonstrate how GAFAM platforms introduce new value-creating roles and mechanisms in healthcare through their manifold products and services. Hereupon, we systematically derive and analyze the strategic impact of GAFAM platforms on value creation in the healthcare market, culminating into a GAFAM-impact framework. Our findings show that GAFAM platforms are about to affect value creation in healthcare in various ways as they diffuse and invert the market at different tie points barging in between conventional value flows and interaction types.

Research paper III.3 refers to the gap of digital platform regulation (DPR). Specifically, we aim to draw on empirical evidence, interdisciplinary DPR research, and IS knowledge to conceptualize and understand the actual regulatory problems with digital platforms in order to derive regulatory options. At this, we analyze 128 cases of platform-induced problems and 83 historical regulation cases in due consideration of platform and regulation theory. The outcome of this paper is twofold: First, we provide a conceptual classification of digital platform problems with a special focus on the role of IS and IT. Second, we derive regulatory options and develop a taxonomy of digital platform regulation. Our findings show that digital platforms capitalize on both platform- and monopoly-related problems to assert themselves in different markets. This way, they even have become serious challengers to the regulator in governing markets through controlling market access, key conditions and resources.

The concluding *Chapter IV* synthesizes the findings of this thesis, portrays its contribution to IS research, and offers further pinpoint research opportunities in the DT research landscape. Figure I.3-1 provides an overview of the thesis' structure, involving the focal points and approaches of the included papers.

Chapter	I – Introduction	II – Studies on the Impact of Digital Technologies				III – Studies on the Impact of Digital Platforms			IV – Conclusion
Paper	I.1: Background & Motivation I.2: Aim & Scope I.3: Structure	II.1: Technology Impact Types	II.2: Organizational Ambidexterity	II.3: Data-driven Business Models	II.4: On-demand Healthcare	III.1: Platforms in Insurance	III.2: GAFAM in Healthcare	III.3: Digital Platform Regulation	IV.1: Synthesis IV.2: Outlook
Focus		DT: Foundations and Overview	DT1: Value Creation Model	DT2: Value Proposition Model	DT3: Customer Interaction Model	Platform Impact on Traditional Companies	Platform Impact on Traditional Industries	Platform Impact on Economy and Society	
Research Question		How can we classify the impact of digital technologies on companies along the three dimensions of digital transformation?	How can hospitals explore and integrate innovative technologies while maintaining their IT ecosystems?	What makes a data-driven business model and what are its core elements?	What is on-demand healthcare and what are the relevant components?	How and to what extent might multi-sided platforms change value creation of the future insurance industry?	How do GAFAM platforms affect value creation in the future healthcare market?	How can we classify negative impact patterns of digital platforms and relate them to appropriate regulatory measures?	
Methods & Data		‣ Structured literature review *on digital technologies* ‣ Case study analysis, qualitative content analysis, & morphological analysis *w/ 75 DT projects in companies (from online publications)* ‣ Systematic classification *on basis of findings*	‣ Structured literature review *on digital health barriers* ‣ Structured Interviews *w/ 20 startup representatives* ‣ Focus group interview *w/ staff (hospital IT; IT provider)* ‣ Case study analysis *w/ 36 digital health startups (from online sources)* ‣ Systematic classification *on basis of findings*	‣ Structured literature review *on data-driven business models* ‣ Systematic meta-taxonomy development *from 26 taxonomies after SLR*	‣ Structured literature review *on on-demand healthcare* ‣ Structured Interviews *w/ 14 digital health experts* ‣ Case study analysis *w/ 16 digital health services (from online sources)* ‣ Systematic definition and framework development *on basis of findings*	‣ Case study analysis, qualitative content analysis, & morphological analysis *w/ 57 insurtech services (from online sources)* ‣ Value network analysis and e3 value modeling *w/ findings from literature review and case study analysis*	‣ Case study analysis, qualitative content analysis, & morphological analysis *w/ 53 GAFAM services (from online sources)* ‣ Value network analysis and e3 value modeling *w/ findings from literature review and case study analysis*	‣ Case study analysis, qualitative content analysis *w/ 128 platform issues w/ 83 regulation cases (from online sources)* ‣ Systematic classification & taxonomy development *w/ findings from literature review and case study analysis*	
Key Results & Findings		‣ Technology framework ‣ Classification of impact *60 impacts, 10 impact types* ‣ Coherent conceptual model of technologies, causes, and impact	‣ Categorization of digital health innovation barriers *27 barriers, 6 barrier types* ‣ Assessment of barrier-mitigating effects of HDMP ‣ Classification + multi-level framework of hospital digital innovation impact *parties, impact areas/causes*	‣ Taxonomy of data-driven business models *14 DDBM building blocks*	‣ Conceptual framework of on-demand healthcare *prerequisites, drivers, service standard types/attributes* ‣ Definition of on-demand healthcare	‣ Traditional insurance value network *w/ 15 roles* ‣ MSP-impacted insurance value network *w/ 25 roles* ‣ Taxonomy and standard types of MSP in insurance *competition, coordination, cooperation, collaboration*	‣ Value network of traditional healthcare market *w/ 19 roles* ‣ Value network of platform-impacted healthcare market *w/ 37 roles* ‣ Classification of healthcare platform business models ‣ GAFAM impact framework *facilitators, activities, effects*	‣ GAFAM business architecture ‣ Classification of digital platform problems *6 problem classes, 17 causes* ‣ Taxonomy of digital platform regulation *3 gatekeeper dimensions, 7 regulatory options*	
Publication		Pousttchi K, Gleiss A, Buzzi B, Kohlhagen M (2019). **Technology Impact Types for Digital Transformation.** *21st IEEE Conference on Business Informatics (CBI) 2019, Moscow (Russia).*	Gleiss A, Lewandowski S (2021). **Removing Barriers for Digital Health through Organizing Ambidexterity in Hospitals.** *Journal of Public Health (online first).*	Dehnert M, Gleiss A, Reiss F (2021). **What Makes a Data-driven Business Model? A Consolidated Taxonomy.** *Proceedings of the 29th ECIS 2021, Marrakesh (Morocco).*	Gleiss A (2020). **The Patient Will See You Now – Towards an Understanding of On-demand Healthcare.** *22nd IEEE Conference on Business Informatics (CBI) 2020, Antwerp (Belgium).*	Pousttchi K, Gleiss A (2019). **Surrounded by Middlemen – How Multi-sided Platforms Change the Insurance Industry.** *Electronic Markets 29(4): 609-629.*	Gleiss A, Kohlhagen M, Pousttchi K (2021). **An Apple a Day – How the Platform Economy impacts Value Creation in the Healthcare Market.** *Electronic Markets (online first).*	Pousttchi K, Gleiss A, Degen K (under review). **Identifying the Patterns. A Systematic Approach to Digital Platform Regulation.** *Submitted to: International IS Journal (3rd Review Round)*	

Figure I.3-1: Thesis Structure and Contents

II Studies on the Impact of Digital Technologies

II.1 Technology Impact Types for Digital Transformation

Authors: Pousttchi K, Gleiss A, Buzzi B, & Kohlhagen M

Published in: 21st IEEE Conference on Business Informatics (CBI 2019), Moscow (Russia)

Abstract: *Digital transformation is based on direct and indirect effects of the application of digital technologies and techniques on organizational and economic conditions on the one hand and new products and services on the other. Its impact can be distinguished in three dimensions: value creation model, value proposition model and customer interaction model. The paper provides a generic model that helps exploring potential cause-effect relationships between the application of digital technologies and their impact on a company along the three dimensions. Based on 75 case studies, the outcome is threefold: (1) a systematic categorization of digital technologies, (2) a set of 10 detailed impact types of digital transformation along with their subgroups, and (3) a coherent model of technologies, causes and impact types along the three dimensions of digital transformation.*

1 Introduction

Digital transformation is based on direct and indirect effects of the application of digital technologies and techniques on organizational and economic conditions on the one hand and new products and services on the other. Besides constantly increasing computing power and miniaturization of classical IT components, the ubiquitous integration of these components into all types of technology has to be taken into account, especially in conjunction with:

- comprehensive use of sensors and actors including audio and video recordings,
- use of mobile communication technologies for networking and automated communication with very low latency (internet of things),
- elicitation, archiving and processing of very large data sets with the application of big data techniques,
- various techniques of machine learning,
- advanced forms of human-computer interaction.

Particularly, the combination of these factors leads to new potentials for comprehensive automation of cognitive und mixed mechanical-cognitive tasks. Current examples for the first are automated comparisons of legal documents, for the latter self-driving cars or the autonomously flying drones. Further relevant techniques simulate or extend reality with digitally generated information (virtual/augmented reality).

The impact on enterprises and industries can be distinguished in three dimensions (value creation, value proposition and customer interaction (Pousttchi 2017, see Figure II.1-1). The first dimension includes the technology influence on business processes, the general organization of an enterprise, and its workforce. The second dimension includes the influence on the selection of products and services proposed to the market and their according revenue models. The third dimension includes all types and mechanisms of interaction with customers, and especially impacts of platform-economy dynamics (Pousttchi and Gleiss 2019).

Digital transformation does highly impact a company's business activities and therefore its success as available academic and practical contributions indicate. However, there is still little knowledge of the implications in their entirety and how this is induced by the exploitation of specific digital technologies. Against this background, the aim of the paper is to provide a theoretical foundation that helps to further explore potential cause-effect relationships between the application of digital technologies and their impact on the enterprise along the three different dimensions. Based on 75 case studies, the outcome is a technology categorization with 22 characteristics to be considered in a digital transformation project on the one hand and a set of 10 detailed impact types of digital transformation along with their subgroups on the other hand.

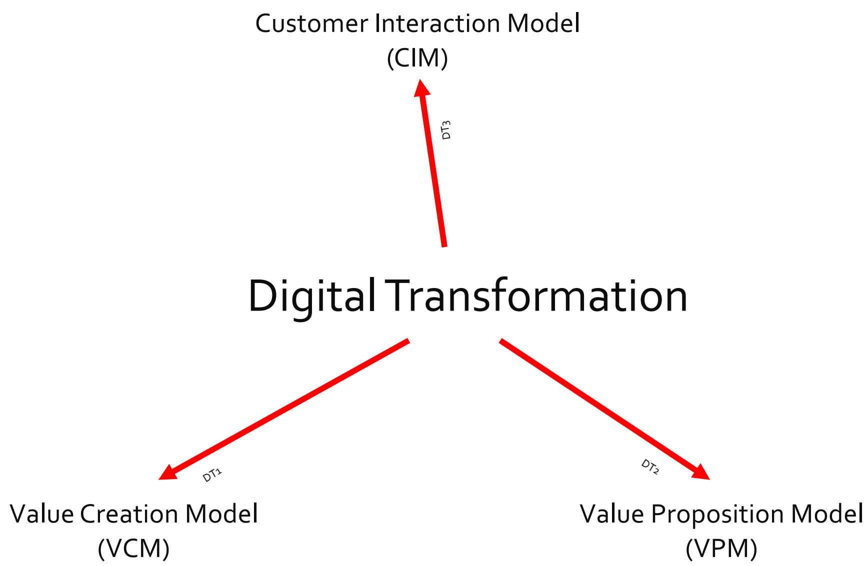

Figure II.1-1: Dimensions of Digital Transformation (adapted from Pousttchi 2017)

The rest of the paper is organized as follows: In section 2 we conduct a literature review and describe our methodical approach. In section 3 we identify relevant technology characteristics and their instances. In section 4 we develop a full set of technology impact types and their subgroups, resulting in a generic, coherent model that summarizes technologies, causes, and impact types and followed by a conclusion in section 5.

2 Background

2.1 Literature Review

Digital Transformation affects many industries as digital technologies increasingly change the way companies create and offer their propositions and interact with their customers (Pousttchi 2017). The combination of new technologies with innovative methods of data processing and analysis not only improves and disrupts existing business processes, but also enables completely new business models and markets (Constantinou and Kallinikos 2015; Seddon et al. 2017). Consequently, companies need to react properly to such digitally induced changes (Gimpel and Röglinger 2015) by developing and pursuing adequate strategies to exploit digital technologies in order to ensure or enhance competitiveness in global markets (Bharadwaj et al. 2013; Matt et al. 2015; Pagani 2013). The notion of digital transformation has been conceptualized in several ways. What most definitions have in common, is that they refer to digital transformation as a (massive) change process that companies undergo due to the emergence of new technologies and its social and economic implications (Pousttchi 2017; Morakanyane et al. 2017). Research on digital transformation has proliferated within the last years as the number of contributions and research calls indicates.

Some research papers shed light on the current state of the art by providing literature reviews on certain facets of digital transformation, e.g., concepts (Morakanyane et al. 2017), impact areas (Henriette et al. 2015), drivers, success factors, implications (Osmundsen et al. 2018), or the IT of organizations (Gerster 2017). Empirical contributions often concentrate on specific aspects. Some of this research delivers insights on digital transformation processes or effects within specific industries, such as automotive (Chanias and Hess 2016), healthcare (Agarwal et al. 2010; Smith and Watson 2019; Ghosh et al. 2018), fashion retailing (Hauser et al. 2019), newspapers (Karimi and Walter 2015), financial services (Cziesla 2014), or public procurement (Muñoz-Garcia and Vila 2018). Other contributions focus on specific components of digital transformation within companies, such as strategies (Ghosh et al. 2018; Westerman and Bonnet 2015; Matt et al. 2015) and its implementation (Berghaus and Back 2017), agility (Fuchs and Hess 2017; Mikalsen et al. 2018), drivers (Liere-Netheler et al. 2018; Klötzer et al. 2017), challenges (Henriette et al. 2016), or customer experience (Sahu et al. 2018), decision-making (Pousttchi and Dehnert 2018) and engagement (Sebastian et al. 2017). Likewise, the role of social media (Aral et al. 2013), enterprise architecture (Hafsi and Assar 2016; Kar and Thakurta 2018), or staff, organization and culture is examined (Müller and Renken 2017, Hafezieh and Pollock 2018; Eden et al. 2019; Kumar et al. 2016).

However, there is only little knowledge of the potential impact of digital transformation processes of companies. Morakanyane et al. (2017) derive the following key impacts by means of a concept-oriented literature review: value creation, operational efficiency, competitive advantage, and improved relationships. Likewise, Henriette et al. (2015) conduct a systematic literature review to explore how digitalization transforms business models, operational processes, and user experience. Osmundsen et al. (2018) pursue a similar approach and deduce the following three implications as a result of digital transformation: reformed IS organization, new business models, effects on outcome and performance. Horlach et al. (2016) review the role of bimodal IT in organizations and conclude that digital transformation will raise the coexistence of traditional *and* digital IT. Assar and Hafsi (2018) propose approaches to manage the impact of digital transformation on information systems.

Empirical contributions, in contrast, often focus on very context-specific impacts (e.g., automotive (Chanias and Hess 2016)). Piccinini et al. (2015) investigate the impact of digital transformation on automotive organizations highlighting the emergence of physical-digital paradoxes, while Hildebrandt et al. (2015) find out that OEMs are more likely to master digital transformation if they are able to acquire, integrate and commercialize external knowledge about digital technologies. Likewise, other researchers reveal how digital transformation affects the organization of large manufacturing companies (Bilgeri et al. 2017) or sourcing strategies of companies. Specifically, Demirbas et al. (2018) demonstrate that a financial service provider's outsourcing motivation has shifted from cost reduction to innovation, resulting in a decline in offshoring activities. Pousttchi and Gleiss (2019) explore the increasing role of multi-sided platforms in the insurance value network, which get empowered by exploiting digital technologies.

Other contributions investigate the role of cloud-based process changes. ICT service providers might benefit from the virtualization of their services in terms of a cloud-based digital transformation (Clohessy et al. 2017), while SMEs can improve their organizational performance resulting from service-oriented digital transformation activities, such as B2B-portal functionality (Chen et al. 2016). Nwankpa and Roumani (2016) ascertain the positive influence of digital transformation on the performance and innovation competencies of a company. Similarly, digital transformation can improve information quality and therefore help firms sense and respond to customer needs (Setia et al. 2013) or to increase performance due to the visibility of work, respectively (Timonen and Vuori 2018).

Altogether, the existent literature examines several aspects of digital transformation activities. However, it is missing a generic framework that covers digital transformation in its entirety and contextualizes causes, impacts and potentials of digital transformation activities in a structured manner. Therefore, the aim of this paper is to pursue a holistic and concept-oriented approach to provide such a generic model on an empirical, technology-focused basis that might give direction to explore potential cause-relationships of digital transformation activities and projects.

2.2 Methods

In order to gain a deeper understanding on how digital transformation can affect a company, we aim to empirically explore the various impact types from exploiting digital technologies. For this purpose, we apply a three-step approach. First, we systematically screened and categorized digital technologies on the basis of existent literature resulting in a hierarchically structured technology framework. Second, we conducted a multiple, concept-oriented case-study analysis in order to explore the multiple facets of potential impacts on the basis of 75 companies that have undergone digital transformation processes. Third, we inductively aggregated these impacts, resulting in 10 impact types. Following this approach, our research started with a systematic technology screening. For the sake of completeness of the technological foundations of digital transformation, we detected and screened existent literature on digital technologies both from research and practice.

Starting with the Gartner Hype Cycles from 2016 to 2018 and coherent guidelines on evaluating emerging technologies according (Peppard et al. 2011), we progressively complemented our technology portfolio with findings from academic (Information Systems, (Business) Informatics, Technology Management, Computer Science) and practical contributions (white papers, trend reports, annual reports, IT association guidelines, technology manuals) until theoretical saturation. In academia, this includes research and catchword papers focusing on specific technologies (e.g., Nofer et al. 2017; Lee 2008); in practice, we mainly screened publications from consulting and IT companies (e.g., PwC, SAP) as well as associations (e.g., Bitkom), complemented by an analysis of real-world cases.

For a systematic and complete categorization of the technologies identified, we applied the morphological method, a highly systematic approach for structuring multi-dimensional problems. It is particularly suitable for the exploration of complex problems that cannot be solved with formal (mathematical) methods, causal modeling, or simulation. The approach involves the identification and definition of the investigated problem's essential characteristics and the assignment of relevant instances to each characteristic. The aggregate of all critical characteristics and instances is represented by a morphological box, which allows for a structured analysis, systematization, and comparison of complex phenomena (Zwicky 1966; Ritchey 2013).

Hence, we first identified the main technology categories as characteristics before exploring and determining their distinct instances, i.e., subordinate digital technology types. The result is a complete morphological box with disjoint technology categories and types. The morphological box has been extended, modified and validated through the application and instantiation with real-world cases as well as discussions with practitioners and researchers. In order to provide a better understanding of how the technology categories related to each other we derived and developed a hierarchically structured technology framework. The framework helps to classify the technology categories by means of convergence, networking and data processing capabilities, and thus, complexity and sophistication of the respective technology types.

Based on the theoretical foundation of digital transformation and the technology framework, we conducted a multiple, concept-oriented case-study analysis in order to identify impact types from digital transformation activities for companies. A multiple-case study design is a viable research strategy to describe and understand scarcely explained but complex phenomena and to develop or test theory from empirical evidence (Benbasat et al. 1987). Empirical cases therefore help to both explore and substantiate knowledge about theoretical constructs by means of a theoretical replication, i.e., cases must be selected carefully so that the case-study design can lead to contrasting results for anticipatable reasons (Yin 2009).

Following these guidelines of multiple-case study research we developed a concept-oriented documentation scheme to protocol and analyze 75 empirical cases of companies from 40 industries and of different size that have undergone digital transformation activities or processes. Besides basic data about the company (e.g., sector, size, customer focus), several concepts have been applied to analyze each case: industry maturity and innovativeness, company innovativeness, market position, initial situation, competitive strategy, motivation for digital transformation activity, added-values generated, and the impact of the digital transformation process or activity. These impacts have been categorized by means of the three dimensions of digital transformation, i.e., value creation, value proposition, and customer interaction model. Each identified impact has been documented, labeled and assigned to one the dimension until theoretical saturation (i.e., adding more cases is not expected to reveal further impacts). Finally, all labeled impacts have been aggregated successively and inductively. We identified a total of 60 possible impacts of digital transformation resulting in 10 impact types.

Based on these impact types, which resulted from our multiple-case study, and in combination with the systematic technology review, we finally propose a coherent model of technologies, causes and impact types along the three dimensions of digital transformation.

3 Technology Framework

Our combined literature review and case-study analysis resulted in three major areas of technology:

- communication and other enabling technologies,
- technologies combining hardware and software in intelligent systems,
- data technologies.

Communication and other enabling technologies comprise all digital technologies and techniques which provide the basis for the development of complex systems and are used across all industries. This starts with *mobile communication systems*. For Wide Area Networks (WAN), mobile telecommunications according to 2G/3G/4G/5G standards are used. Local area networks (LAN) within buildings or compounds typically rely on Wi-Fi connections according to IEEE 802.11 standard family, personal area networks (PAN) and ad-hoc networks on Bluetooth or near-field communication (NFC). *Auto-identification systems (Auto-ID)* are typically based on barcodes, radio-frequency identification (RFID), or biometrical systems. *Positioning* can be realized with different systems outside of or within buildings. Relevant characteristics are cell-of-origin in mobile telecommunication networks as well as satellite-based Global Positioning System (GPS) and its European/Russian/ Chinese equivalents GALILEO, GLONASS, and BeiDou.

Additive manufacturing produces workpieces by layering shapeless or shape-neutral materials on the basis of 3D construction data. 3D printing is especially suited to build complex, light and stable three-dimensional structures and integrate functions. 4D printing adds another dimension. This refers, e.g., to objects that change over time or over differing environmental conditions, such as self-arranging furniture or clothing that adapts to different weather conditions. Printed electronics bring integrated circuits directly on a basis material, such as RFID tags on badges or stickers. *Computer architectures* comprise traditional semiconductor electronics as well as the developing of nano electronics, quantum computing, neuromorphic chips, and biocomputers.

While most of the latter might not be relevant to today's digital transformation projects, we include them to enable a holistic view on future technology options. Finally, the relevant type(s) of operating system(s) and of application software have to be specified.

At *combining hardware and software to intelligent systems*, we refer to eight components. *Mobile devices* basically comprise smartphones, tablets, and wearables. *Stationary devices* are typically desktop or laptop computers. *Ubiquitous computing (UC)* might integrate smart speakers, smart clothes, smart objects/embedded systems or reactive environment. The *human computer interface (HCI)* uses (multi-touch) displays, virtual reality, augmented reality, volumetric displays, conversational user interfaces, virtual assistants, and gesture control.

The characteristic *technical augmentation of human body and mind*, often also referred to as *human enhancement*, comprises technologies and techniques used directly connected to or even integrated in the human body for recovery, performance improvement or functional enhancement. Relevant instances include brain computer interfaces, implants, and prostheses or orthoses. *Robotics* refers to robots as typical actors in a technical system which exert physical influence on the environment.

	Characteristic	Instances								
Communication and other enabling technologies	***Mobile communication systems***	Mobile communications	WLAN	Bluetooth	NFC	Other	None / wired only			
	Auto-identification systems	Barcode	RFID	Biometrical systems	Other	None				
	Positioning	Cell of Origin	GPS	Indoor positioning	Other	None				
	Additive manufacturing	3D printing	4D printing	Printed electronics	None					
	Computer architecture	Semiconductor electronics	Nano electronics	Quantum computing	Neuromorphic chips	Biocomputer	Other			
	Operating systems (OS)	Desktop OS	Mobile OS	Embedded OS	Realtime OS	Other				
	Application software	Native desktop application	Native mobile app	Web app	Hybrid app	Embedded application	Other			
Combining hardware and software to intelligent systems	***Mobile devices***	Smartphone	Tablet	Wearable	Other	None				
	Stationary devices	Desktop computer	Laptop	None						
	Ubiquitous computing	Smart speaker	Smart clothing	Smart object / Embedded system	Reactive environment	None				
	Human-computer interface	(Multi-touch) display	Virtual reality	Augmented reality	Volumetric display	Conversational user interface	Virtual assistant	Gesture control	Other	
	Technical augmentation of human body and mind	Brain-computer interface	Implants	Prostheses & Ortheses	Other	None				
	Robotics	Industry robot	Collaborative robot	Service robot	Humanoid robot	Autonomous mobile robot	Modular robot	Soft robot	Other	None
	Mobility	Connected vehicle	Autonomous vehicle	Drone	Vehicle sharing	Other	None			
	Internet of Things	Virtual equivalent	Spontaneous networking	Cyber-physical systems	IoT platform	None				
Data technologies	***Established database technologies***	Relational data model	Object-oriented data model	Hierarchal data model	Other	None				
	New database technologies	NoSQL database	In-memory database	Distributed file system	Blockchain	Other	None			
	IT infrastructure	Local	On-premise	Cloud computing	Serverless computing	Edge computing	Other			
	Data analytics	Data mining	Text & Sentiment	Video & Audio	Web	Geospatial	Predictive	Other		
	Big Data	Data integration	Batch processing (MapReduce)	Stream processing	Search & Discovery	Visualization & Dashboards	Self-service analytics	Realtime analytics	Other	None
	Artificial intelligence	Rule-based systems	Machine learning	Neural networks	General artificial intelligence	Other	None			
	Information security	Encryption	Biometrical systems	Hardware security	Software-defined security	Browser isolation	Cloud security	Deception	Other	

Figure II.1-2: Technology Framework for Digital Transformation

Instances can be classic industry robots, collaborative robots, service robots, humanoid robots, autonomous mobile robots, modular robots, and soft robots, e.g., using soft plastic resembling to human arms for gripping devices, often also using pneumatic control in order to grip fragile objects. Robots can be used in very diverse form factors – in Japan, for instance, as pets. The last two categories are *mobility* in various settings and *IoT functionality*, especially including virtual equivalents ("digital twins"), spontaneous networking, and cyber-physical systems.

Finally, the characteristic *data technologies* consists of seven components. *Established database technologies* refer to the classic three data models, *new database technologies* to NoSQL, in-memory, distributed file systems, or blockchain. *IT infrastructure* can be local, on-premise, cloud, serverless or by means of edge computing. The characteristic *data analytics* comprises (classic) data mining and predictive analysis as well as in particular the distinction of text and sentiment, video and audio, web, and geospatial data. Next are *big data* techniques including data integration, batch processing (MapReduce), stream processing, search and discovery, visualization and dashboards, self-service analytics and real-time analytics. The use of *artificial intelligence* includes rule-based systems, machine learning, neuronal networks and general artificial intelligence. While the latter always draws special public (and political) attention, its existence seems to be a very far prospect. The final category is the use of *information security* techniques. Figure II.1-2 shows our categorization with all areas, characteristics and instances of digital technologies by means of a morphological box according to Zwicky (1966).

4 Derivation of Impact Types

As our literature review indicates, digital transformation is a complex and multifaceted phenomenon. Its convergent character makes it barely possible to assign the eclectic impacts distinctly to their underlying causes and technologies (see section 3). In order to gain a deeper understanding of how these technologies might be exploited for digital transformation and how this finally affects a company's business activities, we conducted a concept-oriented case-study analysis. Thus, we considered 75 real-world companies which have undergone a digital transformation process, of different size and from different industries (e.g., financial services, retail, telco, manufacturing, agriculture). As a result, we identified 60 possible impacts, which we inductively aggregated to a full set of 10 impact types. This section aims to discuss these impact types, resulting in our schematic impact model for digital transformation activities and processes (Table II.1-1). Digital transformation processes and activities can have various implications. Some are intended, others are not, some become immediately apparent, others arise years later. We grouped the impact types according to the dimensions shown in Section 1.

With respect to the value creation model of a company the first impact type refers to *process alignment*. The implementation of digital technologies can affect the business processes in many ways, i.e., transparency, speed, efficacy, efficiency, integration, automation. In some cases, process alignment aimed at meeting (new) legal requirements, changing the degree of the customers' process involvement, or tying in upstream processes of suppliers with internal ones. Another impact type relates to the *staff* of a company. At this, digital transformation can change recruiting practices and help

Table II.1-1: Technology Impact Types for Digital Transformation

#	Impact Type	Impact	Description
1	process alignment	transparency	transparency for management can be increased
		speed	processes get faster
		efficacy	processes get more effective
		efficiency	processes get more efficient
		integration	processes can be combined to new integrated processes
		automation	human work power can be replaced
		legal requirements	legal requirements are met
		customer involvement	degree of customers' process participation changes
		supply chain	upstream processes are tied in with internal processes
2	staff	skill shortage	skill shortage can be addressed
		empowerment	employees get involved in decision-making
		creativity	creativity is fostered or contained
		inspiration	inspiration can be drawn
		safety + health	importance of wellbeing of staff changes
		recruiting	new staff can be recruited with new approaches
3	exploitation of data	key performance indicators	digitalization allow for new KPI and testing for efficacy, efficiency, or profitability
		digital twins	physical objects (and their states) can be mirrored digitally
		information gain	customers or employees can access more, better, or more recent information
		customer data	data on customer behavior or needs is accessible
		market data	market data allows for improved market analyses and supply
		real-time data	real-time data can be processed and exploited
		monitoring	objects, facilities, commodities, or persons can be monitored (remotely)
		ubiquitous data	data and analyses can be accessed without restrictions on time or place
4	networks	networking	different stakeholders can interact with each other
		cooperation	different stakeholders can cooperate with each other
		platforms	different stakeholders can trade with each other or are dependent on a platform
		network effects	network effects impact the company's performance
5	business development	core business	(offline) core business is affected
		business model adjustment	new (data-based) business models are rendered possible
		business prospects	business can grow and decline
		organizational structure	intra-organizational structures are aligned
		outsourcing	units or tasks can be outsourced
		resource dependency	(digital) resources can be possessed or exploited more independently
		third-party dependency	degree of dependency on service or product providers changes
		structural dependency	degree of organizational flexibility changes
6	product development	product innovation	innovative products/services can be invented
		product creation	new or better products/services can be created
		product integration	products and/or services get combined
		aggregation	products and/or services are aggregated to portfolios or platforms
		design	new designs can be created
		customization	products or services can be customized to customer needs
		cost reduction	product/service helps customers to save money or time
		product quality	product/service quality can be modified
		update functionality	products or services can be updated (continuously)
		interoperability	products and/or services are compatible with other products and/or services
		add-ons	up-/cross-selling opportunities appear
		digital enabler	product/service helps customers with their digital transformation
7	customer behavior	customer attitude	company-related customer experience shifts
		customer decisions	the way customers make purchasing decisions is affected
8	customer relations	customer services pre-sales	pre-sales customers service quality changes
		customer services after-sales	after-sales customers service quality changes
		customer support	quality of customer support changes
		user experience	user experience quality changes
		community building	community building is rendered possible
		customer retention	customer retention is affected
		lock-in	customer is locked-in within the ecosystem
9	channel management	customer interface	style of communication, interaction, or transaction changes
		channel development	mode of communication, interaction, or transaction changes
10	marketing	marketing mix	new ways to promote the product/service are rendered possible
		brand	company brand is affected

addressing skill shortage. Other activities can increase employee empowerment or foster creativity, inspiration, or safety and health of the staff. The third impact type considers new opportunities resulting from the *exploitation of data*. Basically, the availability of new data sources allows for new key performance indicators and an accurate testing of processes or units for efficacy, efficiency, or profitability. Physical objects and their conditions can be mirrored (digital twins) and monitored digitally, supported with real-time data from anyplace (ubiquitous data). Likewise, more, new, better, or more recent data from market or customers can be retrieved. As a result, management, employees, or even suppliers, and customers can access more information individually. The forth impact type subsumes implications from *networks* that allow for interaction, cooperation, or transaction with other market participants, which eventually arise from or result in network effects.

Other impact types are rather related to the value proposition model of a company. Basically, digital transformation can impact the business or the product development activities. Hence, one impact type covers the *business development* of companies. Particularly, traditional companies sense the implications of digital transformation on their (offline-based) core business. The exploitation of digital technologies might either impair or promote the core business, if intended or not. Accordingly, the underlying business model might be modified by digital transformation. This includes the adaptation to new revenue sources, customer segments, resources, or suppliers. Digital transformation might also affect the business prospects of a company. For instance, extending the business model might lead to a growth of business, while external factors (e.g., a lack of demand) can easily force a decline. Such developments might require shifts within the organizational structures or a careful deliberation of the outsourcing strategies. Moreover, digital transformation can either increase or mitigate the dependency on resources, market participants, or structural circumstances (e.g., political or environmental).

Another impact type refers to digitally-induced implications on *product development* as digital transformation gives rise to completely new products and services (product innovation) or improved or modified versions of already existing ones (product creation). Additionally, products and services can be combined to integrated bundles or aggregated with complementary products or services with added value for the customer, e.g., on platforms. Digital technologies do also pave the way for new design configurations as well as customized products and services according to the customers' individual needs and configurations. Especially, mass customization can combine low-cost units of traditional manufacturing with the flexibility of individual customization. Moreover, digital technologies can be exploited for reasons of cost reduction or changes in product quality or simply to offer update functionalities, interoperability, or add-ons. Lastly, companies can purchase enabling products or services for their own digital transformation.

Impact types in the context of customer interaction imply customer behavior, customer relations, channel management, and marketing. Regarding *customer behavior*, companies might conduct digital transformation activities in order to influence the customer attitude towards the brand or manipulate the way they make (purchasing) decisions. As a consequence, the way companies maintain *customer relations* is adjusted alike. This implies changes in the quality of customer service (pre-/after-sales) and support and in the techniques to create user experience. Moreover, companies attempt to increase customer loyalty with digital transformation activities

For that reason, innovative methods of community building and customer retention can be applied, while lock-in effects can be capitalized. Such activities require changes of the *channel management*, which involves modified styles and modes for communication, interaction, and transaction with the customers. On the one hand, look and feel of the channels can be redesigned. On the other hand, the channel portfolio can be adjusted accordingly, e.g., by pursuing either multichannel or omnichannel strategies. In terms of *marketing*, digital transformation can affect the marketing mix of a company as it allows for several new ways of promoting the products and services to the customers. In some cases, digital transformation affects the brand of a company as it can raise brand awareness or enable a rebranding, a brand refresh or the creation of new (affiliated or subordinate) brands.

All in all, our case-study research has revealed 10 impact types across the three dimensions, originating from digital transformation processes or activities of 75 companies. Such processes or activities have always entailed – intended or unintended – an impact on value creation, value proposition, or customer interaction. What is more, each digital intervention revealed a plethora of impacts which might even correlate or cross-fertilize. However, all impact types have their origin in the five underlying causes of digital transformation. Figure II.1-3 illustrates the complex relationship among the underlying causes, resulting impact types, and affected dimensions of digital transformation by means of a coherent model.

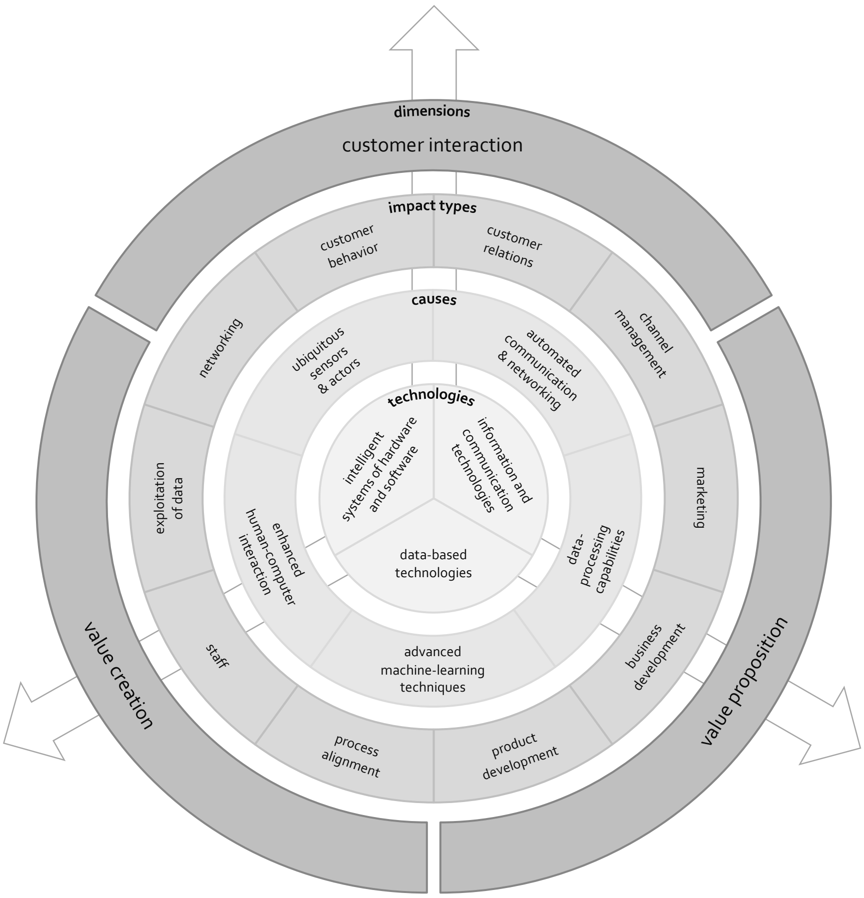

Figure II.1-3: Technologies, Causes, Impact Types, and Dimensions

5 Conclusion

The starting point for our considerations was to better understand and systemize the impact of the application of digital technologies and techniques on organizational and economic conditions on the one hand and new products and services on the other. We explored the impact on companies along the three dimensions of digital transformation: value creation model, value proposition model, and customer interaction model, using data from 75 cases studies from 40 industries. The outcome of the paper is threefold. First, we developed a technology categorization with 22 characteristics to be considered in a digital transformation project. Second, we derived a full set of 10 detailed technology impact types along with their subgroups. Third, we systemize our results in a coherent model of technologies, causes and impact types along the three dimensions of digital transformation.

For researchers, our results provide a more generic understanding of digital transformation by means of a holistic model that covers technologies, causes, and impact types along the three dimensions of digital transformation. Thus, the model give direction to potential cause-effect relationships of digital transformation activities and projects. For practitioners, our results can be used as a reference and as a creativity tool to define a distinct technology mix or systematically develop the future business model along the three dimensions by considering both the technologies and impact types. For instance, our model could be used to explore the potential solution space for an enhanced digital customer interaction model by selecting and exploiting appropriate technologies consciously. Moreover, our results can serve as a basis for assessing a company's status quo of digital transformation and deliver a spectrum of potential implications of future digital transformation initiatives.

Future research could focus on further complement and conceptualize the impact types of digital transformation or even shed light on the correlation between the antecedents and implications of digital transformation processes and activities. Other contributions could differentiate between the exploration and exploitation of digital technologies to initiate transformation processes by empirical cases. From a more conceptual standpoint, research could extend existing theory to further explore and explain the phenomena of digital transformation, e.g., by applying the sociological concepts of hemostasis and entropy.

II.2 Removing Barriers for Digital Health through Organizing Ambidexterity in Hospitals

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Abstract: *Hospitals noticeably struggle with maintaining hundreds of IT systems and applications in compliance with the latest IT standards and regulations. Thus, hospitals search for efficient opportunities to discover and integrate useful digital health innovations into their existing IT landscapes. And although a multitude of digital innovations from digital health startups comes into the market, numerous barriers impede their successful implementation and adoption. Against this background, the aim of this paper is to explore typical digital innovation barriers in hospitals, and to assess how a hospital data management platform (HDMP) architecture might help hospitals to extract such innovative capabilities. Based on the concept of organizational ambidexterity (OA), we pursue a qualitative mixed-methods approach. First, we explore and consolidate innovation barriers through a systematic literature review, interviews with 20 startup representatives, and a focus group interview with a hospital IT team and the CEO of an HDMP provider. Finally, we conduct a case-study analysis of 36 digital health startups to explore and conceptualize the potential impact of DI and apply the morphological method to synthesize our findings from a multi-level perspective. We first provide a systematic and conceptual overview of typical barriers for digital innovation in hospitals. Hereupon, we explain how an HDMP might enable hospitals to mitigate such barriers and extract value from digital innovations at both individual and organizational level. Our results imply that an HDMP can help hospitals to approach organizational ambidexterity through integrating and maintaining hundreds of systems and applications, which allows for a structured and controlled integration of external digital innovations.*

1 Introduction

Digital transformation massively affects the value creation, value proposition, and customer interaction models of companies and entire branches. This also applies to the healthcare sector. Here, digital technologies have huge potential to enhance healthcare quality and reduce costs but face a multitude of adoption barriers (Agarwal et al. 2010; Pousttchi 2017; Pousttchi et al. 2019a). Healthcare is a complex, regulated and fragmented sector. Digital technologies diffuse from multiple directions (Chan et al. 2004; Fichman et al. 2011; Gleiss et al. 2021) and aim to improve the healthcare performance (Lapão 2019), allow for new business models (Menvielle et al. 2017), or possibly reshape the relationship between patients and healthcare providers (Brucher et al. 2018). Thus, they provide new ways and tools for the detection, diagnosis, and therapy of diseases as well as transforming entire processes of and around healthcare (Gimpel and Röglinger 2015; Pousttchi et al. 2019b).

Altogether, innovative and disruptive technologies might conceivably revolutionize the entire healthcare sector with remarkable consequences for providers, patients and other stakeholders (Christensen et al. 2017) – and there are yet technologies to follow which might help hospitals to become "smarter" (Bogdan 2018; Williams 2019). However, practical insights indicate that hospitals noticeably struggle with the massive changes around (Dash et al. 2019; Eddy 2020). Hospitals have to manage a plethora of (partly critical) IT systems and applications and need to comply with latest standards and regulations for IT and patient security. Therefore, it is challenging to simultaneously manage the existing IT systems and continuously explore new technologies. To find a remedy for this problem, hospitals might consider to integrate technologies from digital health startups, which are seen as one important driver of technology diffusion in healthcare (Chowdhury 2012; Villegas 2019).

Against this background, the aim of this paper is to explore how a hospital data management platform (HDMP) might support hospitals to leverage innovative capabilities by integrating digital technologies. We refer to the concept of organizational ambidexterity (OA) and pursue a qualitative mixed-methods approach with three major steps and results: (1) To explore and validate typical DI barriers in hospitals, we conducted a literature review on innovation barriers in hospitals with follow-up interviews with 20 representatives from digital health startups. (2) To assess the mitigating effects of the HDMP, we conducted a focus group session with a hospital IT team and the CEO of the HDMP provider. (3) To theorize on the potential impact of DI in hospitals, we conducted a case-study analysis of 36 digital health startups and applied the morphological method to synthesize our findings from a multi-level perspective. The rest of the paper is structured as follows. In Section 2, we provide background information on the referred theory and the HDMP project. In Section 3, we describe our methodical approach, before we present and analyze our findings in Section 4. At this, we assess how an HDMP might help to overcome barriers and leverage possible effects through the integration of digital innovations in hospitals. In Section 5, we provide a conclusion and outlook.

2 Background

2.1 Related Work: Digital Innovations in Hospitals

The healthcare sector undergoes a massive digital transformation these days as progress in the field of digital health illustrates (Agarwal et al. 2010). In this context, digital health means the usage of ICT in healthcare (Gersch and Wessel 2019) and affects organizations at all dimensions of digital transformation, namely value creation, value proposition, and customer (i.e., mostly: patient) interaction (Pousttchi 2017) as shown in Figure II.2-1.

In terms of *value creation*, digital technologies can help healthcare service providers to implement completely new processes or organizational structures (Bygstad et al. 2017; Denner et al. 2018). Hence, they can likewise improve treatment and reduce costs (Ghosh et al. 2018). For instance, sensors and machine-learning-based algorithms can help to detect diseases or disorders (Shen et al. 2013; Hussainy et al. 2017). In terms of *value proposition*, digital health paves the way for entirely new services or business models (Thambusamy and Palvia 2011), both for traditional healthcare providers and new tech players which enter the promising market. For instance, healthcare providers can offer telemedicine services for remote diagnoses and consultation (Miscione 2007), electronic health records (EHR) (Xie et al. 2019), or mobile devices and applications for the patients (Gurtner 2014). In terms of *customer interaction*, healthcare services providers can exploit these applications and devices for new forms of patient interaction and data generation to address patients' expectations and needs, such as on-demand healthcare solutions (Gleiss 2020).

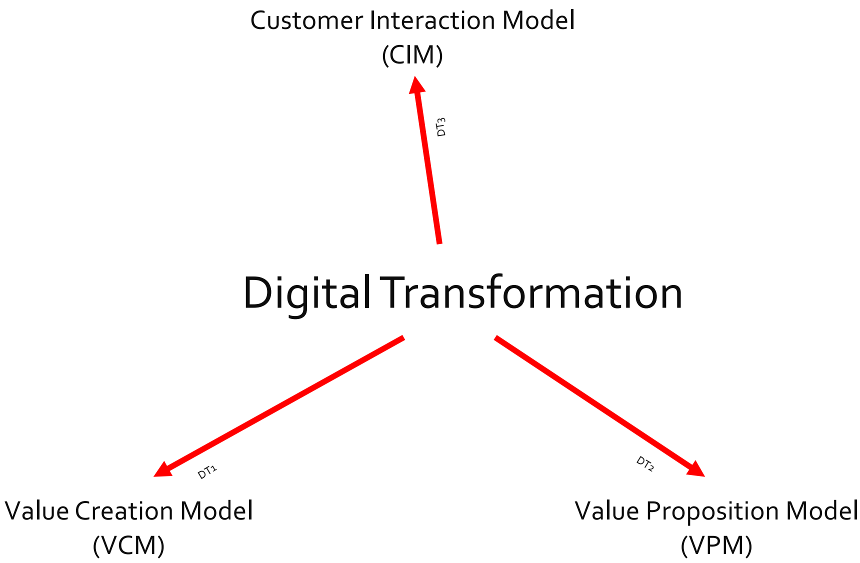

Figure II.2-1: Dimensions of Digital Transformation (adapted from Pousttchi 2017)

A crucial factor is the successful implementation of digital innovations, which implies the carrying out of new combinations of digital and physical components to develop novel products (Yoo et al. 2010). In contrast to the plethora of research in the field of digital innovation (e.g., Yoo et al. 2012; Hund et al. (2019), comparatively few contributions examine the healthcare sector (Kohli and Melville 2019). Vom Brocke et al. (2007) design a clinical process mapping methodology to support information systems innovation in a healthcare context which requires the integration of relevant stakeholders. In line with this, Scheplitz et al. (2019) have highlighted the critical role of healthcare information systems in digital innovation projects regarding processes, information flows, applications and IT infrastructures.

Especially, such information infrastructures seem crucial for the successful implementation of digital innovations (Grisot et al. 2013). Other contributions have explored success factors and reasons for failure of digital innovation projects in healthcare (e.g., Schubert 2004; Teoh 2010; Przybilla et al. 2018; Scheplitz et al. 2019). Further research focuses on the general diffusion of digital innovations in healthcare (Chan et al. 2004; Greenhalgh et al. 2004), especially by harnessing new digital technologies (Brown et al. 2014; Fernández 2017) like telemedicine (Steinhauser 2019) or big data (Ambigavathi and Sridharan 2018).

Altogether, startups bear the potential to revolutionize entire industries and might also play an important role in innovating healthcare (e.g., Chowdhury 2012; Mandl et al. 2015; Christensen et al. 2017; Garbuio and Lin 2019). Digital technologies in hospital care require collaborative innovation among multiple actors both within and beyond hospitals, so peripheral actors like clinicians or technology providers can bring in resources for both innovation and value creation (Aanestad et al. 2019). Particularly, living labs can foster frugal digital innovation based on open collaboration of different actors and stakeholders (Sahay et al. 2018). And although incumbent firms can benefit from collaborating with startups (Kohler 2016; Islam et al. 2017), research has not sufficiently explored such opportunities for healthcare service providers such as hospitals.

2.2 Organizational Ambidexterity of Healthcare Organizations

Hospitals need to manage hundreds of (partly critical) systems and applications which are used simultaneously and routinely (Bradley et al. 2012). Consequently, IT managers in hospitals are busy with the smooth run, maintenance and support of their IT landscape, which makes it complicated to continuously search for and implement new digital applications. They rather focus on exploiting their existing digital technologies than exploring new digital innovations to integrate. This dilemma is broadly covered by the concept of organizational ambidexterity (OA), which was introduced by Duncan (1976). He refers to an organization's ability to implement dual structures for managing the balance of alignment and adaptation as he found that organizations forfeit innovativeness and – in the long-run – competitiveness if they only concentrate on improving their efficiency. Over time, this concept has rooted in the consensus that OA implies the ability of a firm to simultaneously explore and exploit technologies (O'Reilly and Tushman 2004). Only those companies that are able to conduct both explorative and exploitative action are capable of incremental and radical innovation (Gibson and Birkinshaw 2004; Rothaermel and Alexandre 2009). Further research has extended this understanding of ambidexterity as a continuous and simultaneous balance of such activities in trade-off situations, while managing and harnessing these trade-offs helps improving the firm's performance (Rothaermel and Alexandre 2009; Wolf 2019) both on an organizational and individual level (Wolf and Lüttenberg 2020) as shown in Figure II.2-2.

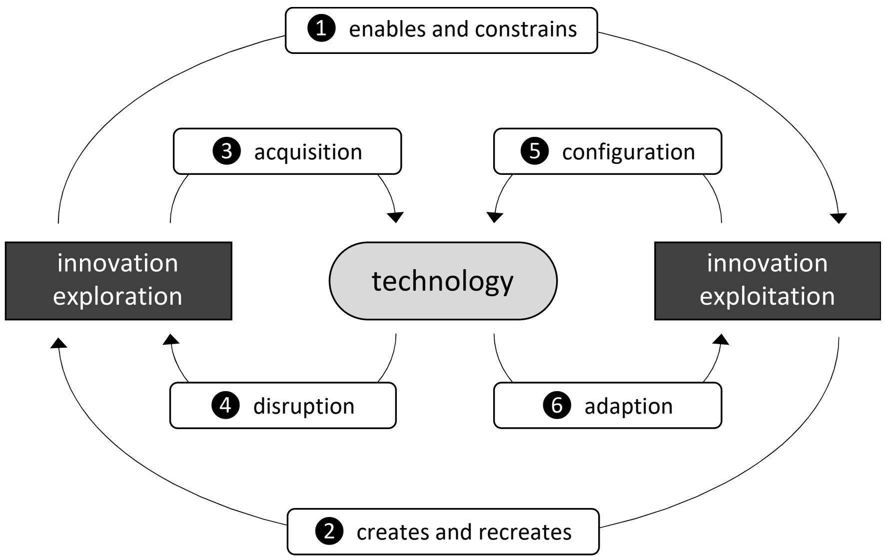

Figure II.2-2: Service Ambidexterity Framework (adapted from Wolf 2019)

Although there is plenty of theoretical research on OA, only a few contributions have applied this concept for studying a company's sourcing strategy. Accordingly, companies need to source new technologies both internally and externally to remain innovative and competitive at the same time (Rothaermel and Alexandre 2009; Raisch and Birkinshaw 2008), and digital infrastructures can be foundational for ambidextrous innovation processes (Montealegre et al. 2019), especially in healthcare settings (Abraham and Junglas 2011). Only a few contributions have adopted the notion of OA in the context of healthcare. Tarafdar and Gordon (2007) illustrate from a resource-based view how OA enables healthcare companies to recognize the strategic importance of innovation, and apply appropriate long-term evaluation criteria for projects. Bodwell (2011) demonstrates how OA is positively related to quality, and Kwak et al. (2016) show that process ambidexterity in healthcare organizations enhances team activities and performance. Burgess et al. (2015) examine the contextual and personal circumstances that enable middle managers to forge compromises between exploration and exploitation. Koster and van Bree (2018) found that OA in a hospital strengthens collaboration through increased interdependency, albeit hospitals rather switch between innovation and exploitation instead of being continuously ambidextrous. In contrast, Kizito and Kahiigi (2018) reveal how ambidextrous structures can be implemented by profound IT governance.

Altogether, organizations can take huge advantage of implementing dual structures to explore and exploit digital innovation and technologies likewise. In this context, externally integrated innovations can play a crucial part in the future innovativeness and competitiveness of healthcare organizations. Thus, the question remains how hospitals can remove barriers to extract advantage from digital health innovations by approaching ambidextrous structures. Against this background, we seek to explore how an HDMP can support such endeavors.

2.3 The "Health Engine" Project in a German Hospital

We accompanied the implementation of the "Health Engine", a hospital data management platform (HDMP), at a large hospital group in northern Germany. The hospital group has nine hospitals (with a total capacity of 2,200 beds and 6,700 employees) and runs 150 merely interoperable applications (50 applications with patient data). The HDMP has been developed by the Swiss software company "the i-engineers" and is widely used by Swiss hospitals. The HDMP is a healthcare-specific data-warehouse architecture with three tiers for comprehensive enterprise information management in hospitals. The database tier contains a performant and reliant Oracle database with PL/SQL, the object-oriented data model follows a clinical logic (structures and processes) and is compliant with IHE, HL7, and DICOM. The application tier provides processing mechanisms through a Java-based Spring Boot microservice framework that includes a REST backend interface (for clients and apps) and components for communicating with external services, peripheral systems, file storages and the database tier. Here, the HDMP provides several APIs. The client tier provides the front-end user interface based on HTML5 and Angular, which also allows for mobile applications.

The implementation entails three major tasks. First, a clear data model for the HDMP repository needs to be defined, both semantically and syntactically. This is important, as future changes might be more effortful. Ideally, the data model contains a master patient index (MPI), which allows for a cross-sectoral harmonization of patient and case records. Second, each system has to be connected separately, which requires manual mapping of the data attributes in the databases and communication servers, and programming of the interfaces between the systems and the HDMP. At this, the hospital and the provider had to work closely together. Third, the systems legacy data has to be replicated in the HDMP for mirroring. For instance, the integration of a bed sensor system to monitor patients' vital data took 14 person-hours, while the HIS integration took several weeks. Once implemented, the HDMP can be configured to retrieve and transfer data from and to many healthcare-related application and information systems in real time, such as HIS, PACS (picture archiving and communication system), as well as generic enterprise systems, such as ERP systems or office applications.

Furthermore, graphical user interfaces (GUI) can be programmed for the staff or patients, combining data from different sources. At this, basic functions can be integrated (e.g., print, PDF converting, text recognition, search, signature, recording). What is more, various data can be stored, managed and archived (e.g., patient, staff, or medical data), which allows for complete data backups. Thus, data is archived redundantly and completely owned and accessible by the hospital. Figure II.2-3 provides an overview of the HDMP architecture and the interfaces. The technical and semantical integration of all resources enables the design of personalized applications (including authorization and access management). For instance, a patient portal can be developed and attached. Consequently, the HDMP structure can be mapped onto the hospital-specific processes and organization structures. As the HDMP is compliant with international healthcare standards (DICOM, HL7, IHE), digital communication with external stakeholders (e.g., healthcare service providers, insurances) is facilitated.

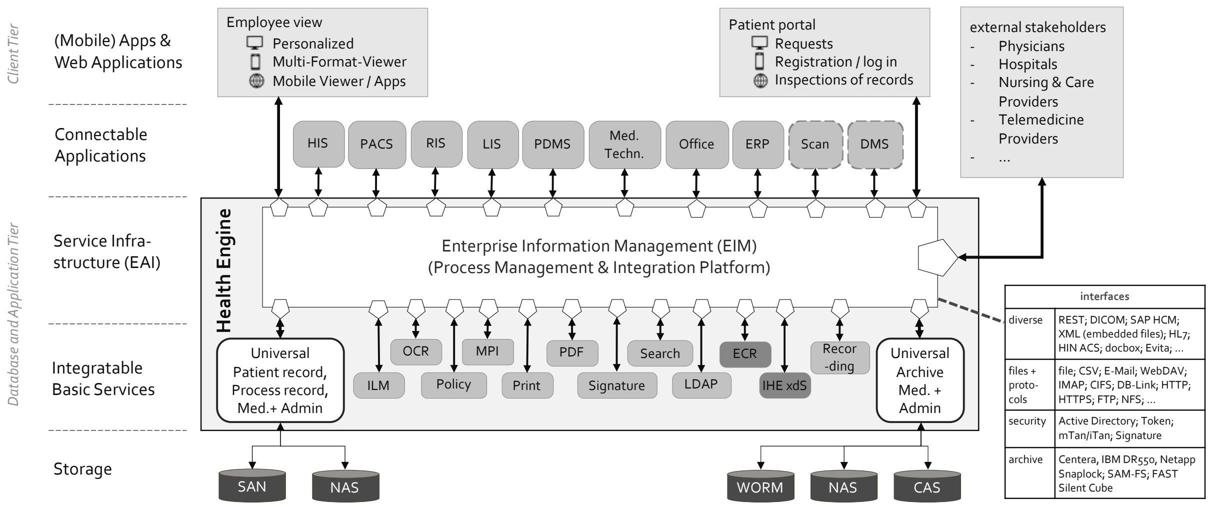

Figure II.2-3: Architecture of the HDMP "Health Engine" (cf. List of Abbreviations)

3 Methodical Approach

To address and frame our research question, we apply a mixed-methods approach consisting of three phases: exploration, consolidation, synthesis (see Figure II.2-4).

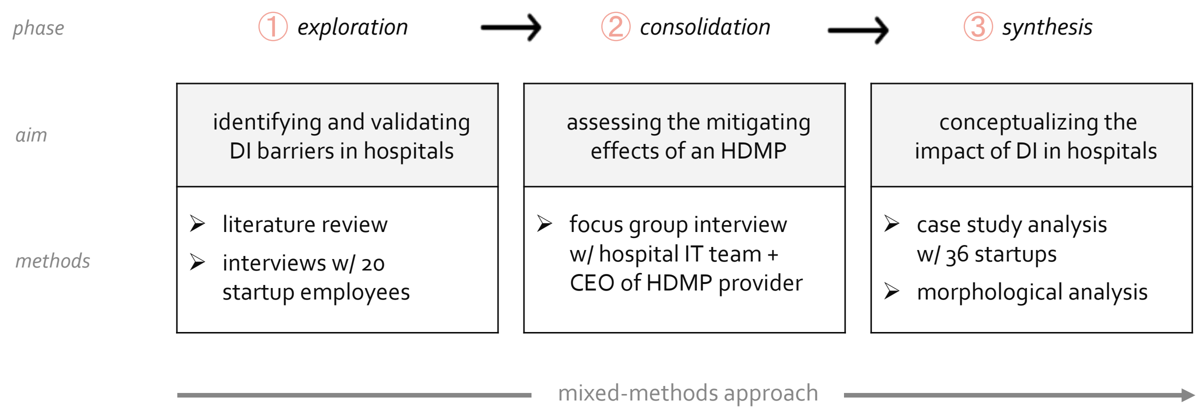

Figure II.2-4: Research Design (Innovation Barriers in Healthcare)

(1) The *exploration phase* answers the purpose of identifying barriers for digital innovations in hospitals. At this, we first conducted a systematic literature review to gather a representative coverage (Cooper 1988; Webster and Watson 2002) by an abstract and keyword search in relevant scientific databases (AISel, IEEE, EBSCOhost, ScienceDirect, Springer, Wiley) for the expression "("barrier*") AND ("digital*" OR "technolog*") AND ("hospital*" OR "clinic*" OR "*health*)", resulting in 952 potentially relevant papers. We then selected those contributions with a clear relation to our research question by reading the abstracts and removing duplicates (n: 56) and full texts of the remainders, which led to a total of 27 relevant research papers. We analyzed these papers to derive and define typical barriers for hospital innovation through an inductive coding method following the guidelines from Mayring (2000). Second, we sought for validation of the identified barriers from the supply side (i.e., digital health startups). Here, we conducted standardized, structured telephone interviews with representatives from 20 startups (e.g., CEOs, sales agents). At this, we specifically posed open-ended questions to elaborate on their experiences with business contacts and negotiations with hospitals (Patton 2014, p. 638). Each interview took 20-30 minutes, the answers were protocolled, coded, and specifically assigned to the barrier types. Altogether, we identified six superordinate barrier types (technological, organizational, behavioral, financial, legal, and structural) as a basis for the following two phases.

(2) The *consolidation phase* serves a dual purpose: For one thing, we sought for validation of the identified barriers from the demand side (i.e., hospitals). For another thing, we aimed to assess the mitigating role of an HDMP in this context. Thus, we conducted a three-hour focus group interview for evaluation (Patton 2014, p. 697) with three participants: the hospital CIO (who is in charge of all digital health projects in the hospital facilities), one of his employees, and the CEO of the HDMP provider. At this, we elaborated on the participants' views and experiences of integrating innovations in hospitals and discussed how the HDMP could mitigate the identified barriers from the exploration phase. The responses were protocolled and assigned to these barriers. As a result of the consolidation phase, we could both substantiate the barriers and assess if and how an HDMP can mitigate them.

(3) In a final *synthesis phase*, we aimed to explore the potential benefits of digital innovations in hospitals once barriers are mitigated or overcome. Here, we first elaborated on impact potentials by conducting a qualitative comparative case-study analysis with 36 digital health startups from a regional healthcare cluster (Table II.2-1). Case studies are fruitful to explore and conceptualize barely explained, complex phenomena from empirical data (Benbasat et al. 1987). For a careful and purposeful case selection, our sample focuses on typical group characteristics of digital health startups with a deliberate balance of homogeneity and variation to identify and illuminate important group patterns (Patton 2014, p. 428; Yin 2009). We applied complementary concepts to these cases to understand, analyze, and compare the innovative capacity and impact potential of each case. Here, we refer to business-related concepts, as resource-based view (Barney 2001), process and value creation (Porter 1985; Hammer and Champy 1993), digital transformation (Pousttchi et al. 2019a), and stakeholder value (Donaldson and Preston 1995). We also applied health-related concepts like healthcare cycles (Fiechter and Meier 1998; Bergman et al. 2011; Knöppler et al. 2016) or interoperability models (Sunyaev et al. 2010). This way, we derived and determined the scopes of beneficiaries, impact areas, and impact causes for each innovation.

Table II.2-1: Overview of Analyzed Cases (Digital Health Startups)

#	Core Value Proposition		#	Core Value Proposition (continued)
1	app to diagnose deep vein thrombosis		19	chatbot application for patient care
2*	system to monitor and control the usage of disinfection agents		20	health IS for small hospitals with a digital patient record
3*	mobile app for the patient-nurse communication		21	wearable and app to record and analyze palsy patients' moves
4*	software for automating cancer medication plans		22*	app for directly booking consultation appointments
5	software to automate the documentation of medical reports		23*	app and cloud to securely store medical data
6*	mobile app to support patients with chronic diseases		24*	app for automatic individual therapeutic exercise plans
7*	mobile app for gait pattern analysis to prevent falls		25	software to detect accounting errors for medical services
8	platform for patient pathway automation		26*	sensor-based UV rays to kill germs
9	app to capture patient-related outcome measures		27*	sensor-based adhesive wearable to monitor patients
10	platform and apps for gynecology wards and patients		28*	gamification-based platform to support therapeutic exercise
11	health IS plugin to modify or personalize the user interface (UI)		29*	healthcare data management and transfer platform for patients
12*	mobile app for nurses to automatically record services		30*	ML-based system for the prognosis of genetically determined diseases
13	platform for psychological online seminars and consultation		31	smart exoskeleton to support the lower back of caregivers
14*	platform for hospitals to find suitable after-care providers		32*	mobile app for an acoustic feedback of a movement's intensity
15*	device and app to record, archive and analyze long-term ECG		33*	P2P technology for secure end-to-end video councils
16	device for insulin injection and app for blood-glucose analysis		34	video system to include therapeutic exercises in daily routine
17*	technology for 3D imaging from ultrasound		35	website to enroll doctors for relevant training courses
18	cyber-physical robotics system to support surgeries		36*	monitoring system to support individual home-based aftercare

** Representatives of marked startups also participated in a telephone interview*

Finally, we condensed our findings into conceptual artifacts. Specifically, we first applied the morphological method to arrange and categorize our findings within the barriers and impact potentials. This method is a highly systematic approach for structuring multi-dimensional problems and involves the identification and definition of a problem's essential characteristics as well as the assignment of their relevant instances. The aggregate of all characteristics and instances is represented by a morphological box, which allows for structured analysis and comparison of complex phenomena (Zwicky 1966; Ritchey 2013). Hereupon, we conceptualized our findings into a more generic framework from a multi-level perspective to emphasize the relationships. Multi-level research enables an integrated understanding of phenomena that unfold across levels in organizations and systems. Micro phenomena are embedded in macro contexts and macro phenomena often emerge through the interaction and dynamics of lower-level elements (Burton-Jones and Gallivan 2007).

4 Barriers for Digital Innovation in Hospitals and the Mitigating Role of an HDMP

4.1 Exploration Phase: Identifying Barriers for Digital Innovation

Digital innovations often face a multitude of barriers, especially in healthcare. Within this sub-section, we present and discuss the findings of our exploration phase, consisting of a literature review and 20 interviews with digital-health startup representatives. Altogether, we aggregated all barriers into six superordinate barrier types: technological, organizational, behavioral, financial, legal, and structural barriers. For each barrier, respective insights from the interviews are referred to by '#' and their number (as per Table II.2-1).

Technological Barriers The available literature discusses technological barriers on different levels ranging from the IT Infrastructure of a country to functionality problems of the service (Akhlaq et al. 2016; Gajarawal & Pelkowski 2020). As McLachlan et al. (2018) point out, one issue is a lack of *interoperability* among new and legacy systems (due to missing APIs). This claim is supported by one startups, which mentioned that it is often difficult to connect their technologies with the core systems of hospitals (#6). Low *compatibility* might be another critical barrier, particularly if the offered service does not work on available devices or OS (Gagnon et al. 2012). Furthermore, not all healthcare facilities can provide the required *network access* (Harst et al. 2019), which was confirmed by the startups (e.g., #27). A *lack of data* often leads to poor data integrity and quality, which in turn adds up to a low reliability and a poor foundation for superior data-based services (Frederix et al. 2019). One startup has faceed troubles in gaining the required information that make their innovations work at all (#15). *Functionality* problems imply difficulties in bringing proof of the technical feasibility, system efficiency, or technological capabilities (Frederix et al. 2019). The overall technological *complexity* refers to implementation and maintenance of digital services (Lim and Anderson 2016; Harst et al. 2019). The complexity is highly dependent on the level of required integration within the hospitals' systems in terms of required data (semantics and syntactics), available APIs, and workflow alignment, which often have to be harmonized with existing systems. Given the variety of systems throughout hospitals, some of the inquired startups prefer the provision of a web-based service over connecting to the core systems of a hospital via APIs, if possible (e.g., #6).

Organizational Barriers Other barriers originate from processes and structures at organizational level. For instance, Stamatian et al. (2013) studied barriers resulting from *workflow deficiency*. Such deficiencies affect decision-making processes that exclude the actually concerned user groups (MacNeil et al. 2019). Additionally, there can be a lack of integration in the clinical work, resulting in more work for the users instead of reducing the workload (Palacholla et al. 2019; Graetz 2020). Issues around physicians include that they simply have no time for non-patient related concerns (Stamatian et al. 2013; Nohl-Deryk et al. 2018). This claim belongs to the barriers most mentioned by the startups (#2, #4, #6, #12, 14, #22, #24). *Hierarchical deficiency* includes missing top-management support, low change management and scattered key players which operate independently within the organization causing unclear roles and responsibilities (Mason et al. 2017; Mohamadali and Zahari 2017; Harst et al. 2019). The startups confirmed that such opacities are a major barrier for them (#2, #4, # 26) and so are long decision-making processes (#2, #26). At last, there are also *cultural barriers* which evolve around the issue of differences in adopting and accessing digital resources (Lim and Anderson 2016; Otto and Harst 2019). Especially, a cultural resistance towards (technology-induced) changes might hamper the adoption or implementation of digital innovations and requires adequate change management approaches (Lluch 2011).

Behavioral Barriers Many barriers occur on an individual, i.e., staff or patient-related, level. According to Frederix et al. (2019), such individual barriers include the attitude towards technology or devoid intrinsic motivation and knowledge. Following Gagnon et al. (2012), a negative *attitude* towards new technologies often roots from a lack of incentives or, especially in terms of elderly patients, low perceived usefulness and confidence in technology in general (Gagnon et al. 2012; Frederix et al. 2019). Plus, some startups experience a mistrust towards their technologies, such as AI (#15). Furthermore, available research states missing *acceptance* of digital health innovations (Holden and Karsh 2010), particularly due to missing or wrong information. *Fear* turns out to be another barrier in healthcare, especially fear of more transparency about the medical processes, which results in a loss of control and strengthens the patient's position (Stamatian et al. 2013; Nohl-Deryk et al. 2018; Harst et al. 2019). Fear and doubts also arise from missing social contact when switching to digital solutions like online consultations (#36). Low *motivation* to explore new technologies is another identified barrier (Stamatian et al. 2013; #4), and so is *knowledge*: A lack of business education of healthcare professionals often leads to ignorance towards anticipated healthcare benefits (Malekzedath et al. 2018). This was confirmed by a startup stating that the benefit of the innovation was not recognized (#4). In line with that, Apathy and Holmgren (2020) identify knowledge barriers resulting from insufficient training opportunities for employees on new technologies.

Financial Barriers Monetary problems concerning digital innovations range from verification issues to missing public funds. Lim and Anderson (2016) stated that the missing proof of *RoI* is a risk for healthcare providers, and thus a market-entry barrier for startups. A similar problem is the uncertain *refundability* of digital innovations (Vannieuwenborg et al. 2015; Lim and Anderson 2016; Frederix et al. 2019; Soobiah et al. 2020). Among others, Desveaux et al. (2019) identify the problem of few *public funds* and missing governmental financial support for digital innovations (Ajami and Arab-Chadegani 2013; Mason et al. 2017; Mohamadali and Zahari 2017; Malekzadeh et al. 2018; Harst et al. 2019). This problem was also stated by the interviewed startups (e.g., #3, #26). *Costs* are a barrier, because high implementation costs often represent a deterrent, and the amount of lifecycle costs is sometimes difficult to estimate (Gagnon et al. 2012; #4). Plus, there is a general lack of (external) financial *incentives* for the introduction and use of digital innovations in healthcare (Nohl-Deryk et al. 2018).

Legal Barriers *Data security* and *privacy issues* are relevant for both users and providers. Patients' concerns about the usage of their data are increasingly rising (Gagnon et al. 2012; Nohl-Deryk et al. 2018). If these two barriers are unclear or addressed insufficiently, trust in these services decreases (Zaidan et al. 2011). Plus, healthcare providers have to ensure legal *compliance* of their IT systems, especially in terms of the GDPR (General Data Protection Regulation) and the patient security law (Blobel and Ruotsalainen 2019). Also, there are *reliability* concerns about the performance or testing procedures of new innovations and their compliance with legal requirements (Vannieuwenborg et al. 2015; Palacholla et al. 2019). Altogether, there are several difficulties in understanding and implementing legal requirements. Moreover, differences in legislation at federal and state level even increase the legal complexity (Apathy and Holmgren 2020).

Structural Barriers On a more generic level, structural barriers can hamper the implementation and diffusion of digital innovations in healthcare. Due to the very nature of health systems, healthcare providers face strict regulation (Ajami and Arab-Chadegani 2013; Zakaria and Mohd Yusof 2016; Apathy and Holmgren 2020). Such structural barriers are oftentimes beyond a hospital's sphere of influence and include issues of standardization, certification, approval and cooperation. Hence, the use of new technologies often rather becomes a burden than an improvement (Graetz 2020). At the same time, existing regulatory guidelines or measures can be unclear and unbalanced. Plus, actors in the healthcare system only make slow progress in comprehensive *standardization*, which results in IT incompatibility, media disruptions, poor processes and insufficient usability of staff or patient applications (Ajami and Arab-Chadegani 2013; Nohl-Deryk et al. 2018). Furthermore, *certification* and *approval* processes (e.g., clinical evidence, certification marks, marketability) can hamper the introduction of new technologies (Anderson 2007). While missing certification excludes the technology's usage directly, missing approval complicates the billing mechanisms for digital services – particularly, if the healthcare service is paid by an insurance (Harst et al. 2019). Additionally, the startups stated poor *cooperation* between the healthcare providers and other stakeholders in the healthcare system (e.g., payers, medical associations) as an additional barrier (e.g., #29, #33).

Altogether, barriers arise at different levels and can either root from shortcomings of individuals like staff or patients (behavioral), of the hospital as a social system (organizational, financial, technological, legal), or of the healthcare system at large (legal, structural). We condensed all identified and aggregated barriers into a morphological box (see Figure II.2-5).

barrier type	barrier					
technological	interoperability	compatibility	network access	data access	functionality	complexity
organizational	workflows	hierarchy	culture			
behavioral	attitude	acceptance	motivation	fear	knowledge	
financial	RoI	refundability	public funds	costs	incentives	
legal	data/IT security	data privacy	legal compliance	data reliability		
structural	certification	approval	standardization	cooperation		

Figure II.2-5: Morphological Box of Typical Barriers for Digital Healthcare Innovations

4.2 Consolidation Phase: Mitigating Barriers through an HDMP

In a second step, we sought to explore to what extent the implementation of an HDMP can mitigate some of the identified barriers. Thus, we conducted a focus group interview with the hospital CIO, one of his employees, and the CEO of the HDMP provider. We present and discuss the findings in this sub-section.

With respect to *technological barriers*, the HDMP can mitigate all barriers except a lack of network access according to the interviewees. Once implemented and configured properly, the HDMP can access, compute and transfer all relevant information systems, applications and databases, and thus might solve issues regarding interoperability, compatibility and data retrieval. What is more, the hospital is able to provide only such data that is required by the startup, and thus enhance functionality and reduce technical complexity. In terms of *organizational barriers*, the HDMP can employ the IT systems to optimally support the actual processes and thus reduce workflow deficiency of new technologies to be integrated. Particularly, the medical controlling unit has integrated access to data from different sources relevant for billing processes. If new technologies work more seamlessly, cultural resistance might diminish as well. For instance, the medical staff agreed with the bed sensor system as the vital data was integrated in the GUI of the used systems. However, the HDMP might probably not mitigate hierarchical deficiencies. It might help to shorten decision-making processes, but not in terms of technology sourcing.

This is different with *behavioral barriers*: If new technologies are integrated user-friendly, work seamlessly and provide added value, the staff's attitude, acceptance and motivation might rise to use these technologies. Especially, if the technologies are intuitive or help improving healthcare services, fear or knowledge gaps might become less important. These effects could have been observed in a project in which patients have been equipped with wearables where the medical staff could manage and monitor the health-related data. Contrarily, the HDMP might hardly help to mitigate all *financial barriers*, albeit some financial risks and costs might be indirectly alleviated through a simpler integration of new technologies, which allows easy testing and piloting. Hence, the RoI, costs, and incentives of new innovations are rather unconcerned, while refundability and the acquisition of public funds for new digital therapies and diagnostics might be accelerated through a faster and simpler integration.

The HDMP might help hospitals to mitigate some *legal barriers*. While issues with security and privacy might even increase through the high degree of interconnectedness, a single point-of-failure architecture, and data redundancy, legal compliance and data reliability might be enhanced through a comprehensive documentation and the data sovereignty of the hospital. In terms of *structural barriers*, the HDMP might only help indirectly. Clinical trials might be conducted and documented more seamlessly (at least from a technical point of view). However, this does not affect the decision processes about certification and approval. And although the HDMP is compliant with common standards in healthcare, it will not solve standardization problems within the entire healthcare system on a national (or supranational) level. Yet, cooperation with other stakeholders might be facilitated.

Altogether, digital technologies can be attached and tested far more easily than before, without rearranging the entire IT landscape or being dependent on access to certain information systems or databases. Accordingly, hospitals can more seamlessly explore the potentials of innovative technologies by leaving their routine processes unaffected. However, the HDMP mainly addresses internal barriers (i.e., technological, organizational, behavioral) if implemented, configured, and introduced appropriately, while rather external barriers (i.e., financial, structural, legal) are more difficult to approach technologically. Altogether, hospitals might come closer to attain a state of OA by leveraging their innovation capacities. Figure II.2-6 consolidates the assessed effects of the HDMP on all identified barriers.

barrier type	barrier					
technological	interoperability	compatibility	network access	data access	functionality	complexity
organizational	workflows	hierarchy	culture			
behavioral	attitude	acceptance	motivation	fear	knowledge	
financial	RoI	refundability	public funds	costs	incentives	
legal	data/IT security	data privacy	legal compliance	data reliability		
structural	certification	approval	standardization	cooperation		

HDMP impact on barriers:	mitigate	none

Figure II.2-6: Assessed Effects of the HDMP on Digital Innovation Barriers in Hospitals

4.3 Synthesis Phase: Conceptualizing the Impact of DI in Hospitals

Once barriers are mitigated, digital innovations might impact hospitals in various ways. Hence, we conducted a multiple-case study analysis (with 36 digital health startups) to explore and conceptualize the potential impact of such innovations. As a result, we specified three different impact dimensions: beneficiaries, areas, and causes. We outline and discuss these dimensions in the following. For each impact dimension, original cases are referred to by '#' and their number (as per Table II.2-1).

Impact Beneficiaries. At least three stakeholder groups would benefit from integrating digital innovations. First, this includes the *patients* who can become safer, healthier or more satisfied. For instance, an app for automatic individual therapeutic exercise plans can improve the recovery (#24), and a mobile app to support patients with chronic diseases (#6) can increase satisfaction. Likewise, the usage of a system to record, archive and analyze long-term ECG (#15) might even leverage all three effects at once. Second, the *staff* might also benefit from digital innovations. Here, some innovations enhance their work processes in terms of efficiency (#5: software to automate the documentation of medical reports), others in terms of effectivity, such as precision (#18: cyber-physical robotics system to support surgeries). This might in turn increase staff satisfaction. Third, the *hospital* as an organization might benefit in several ways. From a healthcare perspective, many innovations can help to enhance the healthcare service quality through better treatment or diagnoses (#27: sensor-based adhesive wearable to monitor patients). From a business perspective, such innovations might improve financial viability (#25: software to detect accounting errors for medical services) or competitiveness through integrating cutting-edge technologies (#30: ML-based system for the prognosis of genetic diseases).

From a marketing perspective, the innovations can raise patient loyalty and reputation (#29: healthcare data management and transfer platform for patients). From a more technological point of view, such innovations can enhance security or legal compliance (#5: software to automate the documentation of medical reports).

Impact Areas. Digital innovations can affect different areas within the hospital. These include various value creation processes within the hospital supply chain. For one thing, this includes the *support processes*: Some startups assist the processes of ICT (#33: P2P technology for secure end-to-end video councils), administration (#20: health IS for small hospitals with a digital patient record), marketing and customer communication (#23: app for directly booking consultation appointments), or procurement (#35: platform to enroll doctors for relevant training courses). For another thing, this includes processes of *indirect healthcare*. At this, digital innovations can facilitate various tasks in terms of admission, supply and discharge (#8: platform for patient pathway automation), anamnesis (#9: app to capture patient-related outcome measures), care (#3: mobile app for the patient-nurse communication), and hygiene (#2: system to control the usage of disinfection agents). Generally, different phases of *direct healthcare* might be concerned, from prevention (#7: mobile app for gait pattern analysis to prevent falls) to diagnosis (#1: mobile app to diagnose deep vein thrombosis), treatment (#13: platform for psychological online seminars and consultation), aftercare (#36: monitoring system to support individual home-based aftercare) to rehab (28: gamification-based platform to support therapeutic exercise). What is more, the innovations support the *hospital staff* (i.e., medical, care, administrative, management) in their daily *tasks* of planning, execution (#31: smart exoskeleton to support the lower back of caregivers), decision-making (#4: software for automating cancer medication plans) and documentation (#12: mobile app for nurses to automatically record services).

Impact Causes. Furthermore, we explored the underlying processual and technological causes which entail the above-mentioned impact. Generally, *work improvement* for staff can root from six impact causes. Some innovations result in a workload reduction or time savings (#19: chatbot application for patient care; #12: mobile app for nurses to automatically record services), others allow for more simplification or usability (#11: health IS plugin to modify or personalize the UI). Additionally, some innovations target emotional factors by improving the work environment (#26: sensor-based UV-technology to kill germs) or collaboration at large (#10: platform and apps for gynecology wards and patients). At this, the innovations exploit basic *IT potentials* (Pousttchi et al. 2019a) such as automation (#24: app for automatic individual therapeutic exercise plans), parallelization (#15: device and app to record, archive and analyze long-term ECG) or time and space override (#34: video system to include therapeutic exercises in daily routine). Mostly, a combination of different digital transformation (DT) causes and elements (Pousttchi 2017; Pousttchi et al. 2019a) is required to leverage the above-mentioned effects.

Among the *DT causes*, we find processing power, miniaturization, cyber-physical systems (CPS), internet of things (IoT), advanced data-processing techniques, artificial intelligence (AI), and human-computer interaction (HCI). For instance, a mobile app for acoustic feedback on a movement's intensity (#32) requires local processing power to steer the technology and a compact device with proper sensors (CPS), connectivity (IoT) and human involvement (HCI). Plus, the gathered data needs to be processed, transferred and analyzed (AI). Among the *DT elements*, the digital innovations enable ubiquity, telemetry, contextualization, identification and the exploitation of data. For instance, healthcare data management and transfer platform for patients (#29) is accessible at any time and from any place (ubiquity), enables the remote control of connected devices and processes like admission preparation (telemetry), and allows for individual treatment (contextualization) and authorization management of patients and doctors (identification). All services are built on the exploitation of administrative and medical data. Figure II.2-7 synthesizes our findings within impact beneficiaries, areas and causes by means of morphological boxes.

beneficiary	impact						
patient	satisfaction	healthiness	safety				
staff	satisfaction	effectiveness	efficiency				
hospital	service quality	financial viability	reputation	security	legal compliance	patient loyalty	competitiveness

impact area type	impact area					
support processes	administration	ICT	marketing	procurement		
indirect healthcare	admission	anamnesis	care	supply	hygiene	discharge
direct healthcare	prevention	diagnosis	treatment	aftercare	rehab	
work tasks	planning	execution	decision making	documentation		
staff	medical staff	care staff	administrative staff	management		

impact cause type	impact cause						
work environment	workload reduction	usability	simplification	time savings	atmosphere	collaboration	
IT potentials	automation	information	time override	space override	parallelization	integration	disintermediation
DT causes	processing power	miniaturization	CPS	IoT	data processing	AI	HCI
DT elements	ubiquity	telemetry	contextualization	identification	data usage		

Figure II.2-7: Set of Morphological Boxes for Impact of Digital Innovations on Hospitals

On that basis, we drew on multi-level theory and considered the organizational impact on the hospital and the individual impact on staff and patients from a different perspective (Poole & van den Ven 1989), which helped us to recognize three further worthwhile findings:

1) At least two different levels are affected from integrating digital innovations into a hospital's value creation. On a micro level, this includes the patients and individual staff members. On a macro level, this includes the hospital as an organization. This conceptualization might be expanded by other stakeholders like external companies (e.g., startups, suppliers, cooperation partners) on a macro level and their staff members on micro level. Plus, one could examine the implications beyond hospitals (e.g., healthcare market and system).

2) Impact causes and areas both apply to both levels. For example, individual time savings might ultimately imply time savings at an organizational level, and a patient can use IoT-based devices or CPS, which in turn might enhance patient monitoring and management for the hospital in its entirety. The same applies to impact areas. For instance, a digital innovation might likewise enhance decision-making

on both an individual (e.g., decision support tool) and an organizational level (e.g., decision coordination tool).

3) Thus, we can assume several interdependencies between both levels. For instance, an improved healthcare service quality by the hospital might implicate an increased patient healthiness and satisfaction, which in turn improves the hospital's reputation, competitiveness and patient loyalty. Similarly, increased staff effectiveness and efficiency might positively affect the hospital's overall performance. Altogether, even if the HDMP might help to mitigate (especially technological) barriers, the socio-economic interdependencies still have to be evaluated carefully. Figure II.2-8 condenses our findings into a conceptual framework.

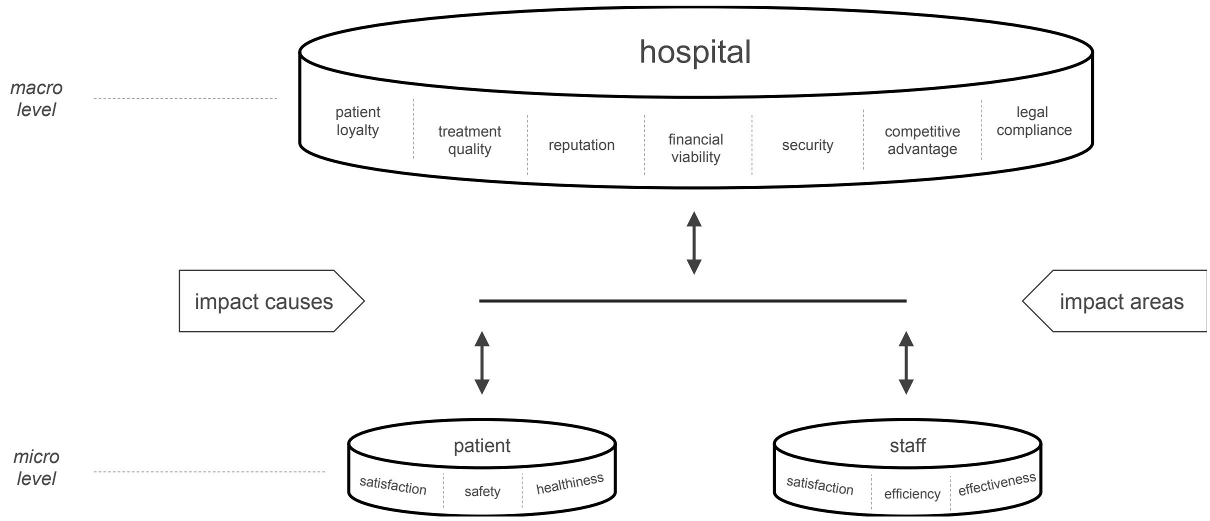

Figure II.2-8: Multi-Level Framework of Digital Innovation Impact on Hospitals

5 Conclusion

The starting point of our research endeavor was the notion that hospitals often lack a strategic approach of integrating innovative digital technologies to improve their value-creating capacities, while a multitude of digital innovations from digital health startups enters the promising healthcare market. Against this background, we sought to explore how hospitals could more easily integrate digital healthcare innovations through an HDMP in order to approach OA. Our results are threefold: First, we provide a systematic overview of literature-based and practically validated barriers for digital health innovations in hospitals. Second, we provide an assessment of how an HDMP might help mitigate such barriers. Third, we conceptualized the potential impact of the integration of digital innovations in hospitals from a multi-level perspective.

Our findings reveal that an HDMP helps hospitals to raise their innovative capacities through ambidextrous structures. Especially, it can help to mitigate technological (connect or integrate new technologies), organizational (workflows and culture), and behavioral barriers (as acceptance and motivation). However, such a platform alone cannot *solve* all problems of sourcing digital technologies, particularly in terms of externally-induced barriers, such as legal or structural ones. Thus, there might be complementary and less technology-oriented approaches to surmount barriers for innovation (e.g., change management)

As a contribution to research, we added another puzzle piece into the emerging field of digital health by applying a socio-technological lens to the healthcare domain. At this, we provide a systematic understanding of potential barriers and impact potentials of integrating digital innovations in hospitals. Additionally, we show how an HDMP might help hospitals approaching OA and extract advantages from new technologies by overcoming such barriers. The conceptual framework provides a first structured overview of potential innovative capacities of digital health projects in hospitals at both organizational and individual level, including generalized assumptions of the relationships. As a contribution to practice, we sensitize about barriers digital innovations typically face, present a solution to mitigate such barriers, and provide an overview of potential benefits to capture. Thus, healthcare practitioners might employ this overview to systematically evaluate their IT landscapes and the potential benefits of new technologies.

By its qualitative nature, our research entails several limitations. While the identified literature-based barriers might be comprehensive and inherently logical, other researchers might have coded and derived other items and classes. The same applies to the impact types, which result from the deductively selected and applied concepts as well as the selection of considered cases. Furthermore, the assessment of the mitigated barriers is a subjective view on the observed clinic group in our case. Hence, these findings are only partly generalizable. We see two avenues for future research. From a technological standpoint, research could design options that promote interoperability among existing and new technologies. From a socio-technological standpoint, research could zero in on the interplay of different actors at multiple levels, which hamper or foster digital innovations in hospitals. Especially, the interdependencies and relationships among all levels should be elaborated, both qualitatively and quantitatively.

II.3 What Makes a Data-driven Business Model? A Consolidated Taxonomy

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Abstract: *The usage of data to improve or create business models has become vital for companies in the 21st century. However, to extract value from data it is important to understand the business model. Taxonomies for data-driven business models (DDBM) aim to provide guidance for the development and ideation of new business models relying on data. In IS research, however, different taxonomies have emerged in recent years, partly redundant, partly contradictory. Thus, there is a need to synthesize the common ground of these taxonomies within IS research. Based on 26 IS-related taxonomies and 30 cases, we derive and define 14 generic building blocks of DDBM to develop a consolidated taxonomy that represents the current state of the art. Thus, we integrate existing research on DDBM and provide avenues for further exploration of data-induced potentials for business models as well as for the development and analysis of general or industry-specific DDBM.*

1 Introduction

The 21st century can be considered as the data era. Phrases like "Data is the new oil" (Parkins 2017) are widely used, and highlight the importance of data as a resource for businesses. Four of the six most valuable companies in 2020 are data-driven tech companies: Microsoft, Amazon, Alphabet, and Facebook (Murphy et al. 2020; Javornik et al. 2019). Globally and industry-wide, other companies try to follow and benefit from the developments in data-driven technologies like Big Data or Artificial Intelligence to extract the value of data (Chen et al. 2012; Günther et al. 2017). This provides new challenges and opportunities for both research and practice. Consequently, a new research strand has emerged around the topic of data-driven business models (DDBM) in recent years. Using data as a key resource, a DDBM enables value creation through activities of data processing and analytics (Hartmann et al. 2016; Schüritz and Wixom 2017) to offer data, knowledge, actions, or non-data products/services as a value proposition (Hartmann et al. 2016; Schüritz et al. 2017), and captures its value through exploitation and monetization (Schüritz et al. 2017).

Available research provides empirical and qualitative evidence and approaches for tackling the challenges of creating and conceptualizing DDBM (e.g., Engelbrecht et al. 2016; Kühne and Böhmann 2018). Particularly, a great part of the DDBM research focuses on the development of tools and methods for the design and ideation of DDBM (Fruhwirth et al. 2020; Lange and Drews 2020), including taxonomies and frameworks. For instance, Hartmann et al. (2016) have provided a first framework for DDBM by adapting the logic of generic business model frameworks to the context of data as a key resource. Further research has explored such business models from a service-dominant logic and particularly explicates data-driven services (DDS) and the role of value co-creation therein (Azkan et al. 2020). Accordingly, a service-oriented business model describes the integration of services into the business model or the usage of services to design new ones. Examples of such taxonomies with a focus on data-driven services are Rizk et al. (2018) or Azkan et al. (2020).

Given the increasing relevance of data in contemporary business models and its economic importance, IS research should sharpen the understanding of the core elements of DDBM and DDS. However, there is yet little analytical consolidation of existing DDBM and DDS taxonomies and frameworks. Instead, IS-related research provides several partly contradictory or redundant conceptualizations. Against this background, we aim to synthesize existing literature for the development of a consolidated taxonomy. Taxonomies are important tools as they provide both researchers and practitioners with fundamental categories to analyze and understand complex domains (Nickerson et al. 2013). This particularly accounts to promising and under-researched phenomena like DDBM. Thus, our interest lies in the question: What makes a data-driven business model and what are its core elements? In response to this question, we build upon current research on DDBM and DDS and develop a consolidated taxonomy on the basis of 26 IS-related taxonomies and 30 empirical cases, following the guidelines from Nickerson et al. (2013). The remainder of this paper is structured as follows: In Section 2, we explain the applied methods, before we present and analyze our results in a systematic manner in Section 3 and 4. We close the paper with a conclusion and discussion on limitations and avenues for future research in Section 5.

2 Methodology

In view of our research question, we pursued a two-phase approach. First, we conducted a systematic literature review (SLR) on DDBM and DDS taxonomies. At this, we followed the guidelines from Webster and Watson (2002), and vom Brocke et al. (2009), which provide a rigorous and traceable approach to systematically identify and structure relevant literature on DDBM and DDS. Second, we compared and synthesized the identified taxonomies through defining the common building blocks, and developing a consolidated taxonomy of DDBM and DDS according to Nickerson et al. (2013). Here, we rely on 30 empirical cases with DDBM to validate and refine our taxonomy. The detailed research process is depicted in Figure II.3-1 and described in the following sub-sections.

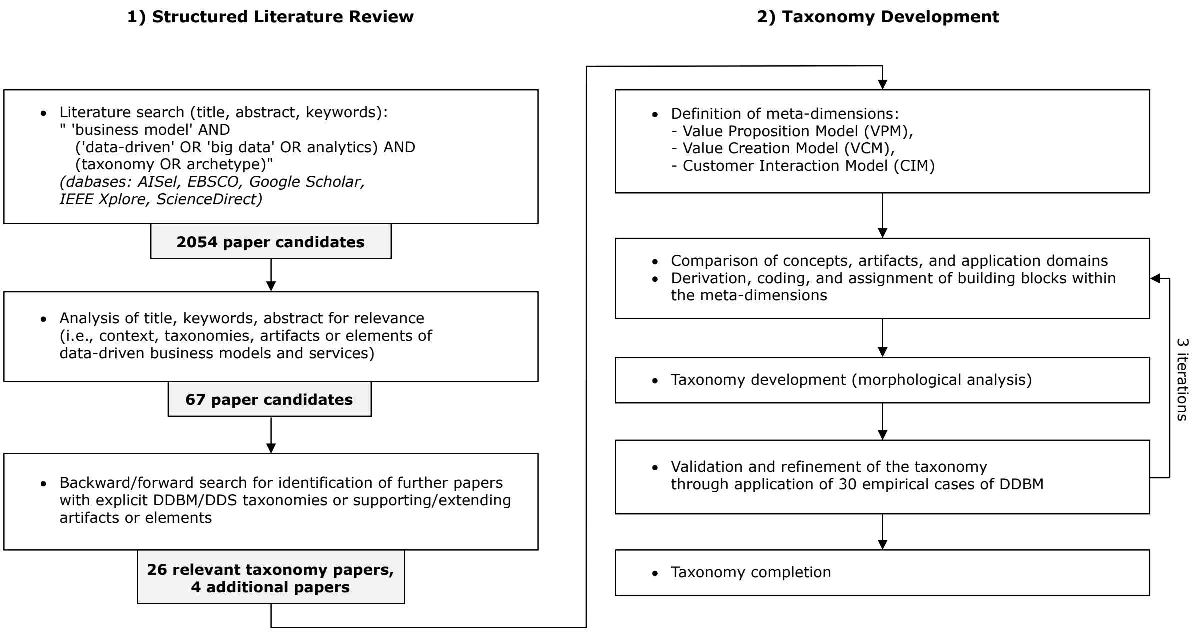

Figure II.3-1: Research Design (Data-driven Business Models)

2.1 Phase 1: Structured Literature Review

In phase 1, we conducted a SLR. In a first step, we searched for IS-related publications within relevant scientific databases (AISeL, Ebsco, Google Scholar, IEEE, ScienceDirect) with DDBM- and DDS-related terms to receive information about the core elements and taxonomies: "'business model' AND ('data-driven' OR 'big data' OR analytics) AND (taxonomy OR archetype)". This search left 2054 potential paper candidates for further analysis.

In a second step, we excluded all publications that were not peer-reviewed and three researchers independently analyzed the remaining publications' titles, keywords and abstracts for relevance. We analyzed the full texts of the remainders and proceeded with a forward and backward search to identify additional relevant papers. This analysis left a total of 67 potential paper candidates.

In a third step, we conducted an internal workshop with our working group to select and compare all papers that specifically either provide taxonomies, inherent elements, and characteristics, or design artifacts for DDBM or DDS. Design artifacts also include business model canvases, which provide a structured overview of DDBM elements. We excluded taxonomies that omit the data dimension, even if a business model's or service's foundation relies on data (e.g., carsharing or platform business models). Finally, we identified a total of 26 papers that contain taxonomies and/or characteristic elements of DDBM or DDS, and four additional papers that provide supplementary information on specific parts (e.g., the customer segment).

2.2 Phase 2: Taxonomy Development

The second phase focused on the development of a consolidated DDBM taxonomy on the basis of the 26 remaining papers from the SLR. At this, we basically rely on the guidelines from Nickerson et al. (2013) for a systematic taxonomy development that combines inductive and deductive reasoning. Accordingly, we first defined meta-characteristics for a first-level classification of any elements of our taxonomy. Given the nature of digital business models, we applied the three dimensions of digital transformation as meta-dimensions from Pousttchi et al. (2019).

In a second step, we collated the 26 papers with regard to their concepts, methods, artifacts, and application domains in order to derive and define the core elements of DDBM and DDS. These elements were first assigned to the meta-characteristics, and then inductively coded to first-level and second-level items. Here, we followed Mayring's proposed procedure for inductive categorizing as part of a qualitative content analysis (2000). The coding was conducted by three researchers separately, and disagreements were discussed until consensus was reached. Furthermore, we evaluated the identified items from the taxonomies and papers for their general applicability. We sorted them out, if they are too limited or use-case-specific, and do not allow for generalizability. For instance, Möller et al. (2020) provide the items "optimization service" and "visibility service", which imply very specific services. Likewise, Azkan et al. (2020) differentiate the platform type. However, a DDBM does not necessarily induce a platform. Based on the derived items from the identified taxonomies, we derived and defined building blocks and respective characteristics of DDBM.

In a third step, we condensed all building blocks and characteristics into a consolidated taxonomy. Here, we applied the morphological analysis, a highly systematic method to structure multi-dimensional problems (Ritchey 2013; Zwicky 1966), to synthesize all building blocks of a DDBM by means of a morphological box. Accordingly, the characteristics of each building block are mutually non-exclusive, meaning it is possible to select more than one characteristic for each building block (Nickerson et al. 2013). This was necessary because the identified building blocks were derived from existing taxonomies where the authors also used the approach of non-exclusive characteristics (Hunke et al. 2019; Möller et al. 2020).

In a fourth and final step, we validated the conceptually developed taxonomy through the application of 30 empirical DDBM cases. For the identification of suitable cases, we conducted online research to find economic reports and overviews of companies with DDBM. Among these reports, we selected as many cases as necessary to achieve saturation in terms of complexity, depth, variation, and context (Gentles et al. 2015). This step caused further refinements of our building blocks and their characteristics. In the following, we repeated step 2 to 4 three times in order to bring the conceptual findings in accordance with the empirical cases until our taxonomy was stable (Nickerson et al. 2013). As a result, we developed an integrated DDBM taxonomy with 14 building blocks and their characteristics of a DDBM.

3 Comparison and Analysis of Existing Taxonomies

As a result of our SLR, we identified 26 papers that contain taxonomies or structuring elements for data-driven business models or services. For the purpose of further comparison and analysis, we sort these taxonomies along with two distinguishing categories: value-proposition focus and application scope. Some publications do not structure DDBM but DDS, which is why we distinguish the two. However, a service can be a business model per se (Azkan et al. 2020). With respect to the application scope of existing taxonomies, we distinguish between industry-specific and general taxonomies to explore the unifying and distinctive elements of these taxonomies. Both differentiations will help us to elaborate on differences and similarities for the development of a consolidated taxonomy of sufficient generalization. Figure II.3-2 provides an overview of the categorized taxonomies.

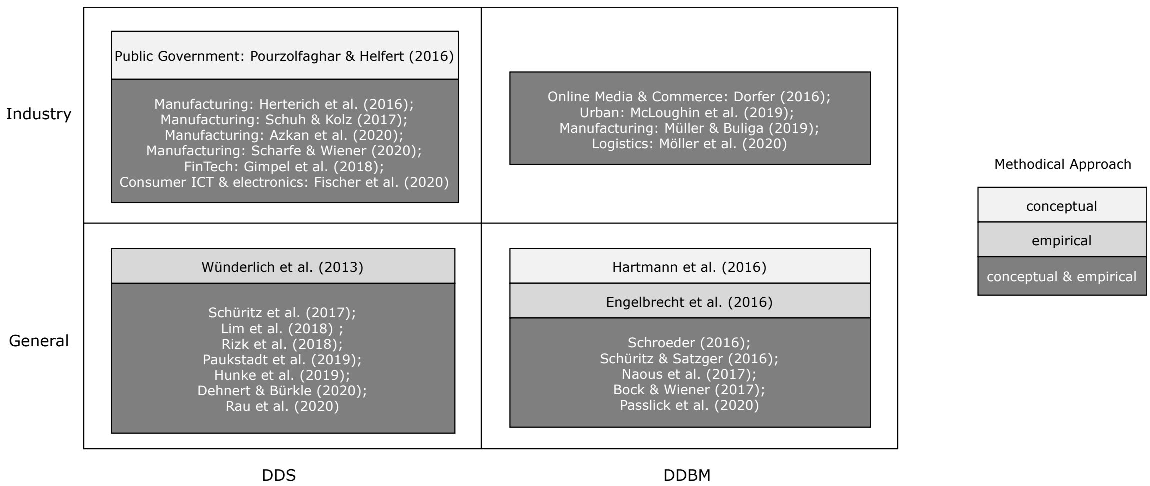

Figure II.3-2: Categorization of Existing DDBM/DDS Taxonomies

Among the 26 taxonomy papers, eight provide *generally applicable* taxonomies for *DDS* (e.g., Dehnert and Bürkle 2020; Hunke et al. 2019), while another seven papers provide *industry-specific DDS* taxonomies, of which four focus on manufacturing data (Azkan et al. 2020, Herterich et al. 2016; Scharfe and Wiener 2020; Schuh and Kolz 2017), one on public government and administration (Pourzolfaghar and Helfert 2016), one on fintech and banking (Gimpel et al. 2018) and another one on smart home and consumer electronics (Fischer et al. 2020). In terms of *DDBM*, we identified seven *generally applicable* taxonomies (e.g., Bock and Wiener 2017; Engelbrecht et al. 2016; Hartmann et al. 2016) and four with an industry-specific focus, i.e., online media and commerce data (Dorfer 2016), urban data (McLoughin et al. 2019), manufacturing data (Müller and Buliga 2019), and logistics data (Möller et al. 2020).

Additionally, we classified the taxonomies by their methodological background, i.e., conceptual and/or empirical. Most publications combined conceptual and empirical approaches, as proposed by the guidelines for taxonomy development from Nickerson et al. (2013). Nevertheless, some researchers used purely conceptual (e.g., Hartmann et al. 2016) or purely empirical approaches (e.g., Engelbrecht et al. 2016). The following sub-sections provide a detailed comparison and analysis of the quadrants.

3.1 DDBM Taxonomies

General. Seven identified papers provide industry-agnostic taxonomies for DDBM. For example, the paper from Hartmann et al. (2016) is one of the first (and most-cited) contributions that scrutinizes the elements of DDBM. Particularly, the researchers focus on such companies that rely on "data as a resource of major importance" to develop a taxonomy "that allows systematic analysis and comparison of DDBM". At this, they pursue a conceptual approach with deductively generated dimensions (value proposition, key resource, key activity, market and customer segment, revenue stream, and cost structure). Through the review and synthesis of the literature on business models, data mining, and analytics, they inductively derive characteristics for each dimension. Key resource, for example, becomes *data source* (internal or external). While internal data is generated inside or through the company, external data is acquired, customer-provided, or freely available. According to the authors, the *key activity* of a DDBM is likewise important. This dimension describes how data is used to generate value. At this, the authors rely on Rayport and Sviokla's (1995) concept of virtual value chains. Hartmann et al. (2016) identify the steps of data generator, acquisition, processing, aggregation, analytics, visualization, and distribution. With respect to DDBM, the authors also emphasize the importance of the *value offering*, which is based on Fayyad et al. (1996) and can be divided into two categories of raw and interpreted data in form of information or knowledge. Hartmann et al. (2016) extend these by non-data-based products and services as a possible offering.

Contrarily, the paper from Engelbrecht et al. (2016) provides an empirically developed, industry-agnostic taxonomy for DDBM based on expert assessments of 33 DDBM from startups. The researchers coded these qualitative data to derive the three most relevant characteristics of DDBM: *data source* (user or non-user), *target audience* (consumers or organizations), and *technological effort* in terms of the complexity of data collection, processing, and analytics (low or high). Therefore, this contribution does not focus on a complete DDBM taxonomy but rather on the relevance of its components. The other publications pursue a combined conceptual-empirical approach to scrutinize the elements of DDBM.

Industry-specific. Four identified papers provide taxonomies with a focus on certain industries. For instance, McLoughlin et al. (2019) apply the taxonomy structure of Hartmann et al. (2016) to 40 cases in order to explore the value generating elements and value propositions of urban data business models. In this context, the researchers argue against the data source dimension. Instead, they highlight the importance of key resources, which not only imply data but also software and hardware components to capture and deliver value. Consequently, they propose a self-contained data framework to sub-classify data by the categories *velocity*, *variability*, *variety,* and *type*.

For another thing, Möller et al. (2020) provide a taxonomy of optimization and visibility services for DDBM in the logistics industry. At this, they pursue a combined conceptual-empirical approach with 49 cases. The key resource data is assigned to the meta-dimension *service platform*, which is further divided into five dimensions: *resource*, *source*, *flow*, *activity*, and *feed*. These dimensions describe what the data is about (resource), who creates it (source), how it is provided (flow), what has to be done before it can be further used (activity), and the delivery frequency (feed). In view of our research question, especially these four taxonomies provide a solid foundation for our integrated taxonomy. While the taxonomy from Hartmann et al. (2016) offers some common ground, those publications help to identify eligible components in the intersection of different industries.

3.2 DDS Taxonomies

General. Eight of the identified papers provide industry-agnostic taxonomies for DDS. For example, Rizk et al. (2018) provide a taxonomy for data-driven digital services, which is based on a conceptual-empirical approach. At this, they propose four main characteristics through the value chain of big data and extracted knowledge. *Data acquisition mechanism* describes how data is generated or acquired, while *data exploitation* explains how value is extracted from data, especially through information processing and advanced analytics. *Data utilization* describes how the generated insights are provided to the customer (e.g., through visualization or recommendations). Finally, *service interaction* describes how the customer interacts with the service (e.g., application, product, or embedded service).

Lim et al. (2018) provide a nine-factor framework for data-based value creation in information-intensive services based on a literature review and case study research. They provide more information on how to close the gap between having data from various sources and creating real value with it in services. The steps can be clustered into three meta-steps: *data collection, information creation, and value creation.* For data collection, the *data source*, the *data collection* itself*,* and the *data* are the three factors that need to be considered. For information creation, the factor data is the input to the factor *data analysis* that finally leads to the factor *information on the data source.* In the subsequent value creation step, the *information* needs to be *delivered*, e.g., through visualization to the *customer (or information user).* The outcome is the final factor *value in information use* like, for example, a driving person who is assisted by a car infotainment service that guides easily through the traffic.

Hunke et al. (2019) provide another dominant taxonomy to conceptualize the use of data and analytics in services, based on a conceptual-empirical approach. At this, they identify meta-characteristics through a literature review and conduct four iterations with 85 cases from IBM, Microsoft, and Oracle. The taxonomy has six dimensions: *data generator*, *data target*, *data origin*, *data analytics type*, *portfolio* *integration*, and *service user role*. The authors offer an interesting perspective by the separation of data generator and data target. Here, data generator describes a person, process, or object that generates the data. This might be an object with sensors. In contrast, the data target is what the generated data is about. Therefore, they are extending data target with the characteristic environment. The data generator (the object with sensors) could measure weather data and therefore needs a distinct data target. Another interesting dimension is the *data analytics type.* Here, the authors provide four types based on four respective questions: *Descriptive* answers the question to "what happened?", *diagnostic* to "why did it happen?", *predictive* to "what will happen?" and *prescriptive* to "what should be done?".

Industry-specific. Azkan et al. (2020) provide a DDS taxonomy for manufacturing industries, also based on the conceptual-empirical approach from Nickerson et al. (2013). As meta-dimensions, they define *value creation* and *value delivery* (from service science), as well as *value capture* (from business model literature). Value creation includes the main value and outcome, the data analytics type, the data sources and types, and the aggregation level, while value delivery describes how the service is delivered, how the service flow is managed, and what type of platform is offered. Finally, value capture contains the pricing model (i.e., subscription-based, transaction-based, or indirect), and how the customer pays (i.e., through the product or service, or data).

Altogether, the service perspective provides useful elements for the development of our consolidated taxonomy. For one thing, data turns out to be pivotal for DDS (and thus, DDBM), be it in terms of generation or exploitation. For another thing, value creation, proposition, and capture appear to be key dimensions to categorize DDBM and DDS. For value creation, especially the factor data analysis play a key role in the identified taxonomies as these are the steps that finally extract the value out of data. Finally, customer communication, integration, and interaction seem to be considerable components in the design of DDBM or DDS. Table II.3-1 summarizes all components of DDBM and DDS derived from the 26 taxonomies and builds the basis for further elaboration.

Table II.3-1: Identified First- and Second-order Items from Literature

Authors	Focus	First-order Items	Second-order Items
Bock & Wiener (2016)	DDBM	n/a	Digital Offering; Digital Experience; Digital Platform; Data Analytics; Digital Pricing
Engelbrecht et al. (2016)	DDBM	n/a	Data Source; Target Audience; Technological Effort
Hartmann et al. (2016)	DDBM	n/a	Data Source; Key Activity; Offering; Target Customer; Revenue Model; Specific Cost Advantage
Naous et al. (2017)	DDBM	Value creation (VC), Resource-based and value configuration (RBVC)	VC: Value Proposition; Customer Segments; Customer relationships; Channels; Revenue streams RBVC: Key resources and activities; Key partners
Passlick et al. (2021)	DDBM	n/a	Key activities; Value promise; Payment model; Deployment channel; Customer segment; Clients; Information layer
Schroeder (2016)	DDBM	n/a	Data users; Data suppliers; Data faciliators
Schüritz & Satzer (2016)	DDBM	Data infusion patterns	Data-infused Value Creation; Data-infused Value capturing; Data-infused value proposition via creation; Data-infused value proposition via capturing; New data-infused business model

Authors	Focus	First-order Items	Second-order Items
Möller et al. (2020)	DDBM (Logistics)	Value Proposition (V), Service Platform (S), Interface (I), Organizing Model (O), Revenue Model (R)	(V): Optimization Service; Visibility Service; Modality; (S): Data Resource; Data Source; Data Flow; Data Activity; (I): Data Feed; Delivery Mechanism; Data Interface; (O): Access to API; API Documentation; (R): Revenue Model; Price Basis; API-Based Revenue
McLoughlin et al. (2019)	DDBM (Urban Data)	n/a	Key Resource; Key Activity; Target Customer; Revenue Models; Cost Structure; Data
Müller & Buliga (2019)	DDBM (Manufacturing)	n/a	Value Creation; Value Offer; Value Capture
Dorfer (2016)	DDBM (E-Commerce)	BMs for cognitive benefits, (CB); BMs for social-interactive ND cognitive benefits, (SICB); BMs for social-interactive benefits (SIB)	CB: General Information gathering; Transaction specific information gathering SICB: General information gathering over social interaction; Social-driven initation of transactions SIB: Networking and contact-management in the context of relationship management; Sharing of content in the context of identity-management
Dehnert & Bürkle (2020)	DDS	n/a	Autonomous acting capability; Sensing capability; Interoperability; Coupling control; Ecosystem; Interaction; User mapping; Data capability; Analytical capability; Output medium
Hunke et al. (2019)	DDS	n/a	Data Generator; Data Origin; Data Target; Analytics Type; Portfolio Integration; Service User Role
Lim et al. (2018)	DDS	n/a	Data source; Data collection; Data; Data analysis; Information on the data source; Information delivery; Customer (information user); Value in information use; Provider network of the service provider and partners
Paukstadt et al. (2019)	DDS	Service Concept (SC), Service Delivery (SD), Service Monetization (SM)	(SC): Value Proposition; Bundle; Main Outcome; (SD): Visibility; Mode of Operation; Actor Interaction; Main Interface; (SM): Payment Mode; Pricing Model
Rau et al. (2020)	DDS	Consumer (C), Data (D), Interaction (I)	C: Consumer Relief; Consumer Benefit; Consumer Risk D: Data Source; Data Analysis; Smartness I: Trigger (T); Representation ©; Integration (I)
Rizk et al. (2018)	DDS	n/a	Data Acquisition Mechanism; Data Exploitation; Insights Utilization; Service Interaction
Schüritz et al. (2017)	DDS	n/a	Subscription; Usage Fee; Gain Sharing; Endure-ads; data-tailored offering; buy-and-sell-data; pay-with-data
Wünderlich et al. (2013)	DDS	Interaction patterns	Interactive service; Self-service; Machine-to-machine service; Provider active service
Azkan et al. (2020)	DDS (Manufacturing)	Value Creation (VCr), Value Delivery (Vde), Value Capture (Vca)	(VCr): Value; Outcome; Analytics Type; Data Sources, Data Types; Aggregation Level; (Vde): Service Delivery; Service Flow; Platform Type; (Vca): Pricing Model; Payment Mode
Fischer et al. (2020)	DDS (Electronics)	Digital Service (DiS), Smart Product (SmP)	DiS: Configuration; Data Analytics; Service Object; Benefit; Duration of Service SmP: Capability Level; Communication; Data Source
Gimpel et al. (2018)	DDS (FinTech)	Interaction (I), Data (D), Monetization (M)	I: Personalization; Information exchange; Interaction type; User network; Role of IT; Hybridization; Channel strategy D: Data source; Time horizon; Data usage; Data type M: Payment schedule; User's currency; Partner's currency; Business cooperation
Herterich et al. (2016)	DDS (Manufacturing)	Material properties (MP), Organizational characteristics (OC)	MP: Data origin; Initiation of data transmission; Relevant data; Data analysis; Digital platform access; OC: Service automation; Lifecycle context; Service innovation
Pourzolfaghar & Helfert (2016)	DDS (Public Government)	n/a	Types; Purpose; Design
Scharfe & Wiener (2020)	DDS (Manufacturing)	Application (A), Integration middleware (IM), Connectivity (C), Machine (M)	A: Application domains; Service type IM: Data analytics; Data sources; Deployment scenarios; Middleware solution C: Interoperability; Communication direction; Interaction partners M: Control autonomy; Actutator purposes; Sensor measure. Objects; Production types
Schuh & Kolz (2017)	DDS (Manufacturing)	n/a	Focus of service provision; Key activities; Revenue model; Connection/implementation; Key resources; Effort for Individualization; Customer access/system integration; Duration of business relationship; Data sources; Data base

4 Development of a Consolidated Taxonomy

Based on the identified items of DDBM and DDS from available literature, we followed the further guidelines from Nickerson et al. (2013). Thus, we defined building blocks of our consolidated taxonomy from literature and cases through 4 iterations (in total), and assigned these building blocks to meta-dimensions. Regarding these meta-dimensions, we rely on the three dimensions of digital transformation (Pousttchi 2017; Pousttchi et al. 2019a), i.e., value proposition model (VPM), value creation model (VCM), and customer interaction model (CIM). Given the digital nature of DDBM, this classification seems particularly suitable. First, the VPM determines the products and services proposed to the market and their revenue models. This view is appropriate because the extraction of data offers both new types of products or services and ways of generating revenues. Second, the VCM determines how digital technologies affect business processes, organization types, and staff. With regard to DDBM, this view is eligible because such business models force new ways of data usage and skills for value generation. Third, the CIM includes all types and mechanisms of interaction with customers. This dimension can be interesting for DDBM, as data can transform the interaction between the customers and enterprises. Table II.3-2 presents the final 14 building blocks (and their guiding questions) with the three meta-dimensions.

Table II.3-2: Meta Dimensions and Building Blocks for the DDBM Taxonomy

Meta-Dimension	#	Building Block	Description
Value Proposition Model (VPM)	[1]	Value Proposition	What does the company offer to the customer?
	[2]	Value Capture	How does the company earn money through the business model?
Value Creation Model (VCM)	[3]	Data Generator	Who or what is generating the data?
	[4]	Data Origin	Where does the data come from?
	[5]	Data Target	About whom or what is the generated data?
	[6]	Data Activity	How is the data handled?
	[7]	Data Analytics	How is the data analyzed?
	[8]	Insights Utilization	In which form are the insights provided to the customer?
	[9]	Cost Structure	How are the costs determined?
Customer Interaction Model (CIM)	[10]	Customer Segment	What kind of customer is it?
	[11]	Target Customer	Who is the customer group?
	[12]	Interaction Type	How does the customer interact with the offering?
	[13]	Service Flow	When is the service provided?
	[14]	Customer Relationship	How is the company supporting the customer?

4.1 Building Blocks in the Value Proposition Model

The value proposition model includes two building blocks. **Value Proposition (1)** describes what the company offers to the customer. This building block determines the overall outcome of the business model and is strongly influenced by the aspect of data. This building block consists of the following characteristics: *Data*, *Information/Knowledge*, *Actions*, and *Non-Data Product* (Fayyad et al. 1996; Hartmann et al. 2016; Rizk et al. 2018; Schüritz and Wixom 2017). Except for Non-Data Product, these characteristics represent the structure of the Data-Information-Knowledge-Wisdom Pyramid (Jifa and Lingling 2014). *Data* describes offering the raw data without the attached meaning, while *Information/Knowledge* describes the provision of interpreted or analyzed data. This could be, for example, provided in form of recommendations or visualizations and the customer can use these to make decisions. *Actions* come one step further and describe how the company itself takes action for the customer, based on the analyzed data. These actions can be, for example, the decision making,the execution of specific process steps or the matchmaking of the customer. A more concrete example is predictive maintenance, where the company proactively replaces the part of a machine based on predictive analytics. The last characteristic of the Value Proposition is the Non-Data Product or Service. An example is an object that receives added value through data (Hartmann et al. 2016) like a watch that is equipped with a sensor.

Value Capture (2) highlights how to gain revenues from the DDBM. It is an important building block because a business model can only sustain in the long run if it creates revenue to cover the costs. The characteristics are based on Hartmann et al. (2016) and Schüritz et al. (2017). *Subscription* describes a periodical payment from the customer. Contrastingly, through a *usage fee,* the customer has to pay as much as he uses the service or product. One factor to measure the usage could be data volume. *Gain sharing* describes how the service or product provider receives a percentage of the revenue that the customer makes through the usage of the offering. *Advertising* describes revenues that are received through advertisers. *Buy-and-sell-data* describes a multi-sided approach, where the provider gains revenues by creating data profiles of the customer and selling them to third parties. *Pay-with-data* describes how the customer provides personal data that can be used in new services or to create new services. Finally, an *asset sale* describes a modus where the offering is provided for a fixed one-time payment.

4.2 Building Blocks in the Value Creation Model

The value creation model consists of seven building blocks that are closely related to the key resource data. **Data Generator (3)** describes who or what generates data for the BM. Hence, this important building block describes one core aspect of the key resource data. For this building block, we rely on the approach of Hunke et al. (2019) for analytics-based services. First, *customer* refers to data that is generated by the direct consumer types of the business model through the usage of an analytical service. This also includes customers of the customer (B2B2C). *Non-customer* refers to humans who generate data for an analytical service but do not consume the service themselves directly, such as social media portals (Hunke et al. 2019). *Process* describes data that is generated through structured activities or tasks performed by people or devices (Hunke et al. 2019). Examples here might be business processes, like manufacturing or consumption processes. *Object* describes data that is generated through physical objects that are equipped with sensors (Hunke et al. 2019). To include other possible Data Generators, we added the characteristic *other*.

Data Origin (4) depicts if the data is generated inside the company (*internal*) or outside of the company (*external*) (Hartmann et al. 2016; Hunke et al. 2019; Lim et al. 2018). This building block determines if the company needs to acquire or obtain the data from external sources or if it is provided through internal sources. External and internal sources are both containing specific restrictions and challenges, like privacy, cost, or effort that needs to be considered to get the data. A DDBM may use internal and external data sources to create its offering.

Data Target (5) represents the flip side of the building block data generator and describes the focus of the collected data. Thus, we can not only identify what or who generates the data but also what or whom the data is about. At this, we extend the structure from Hartmann et al. (2016) by the approach from Hunke et al. (2019) for the generalization because it provides a broader perspective through explicating the data generator more specifically. Consequently, the characteristics resemble those from the building block data generator. One example to clarify this distinction is the following: A smartwatch can generate health data about the customer. Therefore, the smartwatch is the Data Generator, and the Data Target is the customer. Regarding the data target, we add *environment* (e.g., weather), which is oftentimes the objective of data collection and analytics. Plus, we propose o*ther* to include potential future data targets that are not covered by the existing characteristics.

Data Activity (6) summarizes all activities that have to be done after the data is generated and before it is analyzed (Fayyad et al. 1996; Hartmann et al. 2016; Hunke et al. 2020; Lim et al. 2018; Rizk et al. 2018). This building block sharpens the understanding of what to do with the data after its generation. The generated data oftentimes is not directly utilizable where it is generated. Therefore, it is important to understand and determine what needs to be done with data. Here, *data collection* describes the activity of collecting and accessing the generated data, while *data organization* describes the activity of storing the collected data. *Data preparation* describes how the collected data needs to be manipulated for the purpose of further analysis or usage (Hunke et al. 2020).

Data Analytics Type (7) describes what advanced analytics methods can be applied to the data in order to extract information or knowledge from it (Fischer et al. 2020; Hartmann et al. 2016; Hunke et al. 2019; Hunke et al. 2020; Lim et al. 2018; Rizk et al. 2018; Scharfe & Wiener 2020). This is an important building block within most taxonomies. It determines what has to be done to actually generate the value from data (and gaining a comptetitive advantage). The explicit characteristics are *descriptive, diagnostic, predictive,* and *prescriptive* (Hartmann et al. 2016; Hunke et al. 2019). Additionally, we added *none* as a characteristic in case the business model relies on the raw data only as the offering.

Insights Utilization (8) describes how the generated insights are provided to the customer (Hartmann et al. 2016; Hunke et al. 2020; McLoughlin et al. 2019; Rizk et al. 2018). This building block might seem redundant on its face with the building block value proposition. However, we decided to create a separate building block as it completes the concept of the virtual value chain or the knowledge-discovery-in-databases chain (Fayyad et al. 1996; Rayport and Sviokla 1995), and thus sharpens the focus on how the company will finally provide the value proposition to its customers. The characteristics of insights utilization are distribution, visualization, and execution (Hunke et al. 2020; Rizk et al. 2018). First, *distribution* describes the simple supply of the data or information to the customer. This could be, for example, through a data file or an application. Second, *visualization* describes if the company uses advanced techniques to provide the information more comprehensively or graspably to the customer. For instance, infographics present data and information by means of visual and graphical charts and figures to provide the message more catchily and intuitively. Third, *execution* describes if the company uses the information to guide the customers' actions (e.g., digital nudges, or recommendations) or if the company itself processes information for the customer (e.g., schedule query from a database).

Cost Structure (9) adds the perspective of how costs are determined (Hartmann et al. 2016; McLoughlin et al. 2019; Osterwalder and Pigneur 2010). This building block represents the flipside of the revenue model, and thus decides on the success of the entire business model. Here, we rely on Osterwalder and Pigneur (2010) and McLoughlin et al. (2019) to determine the main distinction between value-driven and cost-driven. While *value-driven* determines the price of a product or service through the value that the product or service might give to the customer, *cost-driven* determines the price through the concrete costs that are caused by the creation and offering of the product or service. Additionally, we added the characteristic *other* if the DDBM relies on mixed or other cost structures.

4.3 Building Blocks in the Customer Interaction Model

The customer interaction model consists of five dimensions. **Customer Segment (10)** describes if the DDBM is *business-to-business (B2B)*, *business-to-customer (B2C)*, or *business-to-administrative (B2A)* (Engelbrecht et al. 2016; Hartmann et al. 2016; Lim et al. 2018; Passlick et al. 2021; Wirtz 2019). This building block is a foundation for any business model as it determines to whom the offering is provided and therefore, why the business model may even exist.

Target Customer (11) describes if the business model addresses a *new customer group*, an *existing customer group,* or a *multi-sided customer group* that consists of different actors (Osterwalder and Pigneur 2010; Weking et al. 2018). Thus, this building block complements the customer segment because it offers a different strategic alignment and influence of data-driven products and services in a business model. Especially for incumbent companies, it might be interesting to define if they should focus on their existing customers, try to reach for new segments, or intermediate between two or more groups together.

Interaction Type (12) highlights how the customer is interacting with the company. This is an important building block because it displays how the customer actually receives the offered value. Characteristics within the interaction type are *application*, *product*, or as an *embedded service* in another service or product. (Rizk et al. 2018). Consequently, the interaction can be orchestrated through hardware, software, or combined components. However, especially in terms of B2B, a fourth possible interaction type might be an *API* that provides the data for further processing or usage (Möller et al. 2020).

Service Flow (13) describes if the customer receives the offering manually, in pre-defined time-steps, through specific events, or in a stream (Azkan et al. 2020; Lim et al. 2018; Rau et al. 2020). At *manually*-driven service flows, the customer is proactive in requesting the service. For instance, if it is required to download a document. *Predefined time-steps* describe processes if the service flow comes in intervals. This might be a configured push news service that delivers the latest information on a daily basis. Contrastingly, *event-driven* means that specific (possibly pre-determined) conditions have to occur to trigger or activate the service flow. For example, the detected (or predicted) failure of a production machine might cause an alarm warning in the monitoring system of the production site. *Stream* describes a service that is continuously offered. This might be a smartwatch that always provides the heartbeat or a dashboard over the actual processes in real-time. Altogether, this building block is important because it gives a glance at the time- and activity-related requirements that the corresponding data resources need to fulfill (e.g., availability, currentness) as well as the upstream and downstream events and processes that need to be considerer for the further offering of the value proposition.

Customer Relationship (14) is the last building block in the taxonomy and basically relies on Osterwalder and Pigneurs (2010) Business Model Canvas. This building block determines how the company interacts with its customers for marketing and communication reasons. We added this building block even though it was not mentioned in one of the eight DDBM or DDS taxonomy papers. However, we argue that it is important to understand how the company supports the customer in the long term and how the relationship can be built and sustained. Therefore, we included this building block to complete the Dimension of Customer Interaction. The characteristics contain: *personal* (i.e., face-to-face or virtual communication with humans), *self-service* (i.e., customers can troubleshoot by themselves through, e.g., FAQs), *automated* (i.e., IT-based service control points like chatbots), *community* (i.e., special interest groups of customers like social media channels), or *othe*r types of interaction (i.e., mixed or indefinite). Figure II.3-3 provides an overview of all building blocks and their characteristics. The figures in parentheses within the cells represent the counts of the applied empirical cases.

	Building Block	Characteristics						
VPM	Value Proposition	Data (3)	Information / Knowledge (29)	Actions (9)	Non-Data Product/Service (6)			
	Value Capture	Subscription (22)	Usage Fee (7)	Gain Sharing (0)	Advertising (1)	Buy & Sell Data (1)	Pay-with-data (1)	Asset Sale (9)
VCM	Data Generation	Customer (13)	Non-Customer (12)	Process (10)	Object (19)	Other (0)		
	Data Origin	Internal (15)	External (25)					
	Data Target	Customer (18)	Non-Customer (15)	Process (7)	Object (8)	Environment (6)	Other (0)	
	Data Activity	Data Collection (26)	Data Organization (26)	Data Preparation (30)				
	Data Analytics Type	Descriptive (8)	Diagnostic (7)	Predictive (26)	Prescriptive (16)	None (0)		
	Insights Utilization	Distribution (28)	Visualization (25)	Execution (17)				
	Cost Structure	Value-Driven (27)	Cost-Driven (3)	Other (0)				
CIM	Customer Segment	B2B (27)	B2C (7)	B2A (1)				
	Target Customer	New Customer (24)	Existing Customer (8)	Multi-Sided (3)				
	Interaction Type	Application-based (24)	Product-based (4)	Embedded Service (7)	API (7)			
	Service Flow	Manual (25)	Pre-defined Time (4)	Event-Driven (15)	Stream (16)			
	Customer Relationship	Personal (25)	Self-Service (9)	Automated (8)	Community (5)	Other (0)		

Figure II.3-3: Consolidated Taxonomy of DDBM

4.4 Application of the Taxonomy

We applied the final taxonomy to thirty cases of DDBM to validate the identified building blocks. Figure 3 shows in parentheses the actual number of cases for each characteristic in the building blocks. The strongest impact in terms of value propositions has the characteristic information/knowledge (29 cases), while DDBM also offer actions (9), additional non-data products and services (6), and data (3). The value is captured mostly via subscription-based (22), asset sale (9) as well as usage fee (7) revenue models. The data stems largely from (smart) objects (19), customers (13), or potential customers (12) as well as processes (10). Hence, a greater share of the data comes from external (25) rather than internal (15) sources. The data target is in most cases the customer (18), while non-customers could also receive data (e.g., for advertising purposes) in many cases (15), with objects (8), processes (7), and environment (6) following. Most of the activities are related to all three aspects of data collection, organization, and preparation. While most DDBM draw on descriptive (28) and predictive (26) data analytics, less do so for prescriptive (16) and diagnostic purposes (7). The insights are utilized for visualization (25) to a greater extent, while less for execution (17) and distribution (8). Most DDBM take a value-driven perspective (27) instead of a cost-driven one (3). The sampled DDBM especially have B2B customers (27), while B2C (7) and B2A (1) customers are far less in the focus. These DDBM especially provide an opportunity to gain access to new target customers (24) instead of existing ones (8) or to become part of a platform interaction model (3). The interaction itself largely corresponds to different types, such as embedded services (7) and APIs (7) as well as proprietary applications (24) and products (4). The corresponding services often require data manually (25), automatically in continuous data streams (16), or event-driven (15) in most cases, while less often they draw on pre-defined time modes (4). Finally, most of the DDBM are used for personal customer relationships (25), while many of them also rely on self-service (9) as well as automated (8) or community services (5).

In the following, we provide an exemplary instantiation of the taxonomy application. Synfioo is providing a data-driven service for supply chain and logistics. The concrete offering (building block [1]) is *information/knowledge* through making the supply chain transparent, providing track and trace functions, and offering fault reports. Synfioo captures [2] value through a *subscription-based* model. The data generator [3] is done by *processes* like transport, loading, and sending. Another data generator can be *objects* that are for example equipped with RFID-technology. The data origin [4] is *external*, through logistic companies and the customers of Synfioo. The data targets [5] are *processes* and *objects* that are part of the supply chain, e.g., traffic, vehicles, stocks, and transportation processes. The data activity [6] that Synfioo needs to do is *collecting* the different data from over fifty global data sources, then *organizing* this data and *preparing* it to make [7] *predictions* of the estimated arrivals or provide a *description* of the current dispatching process. The insights are utilized [8] through *visualization* and the *distribution* of the insights. For this DDBM it is not possible to make a clear statement of the cost structure [9] because of a lack of information but we estimate that it is *value-driven*. The customer segment [10] are the supply chain managers and therefore *B2B*. Synfioo is trying to reach a *new target group* [11] because they are currently a start-up and do not own an existing customer base. The interaction type [12] is determined through their *application* or the *API* that they are providing for the integration into third-party software like ERP-Systems. The service flow [13] is *manual*, *event-driven*, and also in form of a *stream* regarding the tracking of the current supply chain. Regarding their website, the customer relationship [14] seems to be *personal* through direct interaction through demo versions or consultancy. The appendix provides an overview of all cases applied to the consolidated taxonomy.

5 Conclusion, Limitations, and Outlook

Our starting point was to understand the building blocks of a DDBM from the current standpoint of IS research and to give an overview of the existing taxonomies in this area, particularly in view of the economic potentials of DDBM and DDS. To integrate the different aspects from prior research, we conducted a structured literature review and followed the taxonomy development approach from Nickerson et al. (2013). The outcome of the paper is a consolidated taxonomy for DDBM with 14 building blocks within the dimensions of digital transformation, based on a systematic taxonomy development approach with 26 existing taxonomies from literature and 30 DDBM cases for validation.

For researchers, the consolidated taxonomy provides a systematic synthesis of available academic DDBM taxonomies and thus adds a puzzle piece towards a coherent understand of DDBM from an IS perspective. Plus, it offers the possibility to further investigate the different building blocks that can be used as a blueprint for the development of further industry-specific taxonomies. For practitioners, the consolidated taxonomy primarily serves as a guidance tool. The developed taxonomy provides a simple and precise overview of the building blocks that practitioners need to consider when developing or transforming a DDBM. Although the developed overview and taxonomy provide both scientific and practical value, it still underlies limitations. As we followed a qualitative research approach, biases in terms of search terms, selected papers, and building blocks cannot be excluded.

Follow-up activities could include further cases to derive potential archetypes of DDBM and DDS. Further research could also analyze specific taxonomies and archetypes of DDBM and DDS, such as in retail, legal, or digital health. Another possible step would be a combination of the conceptual approach for DDBM with a design science implementation approach to explore potentials and barriers from developing and introducing DDBM.

II.4 The Patient Will See You Now – Towards an Understanding of On-demand Healthcare

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Abstract: *The increasing prevalence and ubiquity of digital technologies is changing the needs and expectations of patients towards healthcare services. As a result, a plethora of patient-centered services edges into the healthcare market. Since digital technologies bear the potential to surmount barriers in time and space, patients increasingly demand real-time or near-time healthcare services. Amongst a cloud of related concepts in the context of digital health, one term increasingly typifies this impulse: on-demand healthcare. While this term can be noticeably found in practice, there is hardly some theoretical foundation so far. Against this background, the aim of this paper is to address this research gap and to explore the phenomenon of on-demand healthcare. Based on a design-science approach including a literature review and analysis of in-depth interviews and empirical cases, the outcome of this paper is twofold: (1) a conceptual framework and (2) a proposal for a definition of on-demand healthcare.*

1 Introduction

The ongoing digitalization massively transforms the healthcare sector in various ways. Mobile applications and devices, communication technologies, and the ongoing progress of data processing capabilities pave the way for new forms of diagnosis, monitoring and treatment of diseases (Böttinger and zu Putlitz 2019; Pousttchi et al. 2019a; Rivas and Wac 2018). Moreover, the increasing prevalence, availability and ubiquity of digital technologies is changing the needs and expectations of patients towards healthcare services (Chu et al. 2018). As a result, a plethora of patient-centered services, products and business models edges into the healthcare market from global tech companies and small startups likewise. Thus, patients can choose from a large portfolio of digital products and services to access information or employ other services of (digital) healthcare providers (Pfannstiel et al. 2017; Bogdan 2018). Like in other industries, new (small and big) tech players enter the market with innovative and convenient technologies and applications and thus entirely change the conventional value networks (Pousttchi and Gleiss 2019; Kohlhagen 2019; Gersch and Liesenfeld 2012).Consequently, digital health has become a prevalent, wide and multidisciplinary research stream in recent years and concerns the disciplines of medicine, economics, and business informatics likewise. IS and BI related research has repeatedly emphasized the importance of digital health ((Fichman et al. 2011; Agarwal et al. 2010; Wickramasinghe and Kirn 2013; Constantinides and Barrett 2015; Dünnebeil et al. 2013) since digital technologies can potentially reduce and manage healthcare costs or enhance healthcare quality (Kolodner et al. 2008). The implementation of digital technologies exhibits various different effects (Pousttchi et al. 2019b) with enormous impact on the economy and society likewise (Pousttchi 2017).

Most of all, they bear the potential to surmount barriers in time and space. Hence, patients increasingly demand such services in real-time or near-time with a convenient and seamless user experience (Varshney 2005). Amongst a cloud of related concepts in the context of digital health (such as mobile health, or smart health), one term increasingly typifies this impulse in particular: *on-demand healthcare*.

This term can be noticeably found in practice. According to Accenture it is the second-fastest growing segment of the on-demand economy (Boston and Kovach n.d.). In contrast, there is hardly some theoretical foundation so far, although some contributions indicate that research in this field is required (e.g., Fichman et al. 2011; Agarwal et al. 2010). Against this background, the aim of this paper is to address this research gap and explore the phenomenon of on-demand healthcare. Based on a systematic analysis of available literature and empirical evidence, the outcome of this paper is twofold: (1) a conceptual framework and (2) a definition of on-demand healthcare. The rest of the paper is structured as follows. In Section 2, we describe our methodical approach. In Section 3, we discuss the results of our exploratory mixed-methods approach of screening available literature and elevating empirical insights. In Section 4, we proceed with synthesizing the results of our analyses by means of a conceptual framework and a definition of on-demand healthcare. In Section 5, we come up with a conclusion and an outlook for possible future research.

2 Methodical Approach

We address the research gap and systematically explore the phenomenon of on-demand healthcare with an explorative and qualitative design-oriented approach in order to gain a deeper understanding in terms of analysis and explanation (Gregor 2006). Design science research allows the development of both theories and artefacts that lend utility to practice. It requires a comprehensible, rigorous design and evaluation of artefacts as an approach to solve important, relevant business problems in a specified environment (Hevner et al. 2004). Basically, these guidelines can be condensed into three activities: systematic artefact construction by practice or theory-based insights, evaluation of the functional performance, and reflection on results (Kuechler and Vaishnavi 2012). Results can be models, methods, constructs or instances (March and Storey 2008). Following these guidelines, we conducted a structured mixed-methods research design consisting of two phases: exploration and synthesis (Figure II.4-1). The *exploration phase* contains four basic pillars: analysis of closely related definitions; literature review of on-demand healthcare; conduction and analysis of in-depth expert interviews; screening and analysis of empirical digital health applications.

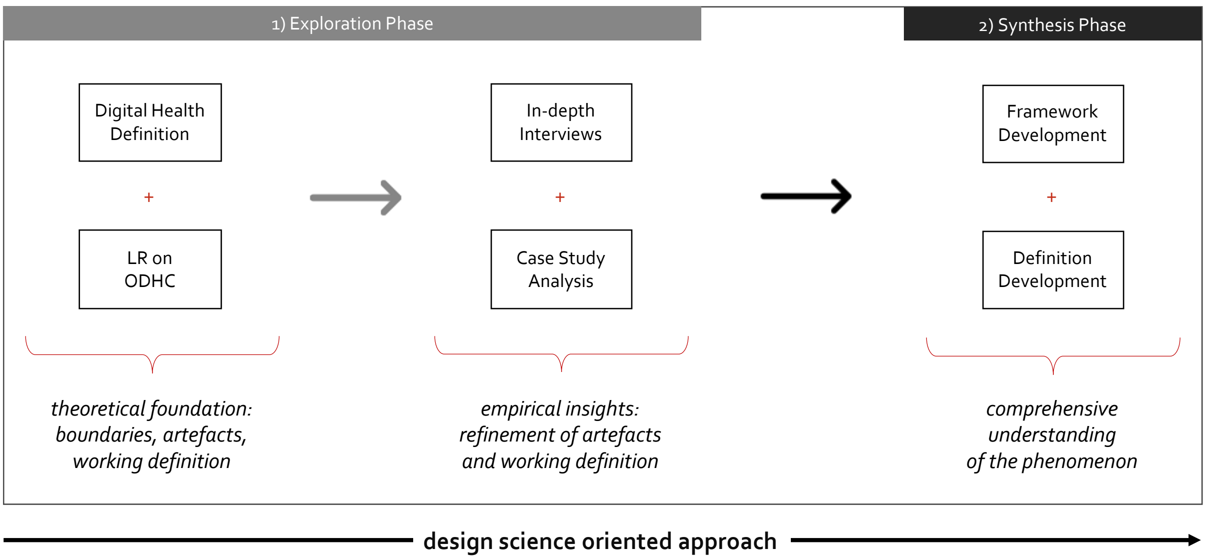

Figure II.4-1: Research Design (On-demand Healthcare)

Hence, we first explored and analyzed available definitions of closely related terms, i.e., digital health, eHealth, mHealth, smart health, health-IT to frame and narrow the definition space of on-demand healthcare. At this, we mainly stuck to available literature in the field of IS and BI, starting with a comparative overview on eHealth from (Oh et al. 2005) and further concentrating on applicable research agendas (e.g., Agarwal et al. 2010) and comprehensive articles in encyclopedias (e.g., Gersch and Wessel 2019). As part of this analysis, we could determine the general scope and boundaries of on-demand healthcare.

Second, we conducted a systematic literature review with the goal of better understanding the new phenomenon (Rowe 2014) of on-demand healthcare. Based on Cooper's Taxonomy (Cooper 1988), we put a focus on research outcomes and theories to identify central issues from a neutral perspective. We apply a conceptual approach to identify artefacts (drivers and components) of on-demand healthcare from a representative coverage of research contributions in the context of digital health to develop an understanding of on-demand healthcare for both general scholars and practitioners. Following the guidelines of Schryen (2015), we conducted an incremental search, which first involved an exhaustive keyword search within the abstracts, titles and keywords of academic papers by using the relevant databases (i.e., aisel, Ebscohost, IEEE Xplore, Wiley, JSTOR, Springer) and the following string: ("on-demand") AND ("health*" OR "doctor" OR "physician"). From 35 identified academic contributions only six proved relevant in covering on-demand healthcare in a narrower sense. That is why we broadened our literature search by practical contributions on on-demand healthcare. We applied a concept-oriented approach to identify prerequisites, drivers, characteristics and goals of on-demand healthcare services. On the basis of our first two analysis steps, we developed a working definition of on-demand healthcare in preparation for the subsequent steps.

Third, we conducted in-depth face-to-face interviews with 14 international digital health experts at HPI-Mount Sinai Digital Health Forum 2019 to capture and conceptualize their understanding of on-demand healthcare. Among the experts were founders of digital health startups, scientists, hospital CIOs and representatives from ICT providers, payers and responsible government authorities. We followed the guidelines from Collis and Hussey (2014) and designed a deliberate mix of open and closed questions in order to explore and collect broad but purposeful information from the interviewees. Thus, we interviewed the experts for approximately 20-30 minutes to zero in on four segments of on-demand healthcare, i.e., general understanding, expected time scope, required building blocks and perceived impact factors. At the end of the interviews, we confronted the experts with a working definition of on-demand healthcare to ask for amendments or extensions. This way, we contrasted the open and explorative questions with graspable content. We recorded the interviews for transcribing and inductively coding the answers in the aftermath to appropriate classes within the respective question segments.

Forth, we identified and analyzed (mainly mobile) digital health applications, which exhibit latent characteristics of our working definition. This implies a qualitative case-study analysis, following the guidelines from (Yin 2009). A multiple-case study can prove useful to approach scarcely explained phenomena by developing or testing theory from empirical data. Therefore, carefully selected cases can contribute to systematically conceptualize new phenomena (Benbasat et al. 1987). Accordingly, we conducted an internet search to identify common digital health applications with varying value propositions. We analyzed 16 of such services with respect to their required resources in order to explore further or more detailed prerequisites, drivers, characteristics and goals of on-demand healthcare which helped us gaining a broader and more tangible understanding of on-demand healthcare.

As part of the *synthesis phase*, we systematically coded, categorized and aggregated our findings from all four pillars to derive a comprehensive overview of the predominant artefacts (i.e., prerequisites, drivers, characteristics and goals) of on-demand healthcare. In a second step, we conceptualized these artefacts and condensed them into a coherent framework and a definition of on-demand healthcare services to provide a graspable result of our efforts, which might prove useful for further research in this context.

3 Exploring On-demand Healthcare

3.1 Definition of Digital Health

In order to determine the boundaries for conceptualizing on-demand healthcare, we first come up with a general understanding of digital health. Digital health is often referred to as eHealth or health-IT (Gersch and Wessel 2019) and covers a broad range of approaches (e.g., patient-centeredness (Chu et al. 2018)), concepts (e.g., personalized health (Böttinger and zu Putlitz 2019; Menvielle et al. 2017)) and technologies (e.g., 3D Printing (Gelinsky 2018)). In IS and BI related research, a plethora of definitions for digital health and eHealth is available which all have a combination of health and the use of technologies in common (Oh et al. 2005). In line with that, the World Health Organization defines digital health or eHealth as the cost-effective and secure use of information and communications technologies in support of health and health-related fields.

Some research contributions have yet conceptualized the broad field of digital health. For instance, Agarwal et al. (2010) have scrutinized digital health regarding its impact (i.e., quality and economics of healthcare) and its adoption (i.e., level and barriers). Fichman et al. (2011) have analyzed the role of IS in healthcare. Thus, the first determined the underlying conditions of healthcare (which is highly personal, competitive, regulated, multidisciplinary, hierarchical and complex) and the proposed potential research opportunities as IS can help to exploit social media for healthcare, enhance evidence-based medicine and facilitate personalized health.

Gersch and Wessel (Gersch and Wessel 2019) basically break up the term digital health into health-IT and eHealth. While health-IT refers to the health-related technical artefacts to support business and care processes as a decisive pillar of digital transformation in health (Bardhan et al. 2015), eHealth applies to resulting economic, social and societal effects and consequences. Thus, digital health is an umbrella term for the use of different IT and IS based artefacts and solutions in healthcare. For one thing, this includes systems closely related to health (e.g., telemedicine, hospital IS, electronic health records). For another thing, it also applies to general digital technologies which diffuse into healthcare (e.g., internet of things, ubiquitous computing).

According to the definition of Gersch and Wessel (2019), the following artefacts have to be taken explicitly into consideration in the context of digital health:

- telematics infrastructure as an essential basis for intersectoral communication and digital health systems and applications;
- telemedicine as the use of ICT for healthcare services to remove barriers in time and space;
- clinical pathways as an equivalent for process management and a systematic analysis, development and improvement healthcare-related processes;
- healthcare-specific IS (esp. for hospitals and clinics) for the support and administration of healthcare-related processes;
- electronic health or patient records (EHR/EPR) for the individual documentation of patient history to support healthcare both directly (i.e., anamnesis, diagnosis, treatment) and indirectly (i.e., communication, coordination);
- health apps and mHealth as a result of the pervasiveness and ubiquity of smartphones and other wearables for supporting documentation, detection, communication and self-management;
- health platforms to ensure interoperability and facilitate intermediation among systems, applications and stakeholders in healthcare;
- health communities through the usage of social media platforms and applications.

As a result, digital health embraces a bunch of different concepts, methods and systems, which therefore constitute a natural boundary for the understanding of on-demand healthcare. Some of these concepts and terms seem to be closely related to on-demand healthcare, others not. If and to what extent, will be elaborated in the following sections.

3.2 Literature Review: On-demand Healthcare

After having defined the boundaries of on-demand healthcare, we screened available literature on this phenomenon. Although there is a plethora of digital health literature available and many topics seem to be attached to on-demand healthcare (e.g., smart health, telemedicine), concrete IS-related academic literature on this phenomenon is virtually non-existent. IS-related contributions, which refer to that term, do not come up with a definition of on-demand healthcare. For instance, Aspria et al. (2014) explore the effects of integrating patients in the development of on-demand webcasts. Zao et al. (2008) describe the development of a platform for on-demand healthcare applications for smartphones and wireless sensor networks. However, both contributions mainly stick to telemonitoring and remote healthcare in their explications, which might be components of on-demand healthcare but do not necessarily constitute it. Likewise, Shen et al. (2013) apply a sensor fusion method to detect depressive disorder with incomplete datasets. They outline the role of (biomedical) cloud computing as a prerequisite of on-demand healthcare, but do not deliver a definition or description.

In contrast, Varshney (2005) seems to refer to the concept of on-demand healthcare from a generic and conceptual standpoint but proposes the term pervasive healthcare as "healthcare to anyone, anytime, and anywhere by removing locational, time and other restraints while increasing both its coverage and quality", including prevention, healthcare maintenance and checkups, short- and long-term monitoring, personalized healthcare monitoring, incidence detection and management and emergency intervention, transportation and treatment.

From a more sociotechnical point of view, the terms mobile health, connected health, IoMT, cloud health, health information and smart health (e.g., Gerhardt et al. 2018; Motamarri et al. 2014; Cripps et al. 2012; Howell et al. 2016; Bajracharya et al. 2019; Rozenkranz et al. 2013) seem also to relate to on-demand healthcare and underline its ubiquitous, ever-present, automatic and networking character. With a focus on the patient-centered aspect of on-demand healthcare, the term seems also to be related with consumer healthcare which allows patients to interact with systems and applications that enable patients to gather health information or co-create value, e.g., by exploiting the potentials of telemedicine or self-management tools (e.g., Sunyaev 2014; Sherer 2014; Wilson 2009; Miscione 2007).

Zooming out to non-IS literature, a few contributions approach the phenomenon from a technical or social perspective. For instance, Paul and Srinivasan (Paul and Srinivasan 2009) develop a logical services-enabling network architecture for on-demand healthcare and present different remote interaction modes between doctors and patients, i.e., text, voice and video transfer. The authors narrowly define on-demand healthcare as a setting, "where patients can connect and interact with doctors in real time". From a sociodemographic view, Dawson (2017) displays the promises of on-demand care for different beneficiaries, i.e., patients, caregivers and family members. The authors define on-demand care broadly as "internet-based platforms and smartphone applications that enable consumers to obtain access to health services. On-demand health care ranges from instant access to physicians and other health providers to transportation options for people living with disabilities".

In contrast, there are several practical contributions that address the phenomenon of on-demand healthcare. Mostly, these contributions ascribe this term to the on-demand economy (Colby and Bell 2016), in which healthcare is not only a lifestyle expression but also an important and fast-growing sector next to transportation and food (McDonald 2015; Boston and Kovach n.d.). In this context, the on-demand economy is closely connected to the sharing economy and implies the timely limited (and paid) access to resources instead of purchasing them (Nota 2016; Natour 2016). Other practical contributions take a psychological perspective and refer to the concept of instant gratification after a transaction (Hanson 2019). In the context of health, the immediate fulfilment of requests implies the likewise immediate treatment of certain injuries and illnesses (JungleWorks 2017), which entails several challenges regarding regulation (AHA n.d.) consumer expectations (Nota 2016) or consumer rights (Natour 2016). Accordingly, healthcare service providers need to understand this ongoing shift to respond adequately. Especially, lack of relevant data and poor coordination among stakeholders in healthcare are seen as major barriers for digital progress and the provision of on-demand services (Nota 2016).

As a result of analyzing the theoretical foundations, we could develop a working definition of on-demand healthcare to lay a foundation for the following two steps of the exploration phase:

"On-demand healthcare implies the immediate and convenient availability of and accessibility to healthcare services whenever a patient needs or requests it, preferably through the use of mobile devices. On-demand healthcare may apply to all digital-health related services such as gathering health information, finding healthcare service providers, scheduling appointments or receiving consultation."

3.3 In-Depth Interviews with Digital-Health Experts

Based on our theoretical findings, we conducted structured in-depth interviews with 14 international digital health experts at HPI-Mount Sinai Digital Health Forum 2019. We posed both closed and open questions to explore and analyze their understanding of on-demand healthcare. Most of the experts have yet heard of the term, but could not offer a concrete or distinct definition. However, most of them understood on-demand healthcare as a service which can be delivered in the very moment it is needed or requested. According to the experts, services imply indirect healthcare such as online information, appointments or orderings as well as direct healthcare such as consultation or council for the purpose of diagnosis or treatment. Some of the interviewees added technical (e.g., "mobile", "telemedicine"), temporal (e.g., "promptly", "when needed"), or spatial (e.g., "remote", "location-independent") constraints.

In order to elaborate these constraints, we explicitly asked for concrete time scopes and distinct technologies. The interviewees' responds define a time scope from one minute to one day, with a tendency to a couple of minutes. Some interviewees differentiate between (1) acute and negligible requests and (2) triage and further actions as decision criteria to evaluate urgency (and thus, immediacy). Among the mentioned concepts and technologies, telemedicine, EHR/ EPR, and mobile technologies (apps, smartphones, wearables) are the most prevalent ones. However, other terms mentioned are chat(bot)s, remote monitoring, search engines, video streams, online appointments, online information and symptom checkers, bandwidth and infrastructure, social media, or quantified self and biometric data.

Finally, we asked for advantages and disadvantages of on-demand healthcare and confronted the interviewees with our working definition to obtain feedback and proposals for adjustments. Among the advantages, the interviewees mostly stated efficiency, flexibility and convenience for the patients. Prompt service delivery has become a requirement of the modern consumer and this attitude increasingly spills over to the healthcare sector. Plus, a prompt medical or administrative aid can be vital in cases of emergency. From the supplier view, on-demand healthcare can render the hospital or clinic visit redundant, a digital triage can unburden the medical facilities and therefore the entire health system. Among the disadvantages, the interviewees mainly stated issues of quality, data security, reliability and reimbursement of the healthcare service. With respect to our working definition, most of the interviewees complied with it or referred to their further statements. Some interviewees emphasized or recommended a focus on patient-centricity and time scopes as well as a generalization of technologies and services.

3.4 On-demand Healthcare Applications

In a fourth step and final step of our exploration phase, we identified and classified apparently typical on-demand healthcare services by means of a multiple-case study analysis in order to refine our understanding of on-demand healthcare and to derive standard types of on-demand healthcare services. At this, we draw on both available literature and empirical cases (i.e., records and websites from digital healthcare services) to identify a sufficient selection of appropriate cases with a preferably broad diversity regarding their respective value propositions.

Mobile applications convey a sense of immediacy by nature. Some (esp. browser-based) applications require network access, others (esp. native ones) require access to hardware components (e.g., camera, sensors) or device functions (e.g., calendar), or data (entered data, storage data) to work properly. However, the usage of a mobile application does not automatically imply availability of or access to a healthcare-related service. Hence, we analyzed 16 mobile applications to derive and consolidate possible prerequisites of on-demand healthcare (Table II.4-1).

Table II.4-1: Analysis of On-demand Healthcare Services

App Function	Example	*Resources*		
		Network	**Device**	**Personal Data**
symptom check / diagnosis	ada, breazytrack	required	mostly required	required
self-management & control	BetterHelp, Vida, Apple	not necessarily	sometimes required	required
health information access	WikiMed	not necessarily	not necessarily	not necessarily
online pharmacy	myCare, PillPack	required	not necessarily	required
online appointment	doctolib Jameda, Solv	required	mostly required	required
physician search and evaluation	Jameda	required	sometimes required	not necessarily
peer communication	Whatsapp, Facebook	required	sometimes required	required
online (video) consultation	Heal, Teladoc, HealthTap	required	required	required

Most of the applications require *mobile network access* (mainly LAN or WAN) in order retrieve data from databases, which are either too rich for offline availability (e.g., symptom check database) or require real-time queries (e.g., online appointments) or communication (e.g., video) chats). However, we found encyclopedias with offline functionality, which implies a big storage footprint but allows permanent availability regardless of network access. Moreover, many apps require *access to device resources*. For instance, symptom checkers or chats often need a camera functionality, while online appointment tools demand calendar access.

Likewise, communication apps demand access to contacts and some self-management tools require access to specific sensors in a smartphone. Unsurprisingly, most app types also require *access to personal data* (either entered or collected from smartphone or wearable sensors). Symptom checkers and self-management tools need body-related data, while other apps require payment data (e.g., online pharmacies) or patient history data (e.g., online consultation) to improve their service quality. Network and data access seem almost vital in order to provide such ubiquitous and contextual services. Plus, the more immersive and high-value the service is (e.g., video consultation), the more resources are necessary on both sides.

4 Conceptualizing On-demand Healthcare

On the basis of available academic and practical literature in the context of digital health as well as expert interviews and factual healthcare services, we explored and identified different facets of digital health to identify potential components of on-demand healthcare. We classified and aggregated these components into a conceptual framework of prerequisites, drivers and standard types of on-demand healthcare, and developed a proposal for a definition.

4.1 Prerequisites and Drivers

As one result of our analyses, we identified two main prerequisites of on-demand healthcare services. Especially the findings from the interviews and cases indicate that such services need to be always available and accessible whenever the patient needs them: This implies a *permanent and ubiquitous availability and access to both the services and their underlying infrastructure*. E.g., an application to check symptoms is useless without connectivity or database access and so is a tool for searching specialized physicians in the vicinity. Likewise, an application for online consultation is highly reliant upon a constant, secure and latency-free transmission of high-quality audio and video data.

Besides the prerequisites, we identified two driver types of on-demand healthcare. Drivers can generally be subdivided into digital drivers and social drivers. First, we present the identified *digital drivers*. The high prevalence and usage of *mobile or smart devices* (smartphones, wearables, smart objects) among both patients and healthcare professionals in conjunction with the ubiquity and availability of (preferably) wireless *internet connectivity* (with high bandwidth and low latency) has globally fostered the occurrence, acceptance and pervasion of digital services in general and, consequently, on-demand healthcare services in particular.

Additionally, sophisticated *sensors and actors (IoT/UC)* are able to capture various kinds and types of data. Advanced *data processing technologies*, such as data mining, big data, cloud/distributed computing and artificial intelligence enable a facilitated or even automated computation, management, transfer and analysis of such data for insights or decision support. These foundations pave the way for both simple and advanced *systems and applications*, which help patients to manage their health issues, such as websites, mobile apps, search engines, messengers, video streams, video chats, chatbots, or social media. Table II.4-2 summarizes the identified digital drivers by the four distinct categories.

Table II.4-2: Digital Drivers of On-demand Healthcare

Driver	Explanation
Communication technologies	The possibility to transfer health data and information with the existing technical infrastructure and necessary speed and bandwidth (e.g., WAN, LAN, PAN)
Data-processing technologies	The possibility to store, compute or analyze (huge amounts) of health data (e.g., Big Data, cloud/distributed computing, AI/ML)
Smart devices	The possibility of *physical* human-computer interaction to capture and exchange data and information (smartphones, PCs/laptops, wearables, smart objects)
Systems and applications	The possibility of *logical* human-computer interaction to capture and exchange data and information (e.g., mobile apps, websites, search engines, messengers, chats, streams, social media)

Next to digital drivers, we also identified *social drivers* as a result of our analysis which promote the occurrence of on-demand healthcare (Table II.4-3). From a sociotechnical standpoint, increasing *technology acceptance* seems to be a crucial driver. Patients are more and more familiar with the usage and ubiquity of digital devices and applications and therefore, progressively expect and demand the availability of digital services. At the extreme, they actively exploit such applications to continuously trace and record medical and body-related data (*quantified self*). Due to digital transformation, patients are spoilt with the *permanent and ubiquitous availability* of (digital and digitally enabled) services which progressively spills out to the healthcare market. Constant access to information about possible diseases or treatments leads to a (perceived) *health literacy* which is also triggered by an increased *health awareness* within the society. More information, however, can support *patient empowerment and involvement* with respect to diagnoses and treatments. Finally*, trust and privacy* issues are crucial for the *acceptance* of on-demand services.

Table II.4-3: Social Drivers of On-demand Healthcare

Driver	Explanation
Quantified self	The possibility to (automatically) capture, store and analyze personal or medical data
Patient involvement	The possibility to actively take part in the process of treatment and decision-making
Permanent availability	The possibility to access services, products or information at any point in time
Ubiquitous availability	The possibility to access services, products or information from any place on earth
Health awareness	The trend of taking care about the personal health and wellbeing
Health literacy	The possibility to (technically) access and (cognitively) understand health information
Trust and privacy	The trend of taking care about the legal use of own personal data by third parties
Technology acceptance	The trend of accepting the ubiquity and usage of digital technologies

4.2 Standard Types and Characteristics

As another result of our analysis, we derived standard types and characteristics of on-demand healthcare services. The screening of mobile applications helped us to define standard types of such services. We classified these by their level of required patient involvement, resulting into three *standard types*: information, transaction, and interaction.

Services with low involvement include websites or apps, which help patients to instantly gather and consume *information* from any place at any time (e.g., search engines, blogs, magazines, encyclopedias like WikiMed). Other on-demand healthcare services reveal *transactional* elements and allow an instant and remote provision and payment of professional services, such as symptom checkers (e.g., ada health), online pharmacies (e.g., MyCare, PillPack), or online tools to fix appointments (e.g., doctolib), search and mediate healthcare providers (e.g., Solv), or rate physicians (e.g., jameda). A third group of healthcare services requires high involvement and *interaction*, such as forums for discussions with fellow patients (e.g., forums or social media groups on Facebook or Whatsapp) or the instant and remote provision of professional services through online consultation via text, calls or video chats (e.g., Heal, Teladoc, HealthTap).

Each service requires initial action from the patient (or automatically: from the patient's device) and a response from the service provider (or automatically: from the application). Hence, we also derived *service request and service delivery attributes* that help define on-demand healthcare services. Such services are always initiated by the patient as a result of a need or an arousal, i.e., they are *patient-driven* and *demand-based*. In turn, the service delivery has to be individual, contextual and personalized, i.e., *patient-related* and *demand-oriented.* Plus, the service requests happen *remotely*, i.e., bridging barriers in time and space, and *upon request*, i.e., only if the patient (or the device through the automatic analysis of sensor data) initiates the process. Hence, the service delivery also happens *remotely* and must occur as soon as possible, in the best case *immediately*. As we set digital health as the boundary of our consideration, such service requests are *digitally enabled* as they avail of modern ICT. Vice versa, the same applies to the service delivery.

4.3 On-demand Healthcare: Framework and Definition

In this section, we conceptualize the findings from our analyses and contextualize them into a coherent framework of on-demand healthcare. On-demand healthcare services can be classified into three standard types (i.e., information, transaction, and interaction), which depend on their level of patient involvement, transmission bandwidth and service complexity. Plus, we identified five attributes each for service requests and deliveries of on-demand healthcare. In order to successfully run and diffuse healthcare services on-demand, we identified necessary prerequisites (i.e., permanent and ubiquitous infrastructure and service access and availability) and two types of drivers (i.e., digital and social). Plus, we formulated the desired outcome of such interventions, namely the maintained or restored wellbeing of the patient or consumer. Figure II.4-2 presents these artefacts by means of a conceptual framework of on-demand healthcare.

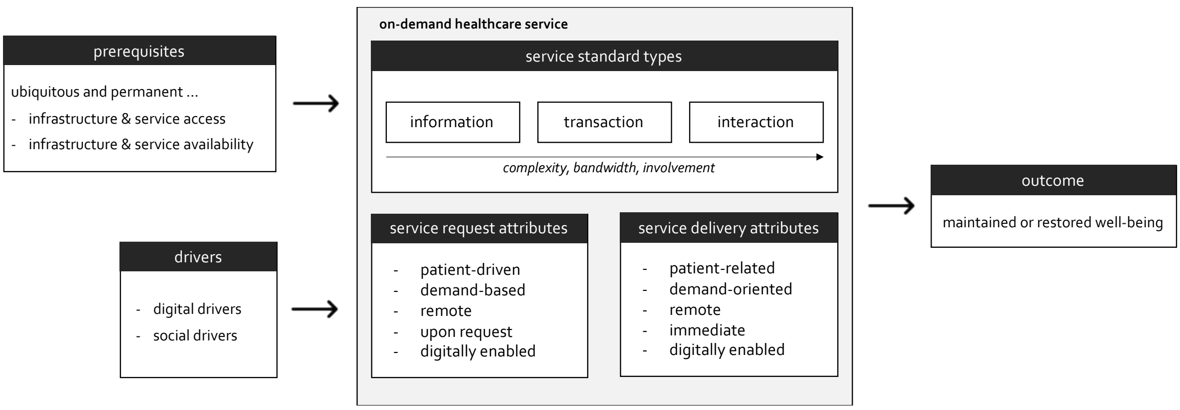

Figure II.4-2: Conceptual Framework of On-demand Healthcare

On this conceptual basis, we aim to propose a definition of on-demand healthcare. In a first step, we split the term into *on demand* and *healthcare*. According to Merriam-Webster, "on demand" means "when requested or needed" (Merriam-Webster 2020a) and "healthcare" are "efforts made to maintain or restore physical, mental, or emotional well-being especially by trained and licensed professionals" (Merriam-Webster 2020b). Following practical literature about the "on-demand economy", the term is inextricably linked with digital services and consumer-driven (Colby and Bell 2016; Hanson 2019) with a tendency of pervasiveness (Varshney 2005). Bearing in mind the stated theoretical boundaries (e.g., Gersch and Wessel 2019; Oh et al. 2005), digital technologies are an inherent condition of on-demand healthcare. In the light of these prerequisites and based on our analyses and framework, we propose the following generic definition of on-demand healthcare:

> *"On-demand healthcare is the request-based, patient-driven, immediate and remote provision of healthcare services by exploiting digital technologies in order to maintain or restore the physical, mental or emotional well-being."*

Thus, on-demand healthcare is a subset of digital health and may – dependent on context – include concepts as telemedicine, online health-information, and mobile or connected health. All in all, the proposed definition in conjunction with the conceptual framework provides some groundwork and understanding of on-demand healthcare by boiling down its components and boundaries to an essence.

5 Conclusion and Outlook

The starting point of our consideration was to better understand and systematize the nature and concept of on-demand healthcare as there was virtually no theoretical foundation of this phenomenon so far, while practical contributions indicate its raison d'être. To address this research gap, we applied a mixed-methods approach and drew on the insights of available literature, expert interviews and empirical cases. The outcome of our paper is twofold: First we derived and developed prerequisites, drivers, standard types and characteristics of on-demand healthcare services in order to develop a conceptual framework. Second, we proposed a definition of on-demand healthcare on this theoretical and empirical basis.

For researchers in the field of digital health, our results can be a starting point and reference when exploring phenomena in the context of on-demand healthcare and substantiating the concept. We hope, our contribution adds another puzzle piece in understanding the complex field of digital health. For practitioners, our results can be used to systematically comprehend and develop such services. Future research could validate and expand the concept of on-demand healthcare, possibly from in-depth cases or patient studies. From a more holistic standpoint, further research is still required to systematically untangle the various and closely connected concepts in the entire context of digital health (e.g., mHealth, connected health, on-demand healthcare).

III Studies on the Impact of Digital Platforms

III.1 Surrounded by Middlemen – How Multi-sided Platforms Change the Insurance Industry

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Abstract: *Multi-sided platforms (MSP) strongly affect markets and play a crucial part within the digital and networked economy. Although empirical evidence indicates their occurrence in many industries, research has not investigated the game-changing impact of MSP on traditional markets to a sufficient extent. More specifically, we have little knowledge of how MSP affect value creation and customer interaction in entire markets, exploiting the potential of digital technologies to offer new value propositions. Our paper addresses this research gap and provides an initial systematic approach to analyze the impact of MSP on the insurance industry. For this purpose, we analyze the state of the art in research and practice in order to develop a reference model of the value network for the insurance industry. On this basis, we conduct a case-study analysis to discover and analyze roles which are occupied or even newly created by MSP. As a final step, we categorize MSP with regard to their relation to traditional insurance companies, resulting in a classification scheme with four MSP standard types: competition, coordination, cooperation, collaboration.*

1 Introduction

The insurance industry is faced with existential challenges these days: demographic change, persistent low interest rates, and, most notably, ongoing digital transformation (Capgemini/Efma 2018a; Nicoletti 2016). The emergence and development of digital technologies does not only affect the structures and processes of traditional insurance companies (e.g., Allianz, Generali, Ping An, Berkshire Hathaway), but also leads to changing customer needs and behaviors (e.g., Deloitte 2016; Naylor 2017). As a result, digital transformation impacts value creation, value proposition, and customer interaction of insurance companies (Pousttchi 2017; Pousttchi et al. 2019a).

Although the insurance industry is historically entangled with information and communications technology to efficiently calculate risks and loss distributions, large companies often struggle to respond adequately to this massive change (e.g., Eling and Lehmann 2018; Scardovi 2017; Naylor 2017). These developments give rise to new players with innovative business models that swiftly adapt and exploit the advantages of new technologies and data sources to address the needs of digital customers – from small insurance start-ups to very large tech companies like Amazon or Google (Capgemini/Efma 2018b; Hook 2018; Moore 2018). In many cases, these players mediate between insurance companies and their customers, facilitate transactions or reduce information asymmetries, and therefore show characteristics of multi-sided platforms (MSP). Despite their growing economic relevance, there is currently little research on insurance-related MSP and their strategic impact on the insurance industry. More generic research on platforms does explore the multiple facets of MSP (e.g., pricing structures, value propositions, user behaviors). However, there is yet little knowledge of how digitally-empowered MSP can transform entire traditional industries (de Reuver et al. 2018) or how the place of traditional insurance companies is redefined in the industry (Eling and Lehmann 2018). The aim of our research is to address this research gap. The insurance industry with its large, solid companies is especially suited for our investigation as it undergoes a massive transformation, which yields many opportunities for new innovative players to step in (e.g., Moore 2018). Practical contributions underpin this impression with empirical findings (e.g., Noack et al. 2017) and suggest that the insurance industry might be highly affected by MSP and the rise of new ecosystems within the next years (e.g., Catlin et al. 2018). This raises the research question how and to what extent MSP might change value creation of the future insurance industry. In response to the research aim, we analyze the state of the art in research and practice in order to develop a reference model of the value network for the insurance industry. On this basis, we conduct a case-study analysis with a special focus on platforms to discover and analyze roles, which are occupied or even newly created by MSP in the network. As a final step, we categorize MSP with regard to their relation to traditional insurance companies.

The outcome of the paper is threefold: a role-based reference model of the insurance value network, identification and analysis of insurance-related MSP configurations and a taxonomy resulting in the derivation of four MSP standard types in the insurance industry. The rest of the paper is organized as follows: In the next section we provide an overview of the relevant literature and describe our methodology. In the third section we develop the reference model. In the fourth section, we identify and analyze (new) roles for MSP, present an enhanced reference model for the (future) insurance value network, develop a classification scheme and derive the standard types. Finally, we conclude and outline potential implications of MSP in the insurance industry for both research and practice.

2 Background

2.1 Multi-sided Platforms

Although the notion of the phenomenon "platform" is centuries-old (e.g., medieval markets; Hagiu 2006), they increasingly have obtained extensive coverage in IS, Economics, and Marketing research within the past decade (e.g., Willing et al. 2017; de Reuver et al. 2018; Hagiu and Wright 2011; Sriram et al. 2015). Especially, the progression of digital technologies has upheaved the virtue and power of platforms (Parker et al. 2017). Since Rochet and Tirole have introduced their model of platform competition in two-sided markets (2003), research on (multi-sided) platforms has increased and diversified to a large extent (de Reuver et al. 2018). As two-sided markets and MSP are interrelated (Bakos and Katsamakas 2008), research still lacks a clear but comprehensive definition and understanding of MSP (Hagiu and Wright 2015) as well as sharp distinctions from two-sided platforms or further platform types (Staykova and Damsgaard 2014).

Basically, MSP have two fundamental characteristics: They facilitate direct interaction between two or more distinct sides of market participants with all sides affiliated with the platform (Hagiu and Wright 2015). While direct interaction refers to the control over the trades' key terms (e.g., pricing and delivering of goods or services) by either of the market participants or the platform, affiliation involves consciously made platform-related investments by either participant side to engage in this interaction (Hagiu and Wright 2015). The existing literature on MSP complements this concept by two further characteristics: Homing and switching costs as well as network effects. The former incur for participants due to the platform affiliation (e.g., Armstrong 2006; Evans et al. 2006, p. 283; Kwon et al. 2017) while the latter appear when the platform's usefulness – and therefore value – is subject to the participant size (Shapiro and Varian 1998; Eisenmann et al. 2006; Song et al. 2018).

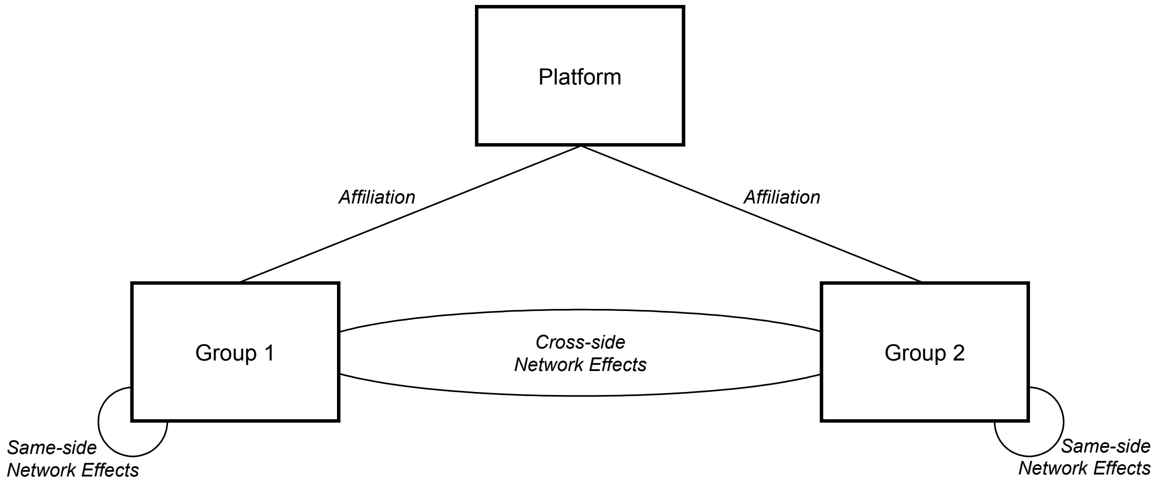

Figure III.1-1: Platforms: Affiliations, Network Effects (adapted from Staykova & Damsgaard 2015)

Network effects are strongly associated with platforms, which create networks by pairing up different market participants (see Figure III.1-1; Rochet and Tirole 2003; Parker and van Alstyne 2005). Network effects are *direct* if the platform's value depends on the number of same-side participants (de Reuver et al. 2018). In the platform context, this phenomenon is also called *same-side effects* (Eisenmann et al. 2006). A common example are social networks where users benefit from the presence of other users (e.g., Baumöl et al. 2016). On the contrary, network effects are *indirect* if the platform's value depends on the number of cross-side participants (Eisenmann et al. 2006; de Reuver et al. 2018). This phenomenon – also called *cross-side* network effects – occurs, for instance, in software platforms where developers benefit from the presence of end-users and vice versa (e.g., Song et al. 2018).

In IS research, three relevant streams have emerged in the past decade: economics, marketing and sociotechnical issues. These three research streams get gradually entangled, e.g., when shedding light on digital platform competition from an architectural view (Kazan et al. 2018). *IS and Marketing*-related research often relates to platform user attitudes (e.g., Bartikowski and Walsh 2014), behaviors (e.g., Siering et al. 2016) or interactions (e.g., Baumöl et al. 2016) and in what way platforms can encourage commitment (e.g., Benlian et al. 2015). From a more *technical and sociotechnical* point of view, IS related research covers IS capabilities (e.g., Tan et al. 2015), ambiguous user behavior (e.g., Becker and Pousttchi 2013), modeling approaches (e.g., Kaczmarek-Heß and de Kinderen 2017), performance features (O'Reilly and Finnegan 2005) and architectures of platforms (Wagelaar and van der Straeten 2007). Others discuss the rise of digital platforms as artefacts (de Reuver et al. 2018), which, for instance, can support collective interaction within online communities (Spagnoletti et al. 2015).

2.2 Digital Transformation of Insurance

Digital transformation affects many industries as digital technologies increasingly change business in three characteristic dimensions: value creation, value proposition and customer interaction (see Figure III.1-2; Pousttchi 2017; Pousttchi et al. 2019b). Furthermore, digitalization has a lasting impact on customer behavior and decisions (Pousttchi and Dehnert 2018; Belk 2013). Traditional insurance companies often still host decade-old legacy systems and therefore require adequate strategies to integrate and exploit digital technologies in order to ensure or enhance competitiveness in global markets (Matt et al. 2015; Pagani 2013). Thus, some of them have addressed digital transformation as part of their strategic alignments (e.g., Allianz 2017a). The combination of new technologies with innovative ways of data processing not only improves and disrupts existing business processes, but also enables completely new business models and markets (Constantiou and Kallinikos 2015; Seddon et al. 2017).

This is particularly the case in networked businesses (Baesens et al. 2016) and therefore also accounts for the insurance industry. Insurance companies are highly dependent from information and communications technologies in order to effectively and efficiently accumulate, store and process huge amounts of data (Yates 2005). On one side, the business implies a "production unit" to produce insurance coverage or amass capital by assessing, quantifying, and pooling individual and collective risks with actuarial methods. On the other side, it involves a "service unit" with (professional) services for customer acquisition, care, and retention through different channels (Farny 2005). Insurance firms are particularly affected by the rise of digital technologies and the changing behaviors of their customers although they are traditionally rather slow in adopting innovative technologies, as available literature indicates (Nicoletti 2016; Crawford 2017).

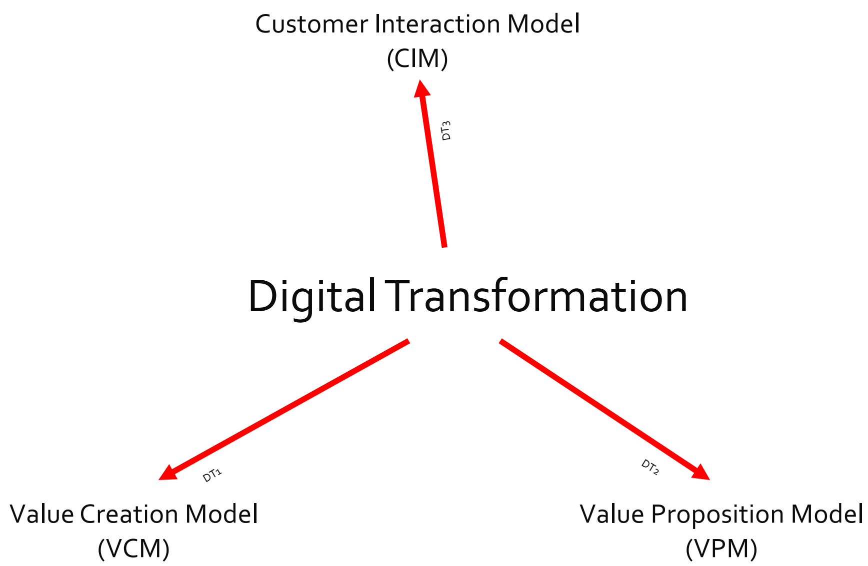

Figure III.1-2: Dimensions of Digital Transformation (adapted from Pousttchi 2017)

With regard to *value creation* of insurances, research addresses the impact of digital technologies on strategies (Granados and Gupta 2013; Grover and Kohli 2013; Hess et al. 2016), management decisions (Fearon and Philip 2005), sourcing and implementation (Herz et al. 2012), performance (Hamel et al. 2012), process automation (Braunwarth et al. 2010), process flexibility (Afflerbach et al. 2014), or innovation (Chen et al. 2009). More importantly, the impact on production-related processes has become popular in the last years as the availability of new data sources opens up further possibilities for risk assessment, forecasting and underwriting processes (Boyer et al. 2012). Particularly, the generation and exploitation of telematics data has gained increased attention within the literature (Baecke and Bocca 2017; Vaia et al. 2012).

In terms of *value proposition* of insurances, research focuses on the impact of digital technologies on new products or services like add-on or micro-insurances (Fleisch et al. 2015), insurances against online defamation (Gatzert et al. 2016), insurances for self-driving vehicles (Vellinga 2017), and insurances against general or specific cyber risks like those from cloud computing (Zhao et al. 2013; Haas and Hofmann 2014).

The majority of present research, however, covers the impact of digital technologies on *customer interaction* for marketing, sales and customer relationship management (CRM) in the light of changing customer behaviors. On the one hand, research addresses possible measures from insurance companies to enhance customer interaction by multichannel (Klotzki et al. 2017) and automated communication (van Doorn et al. 2016). Other contributions investigate changes in customer experience and loyalty (Posignon et al. 2015; Dai and Salam 2014), new forms of personalization (Kaptein and Parvinen 2015), the impact of digital nudging (Weinmann et al. 2016), or innovative ways to collect, process and utilize customer data (Saarijärvi et al. 2014). Customer-behavior oriented research addresses customer characteristics, preferences, behavior or engagement (Derikx et al. 2016; Honka and Chintagunta 2016; Bijmolt et al. 2010).

2.3 MSP in the Insurance Industry

MSP are already involved in the insurance industry to a remarkable extent. On the one hand, so-called insurtechs (i.e., technology-driven startup companies in the insurance industry) and other mediating actors like price-comparison websites enter the insurance market with innovative applications, solutions, or business models. They exploit new digital technologies, data sources and analytical techniques to attract the attention and ownership of the customer (e.g., Catlin and Lorenz 2016; Puschmann 2017; Naylor 2017). Common examples in Germany are Clark, Finleap or Check24, but many more new players have already entered the traditional insurance market (e.g., Noack et al. 2017). In many cases, these players mediate between insurance companies and their customers, facilitate transactions or reduce information asymmetries, and therefore show characteristics of multi-sided platforms (MSP). They place themselves between insurance companies and suppliers or customers and thus affect value creation and customer interaction in many ways (e.g., Rossbach and Hilberg 2016).On the other hand, traditional insurance firms use or develop platforms themselves for reasons of improving their IT infrastructures (e.g., Ergo and IBM (Daniel 2018)), obtaining external know-how, services and other resources (e.g., Generali and Amodo (Peverelli and de Feniks 2018)), distributing or selling products (e.g., Concordia (Scheuermann 2017)), collaborating with other insurance companies (e.g., blockchain platform b3i (Wills 2017)) or cooperating with companies from other industries (e.g., single sign-on platform Verimi (Bialek 2018)). In these cases, they leverage the potential of digital technologies themselves to gain competitive advantage. Despite the practical relevance of platforms in the insurance industry, comparatively few contributions from IS or service research study the strategic impact of platforms on value creation in the insurance market entirely. While some contributions examine the complementary part of insurances within the sharing economy (Weber 2014; Puschmann and Alt 2016; Täuscher et al. 2017), others explore the increasing implications of price-comparison sites on both insurance firms and customers (Robertshaw 2011; Son et al. 2006) or the potential impact of platform technologies like blockchain on the organizational structures of insurance firms (Hans et al. 2017). Only by way of example amongst other industries, some contributions relate platform research with insurances (Dietl 2010; Markus and Loebbecke 2013) and use the example, for instance, to explore the phenomenon of internet-driven re-intermediation in traditional markets (Parker et al. 2017) or the importance of collaboration in business networks to enhance customer relationship (Heinrich et al. 2011).

In summary, it can be stated that the insurance industry is highly affected by the emergence of digital technologies, which especially give rise to new players. Although evidence from practice indicates that MSP impact traditional insurance companies in many ways by leveraging the potential of new technologies (e.g., Catlin et al. 2018), current research does barely add up to their share of the massive transformation traditional markets undergo. What is more, there is yet little understanding of how MSP affect value creation in an entire industry by occupying or creating new roles and how their new value propositions lastingly impact customer access and interaction for traditional players in the market.

2.4 Methods

We first tackled our research question by screening available literature on MSP, following the guidelines from Webster and Watson (2002). This implies a search in relevant scientific databases (i.e., AISel, IEEE Xplore, ACM DL, EBSCO Business Source Premier, ScienceDirect, SpringerLink, Proquest, Google Scholar, Wiley) for the expression *("platform*" OR "MSP*") AND ("insur*")* with a focus on high-quality journals (A+, A or B according to the VHB JOURQUAL3 ranking) and within relevant research strands (i.e., Information Systems, Business Informatics, Economics, Professional Services, and Insurance). During this, only those contributions with a clear relation to MSP in the insurance industry were selected. Subsequently, backward and forward searches are applied and repeated until no further relevant articles could be identified. In order to bring our research question into line with the big picture, we extended our literature review with research on digital transformation of the insurance industry with a concept-oriented approach along the three dimensions of digital transformation. We also synthesized existing literature reviews on MSP within three entangled research strands in IS. On that basis, we applied an exploratory, qualitative empirical approach from a positivist perspective to gain a deeper understanding of the impact of MSP on the insurance industry (Myers 1997; Orlikowski and Baroudi 1991), and combined it with design-oriented modeling. Our research design consists of three main steps. (1) We developed a role-based reference model of the current insurance value network, (2) we applied it for the identification and analysis of MSP configurations therein and (3) finally derived a taxonomy of MSP in the insurance industry resulting in four standard types (see Figure III.1-3).

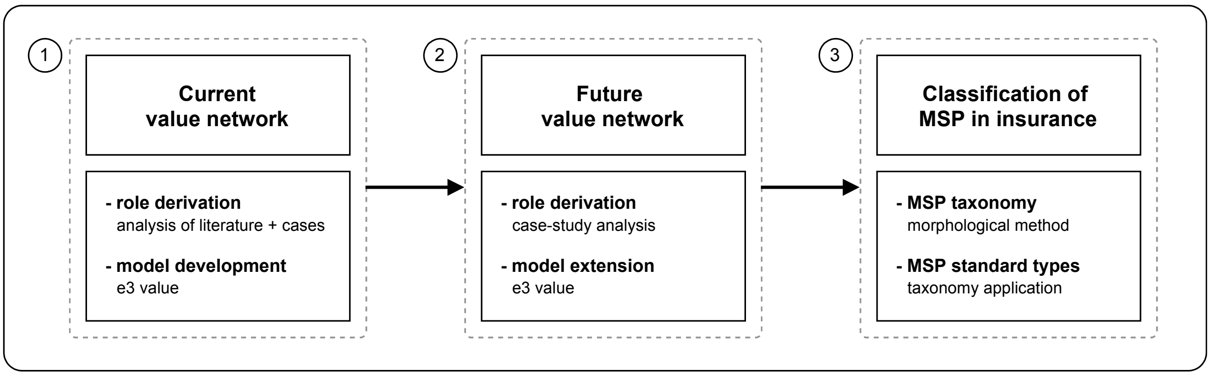

Figure III.1-3: Research Design (MSP in Insurance)

For the development of the reference model, we applied a design-oriented approach. Design science research allows the development of both theories and artefacts that lend utility to theory. It requires a comprehensible, rigorous design and evaluation of artefacts as an approach to solve important and relevant business problems in a specified environment (Hevner et al. 2004). Basically, these guidelines can be condensed into three activities: systematic artefact construction by practice or theory-based insights, evaluation of the functional performance, and reflection on results (Kuechler and Vaishnavi 2012). Results can be models, methods, constructs, or instances (March and Storey 2008).

(1) Following these rules, we first developed value-creating roles as theoretical instances of our reference model. For this purpose, we reviewed existing academic literature on both general and insurance-related value chains and networks to identify value-creating roles. In order to discover further roles, we examined relevant processes of value creation (e.g., sourcing, distribution), value proposition (e.g., products and services), and the (digital) customer journey within traditional insurance companies. This process includes screening of written material or records (e.g., company websites) and direct observation of the market (Yin 2009; Benbasat et al. 1987). Empirical cases help to both substantiate identified roles from literature and explore further relevant roles within the network (Yin 2009). We completed the relevant set of roles for our reference model until theoretical saturation, i.e., adding cases is not expected to reveal new roles anymore (Eisenhardt 1989).

We systematically combined these instances to a generic model by developing their interrelationships – i.e., the identified and conceptualized roles were synthesized with the according value flows to a value network for the traditional insurance industry. The value network is essentially based on e3-value, a method to depict value streams among actors in business models (Gordijn et al. 2000). To achieve a higher analytical value, we extended and modified this method by the role concept introduced by Pousttchi 2005 and Pousttchi 2008. This concept distinguishes actors, roles, and activities: The generic model aggregates activities to roles, while roles can be assigned to actors as part of an analysis (Pousttchi and Hufenbach 2014), i.e., a real-world actor can assume one or more roles in the value network by conducting the inherent role activities. Value streams represent the value flow (i.e., commodities or payments) among roles in a network and can also amount to zero. Important core roles in a model can be depicted in greater detail by means of an introspective analysis. This implies the definition of this role's main value-creating activities. The application of an introspective analysis on the core role within the reference model allows to investigate and define how its main value-creating activities interrelate with their inner and outer environment (i.e., activities and roles). As a further step to ensure utility and correctness, we validated the resulting reference model in discussions with practitioners, which led to minor modifications.

(2) In a second step, we extended our model with regard to the influence of MSP. For this purpose, we built on the identified roles and conducted a case-study analysis with a strong focus on MSP. Following the data collection principles from Yin (2009) and Benbasat et al. (1987), we mainly rely on written material about digital transformation, insurtechs, and platforms in the insurance industry, i.e., company websites as well as white papers, overviews, and articles in professional journals, magazines, or newspapers. At this, we collected market actors to examine their MSP characteristics and business models. Thus, we identified roles occupied by MSP in the insurance value network. Our case study findings were classified, synthesized and applied to the previously developed value network to explore and systematize the theoretical and practical implications (Gregor 2006; Ågerfalk 2014). We considered different tie points within the reference model between the core and periphery of insurance companies to illustrate the emerging configurations in the market. In the end, our reference model combines both technology-oriented and management-oriented viewpoints, showing the relevant platforms and value streams in the insurance industry (Hevner et al. 2004).

(3) In a third step, we complemented our analysis and addressed the MSP phenomenon from a completely new angle (Poole and van de Ven 1989) for the purpose of demonstrating their linkages to traditional insurance companies. In order to develop an MSP taxonomy and to derive disjoint MSP standard types in the insurance industry from our findings, we applied the morphological method, a highly systematic approach for structuring multi-dimensional problems. It is particularly suitable for the exploration of complex problems that cannot be solved with formal (mathematical) methods, causal modeling, or simulation. The approach involves the identification and definition of the investigated problem's essential characteristics and the assignment of relevant instances to each characteristic. The aggregate of all critical characteristics and instances is represented by a morphological box, which allows for a structured analysis, systematization, and comparison of complex phenomena (Zwicky 1966; Ritchey 2013).

3 Development of the Value Network

Value creation of insurance companies has commonly been depicted by means of distinct value chains, since insurance business holds many characteristics incomparable to other industries (see Figure III.1-4; Koehne 2006; Altuntas and Uhl 2016; van Rossum et al. 2002). Although the value chain as both a concept and an analysis tool has proved useful for decades to visualize linkages of value creating activities, it becomes increasingly inappropriate when it comes to capture and explain the value streams and other interrelationships within and among companies in contemporary industries (Peppard and Rylander 2006). Especially, increasing dematerialization (Barile et al. 2016), digitalization (El Sawy and Pereira 2013; Markus and Loebbecke 2013), and interconnectedness (Bharadwaj et al. 2013) favor the emergence of platforms and other new business models (Basole and Karla 2011; Zott et al. 2011) as well as new forms of collaboration, cooperation, or competition (e.g., Mantena and Saha 2014; Pant and Yu 2018; Ceccagnoli et al. 2013). Therefore, new ways to visualize these new forms of value creation are required (Amit and Zott 2012). Many researchers have explored respective value networks in specific industries (e.g., Jeansson et al. 2017; Morgan et al. 2013; Pousttchi et al. 2015; Pousttchi and Hufenbach 2011; Razo-Zapata et al. 2013). However, comparatively few have done so with a focus on the insurance industry (Fjelstad and Ketels 2006; Köhne 2006; Laffey and Gandy 2009) although the value chain's appropriateness has already been discussed controversially in the light of digital transformation (cf. Eling and Lehmann 2018; Perissinotto 2003).

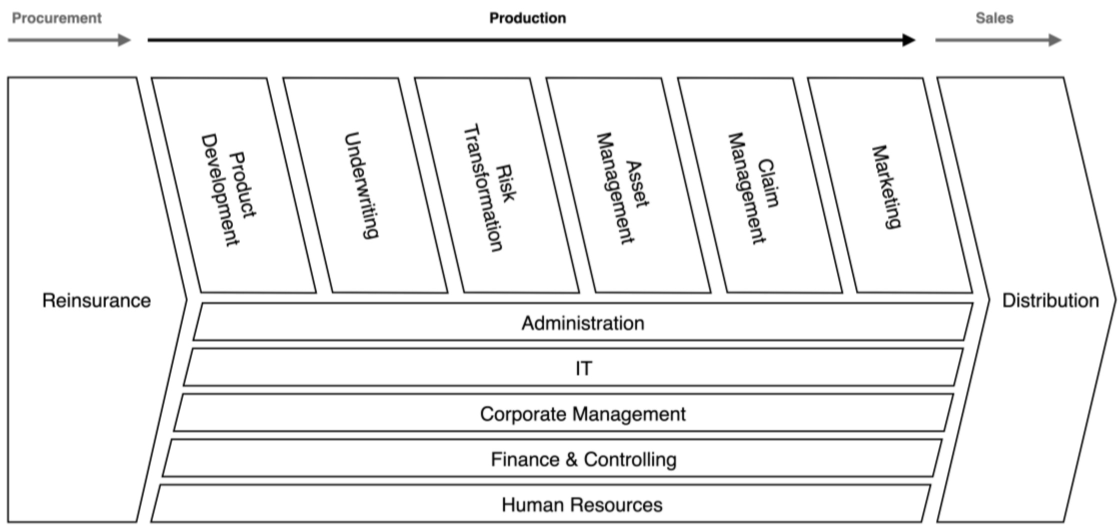

Figure III.1-4: Classic Insurance Value Chain (adapted from Köhne 2006, p. 261)

Following the guidelines of design science research, we develop an insurance value network that helps us to identify and illustrate the impact of platforms with respect to current and future value creation. This implies the conceptualization of roles from literature and practice. Some value-creation activities and roles are derived from classical literature on insurance value chains (e.g., Altuntas and Uhl 2016; Farny 2005; Nguyen and Romeike 2013) and then validated with practical evidence. Other roles originate from empirical findings of our case study research and go beyond the traditional value configuration. The core of our reference model comprises the role of the *insurance product provider*, which effectively develops insurance products (see Figure III.1-5).

It contains definite value-creation activities insurance companies traditionally accomplish. However, traditional insurance companies are not limited to this role. In order to receive a more detailed view in a later stage on how insurance companies are entangled with MSP in the value network, we integrate an introspective analysis that allows for the interdependencies with the core value-creation activities of an insurance product provider. The decomposition of this important role is useful as it demonstrates the basic value-creation activities of this role and how they specifically interrelate with other value-creation activities within the role or with external roles in the insurance product provider's environment.

These closely intertwined value-creation activities are derived from the classic insurance value chain and are defined as product development, underwriting, risk transformation, and asset management. *Product development* includes market research, concept development and maintenance, premium definition and adjustment, technical statistics and auditing. *Underwriting* includes the calculation and customization of products depending on the customers' individual risk characteristics as well as both standardized and complex application processing, issuing, or provisioning. *Risk transformation* includes taking and balancing individual risks by pooling them over time into collective ones. *Asset management* includes the handling of savings, investment decisions, development of investment products, or strategic and tactical asset allocation.

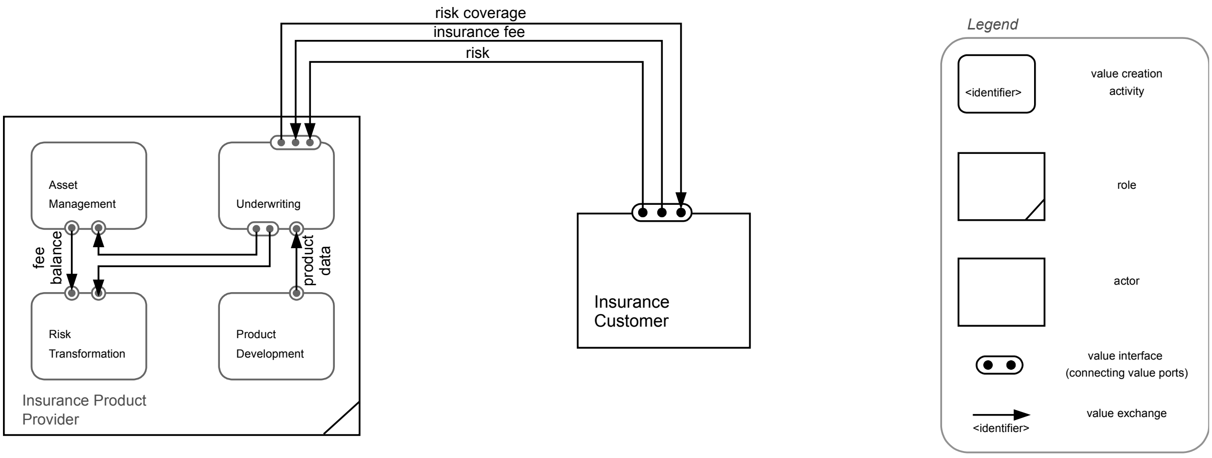

Figure III.1-5: Insurance Product Provider with Insurance Customer

In a next step, the coherent analysis of typical value exchange activities of insurance companies helps to identify the periphery of the insurance product provider, which comprises further relevant roles and actors providing goods, services, or resources. On the sourcing side, these include R&D operator, IT service provider, reinsurance service provider, capital provider, insurance consultant service provider, and statistical data provider.

The role of an *R&D operator* involves originating and testing new products, services, and processes. This is no traditional value-creation activity of an insurer. Yet, innovation is increasingly important for insurance companies to keep pace with competition and digital transformation as findings from practice and research indicate (Pretty 2017; Ringel and Rosenbaum 2016; van Rossum et al. 2002). Insurers increasingly cooperate with other companies in order to promote research on innovative insurance products (e.g., Generali and Progressive (Vrobel and Donohue 2016)) or cross-industry services where insurance know-how is required or at least beneficial (e.g., Allianz Automotive (Allianz 2017b)). Even more important is the role of an *IT service provider*, which supplies the insurance product provider with vital IT resources (e.g., standardized or customized hardware, applications, databases and data warehouses) for the operation of the IT systems and cross-functional support of all activities. For the purpose of reducing complexity, the IT service provider is connected only and directly with the role of the insurance product provider. Technically speaking, each role (and value-creation activity) would require sufficient IT resources likewise.

The role of the *reinsure product provider* is crucial for the purpose of averting risks and reducing potential losses, especially due to major catastrophic events, which could endanger an insurer's viability. For economic reasons only, reinsurance can also be bought for garnering arbitrage revenues. A *capital provider* is necessary for the provision of financial services or resources, such as loans, bonds, or investments. This becomes increasingly important in the light of the EU Directive Solvency II, which specifies the minimum amounts of capital European insurers must always have available to reduce the risk of insolvency (2009/138/EC, Art. 87 et seqq.). In order to continuously improve the process of producing and maintaining insurance policies, an insurance product provider requires expertise and know-how from *insurance consultant service providers* (e.g., new actuarial methods or changing customer behavior) as well as statistics from *statistical data providers* (e.g., weather data or data about potentially new markets). Usually, these four roles are accomplished by a reinsurer (e.g., Munich Re, Hannover Re). However, expertise might also be delivered by insurance consultancies (e.g., Bain & Company), statistical data by specialized institutes (e.g., destatis).

Our reference model contains further necessary roles to comply with the service delivery aspect of insurance products: the role of a *customer and claim manager* includes taking care for customer inquiries and claims settlement, i.e., standardized and complex loss or damage assessment, compensation payments or actions, claims controlling, fraud detection, and the initiation of further measures like follow-up support, collection of statistical data, or future damage containment. A *customer support service provider* intercepts initial and repetitive customer concerns or incident and loss reports. In the latter case, an insurer often is both reliant upon a *loss assessment service provider* (e.g., experts, assessors) and, when a loss cannot be compensated financially, a loss removal service provider (e.g., physicians, craftsmen, vehicle repair shops).

With respect to sales promotion, a *marketing service provider* is responsible for strategic (e.g., brand management and customer retention) and operative (e.g., promotion and advertisement) marketing measures. A *sales manager* informs potential customers about their individual risks and respective insurance products to expedite the contract closing. This role is traditionally accomplished by brokers, agents, direct sales subsidiaries or websites of insurance companies. Finally, insurers collect and process data from their customers for individual fee calculation (ex ante) or usage-based fee adjustments (ex post). For these purposes, the roles of a *customer data aggregator* (collection and storage of raw data) and a *customer data provider* (processing and analysis of raw data) are required. These roles strengthen the actuarial competencies by exploiting new data sources, which becomes increasingly important in the view of big data, smartphone usage, and telematics.

Value creation in our reference model starts with the role of the R&D operator, which supplies product development with new ideas or proposals for risk assessment of former products or new risks and damages to be insured and covered. In the light of digitalization and innovation processes, R&D becomes increasingly important for insurance companies and goes beyond the simple support of product development (Miles 2007). Insurance companies try to exploit the potential of new technologies and big data to develop innovative business models or revolutionize their processes in order to keep pace with the competition (Haapio et al. 2018; Naylor 2017; Nicoletti 2016). However, product development plays an important part in value creation by originating insurance products on the basis of different data (e.g., risk, marketing, sales, claims) and supplying the marketing and sales roles with product information (e.g., Johne 1993).

For adequate underwriting, the insurance product provider receives customer contract data from the sales manager in exchange for a commission and closes the contract with the customers by taking their risks in exchange for insurance fees. The customer data provider adds usage and behavior-based data of the customers. Remaining amounts of the customer's insurance fees (less expenses provision, administration, operation) are transferred to asset management while risks are passed to risk transformation. To pool and transform these risks and assets successfully, the insurance product provider receives risk protection, financial resources, statistical data and actuarial assistance from the reinsure product provider, capital provider, statistical data provider, and insurance consultant service provider (e.g., Schmid 2015).

Direct customer interaction is conducted by the marketing service provider (sending advertising messages and collect response data), the sales manager (offering products and collect contract relevant customer data), and the customer support service provider for existing customers (taking and forwarding customer inquiries and claims). These three roles commonly work closely together, draw on similar databases, or are even combined to one actor in the market; e.g., the insurance agent as the customer's single contact person (Johne 1993). Customers' insured damages are examined by the loss assessment service provider and refitted by the loss removal service provider, which both are usually paid by the insurance product provider, coordinated by the customer and claim manager in the back-end and the role of the customer support service provider in the front-end.

Customers' raw data is accumulated by the customer data aggregator, which in turn provides the data-collecting device or application to the customer. An application might be an insurer's mobile app for policy management, digital policy IDs or assistance services (e.g., Meine Allianz, GEICO mobile), a device might be an OBD2 compatible trip computer or gauge (Marabelli et al. 2017). Aggregated data is transmitted to the customer data provider, which provides processed and pseudonymized data to the insurance product provider to enable usage-based pricing. Particularly, in the light of an increasingly data-driven society, insurers road-test new data sources to augment their underwriting activities or to offer telematics-based insurance products. Further data-based services are already tested and implemented in practice, such as social network profiling (e.g., Admiral and VisualDNA (Christl and Spiekermann 2016)). The insurance product provider requires sufficient IT resources from the IT service provider to conduct the tasks appropriately (e.g., Schmid 2015).

All in all, value creation in the insurance industry involves a handful of specific but necessary roles and activities, which are interdependent and hence require coordination to operate successfully. Figure III.1-6 shows the resulting role-based reference model of the insurance value network. Dashed lines indicate those roles traditional insurance respectively reinsurance companies typically occupy: An insurer assumes the roles of the insurance product provider, IT service provider, sales manager, marketing service provider, customer support service provider, customer data aggregator, and customer data provider. A reinsurer commonly takes up the roles of the reinsurance product provider, capital provider, insurance consultant service provider, and statistical data provider.

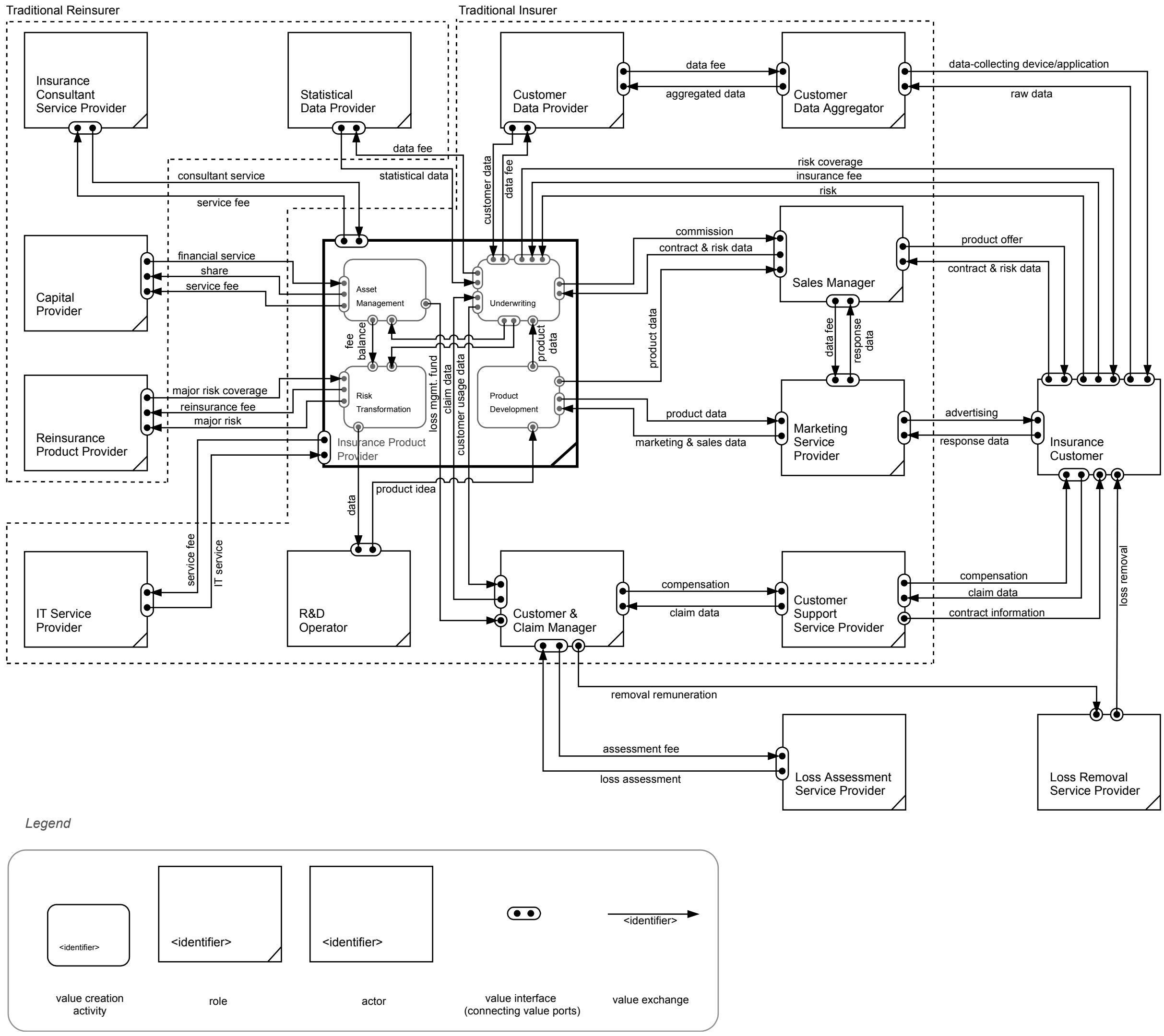

Figure III.1-6: Current Insurance Value Network

4 MSP in the Insurance Value Network

4.1 New Players, New Roles

Based on the value network configuration of the previous section, we apply a platform-focused case-study analysis to expand the current insurance value network by new roles emerging from the emergence of new players in the market. Based on their value-creation activities and their value propositions, these new roles can be integrated into the value network. In a subsequent step, their impact on customer interaction can be deduced and illustrated. Hence, this section aims to show in which various ways MSP are exerting influence on the value creation in the insurance industry. Two major effects have to be distinguished in the value network: MSP assuming already existing roles (colored light grey in Figure 7) and MSP creating new roles (dark grey).

In many cases, MSP aim to occupy existing roles from traditional actors. Mostly, they capture the role of the *customer support service provider* to become the customers' (one-and-only) contact point for gathering information about their contracts, for managing contract details, or for reporting damages or losses (e.g., Clark, allesmeins, Motionscloud). As customers, regardless of their age, get more and more familiar with the use of smartphones, they become increasingly receptive for innovative services (i.e., products or applications). Hence, if market players can offer such services in a convenient, entertaining and useful manner, they are able to reach the customers (Davis 1989; Pousttchi and Goeke 2011). As a result, innovative insurtechs are able to collect valuable usage data from the customers' smartphones and might therefore occupy the role of the *customer data aggregator* and – depending on their data-processing capabilities – the role of the *customer data provider*. As successful data processing relies on large datasets and fast, reliable technologies (e.g., database systems, data transfer techniques, computing), these two roles are likely to be assumed by considerably more powerful MSP like mobile operating system providers with proprietary application marketplaces (Apple/iOS, Google/Android). In the special case of car insurance, producers of driving-style analysis systems or devices come into consideration for these two roles while existing actors include car manufacturers (e.g., VW Connect, Toyota G-Book) and telematics system suppliers (e.g., Yellowfox, Amodo, Octo).

In other cases, MSP build upon their technological resources to create completely new roles which mediate between two or more other roles. They consequently further expand and modularize the value. To a great extent, this occurs when MSP mediate between insurance customers and insurance companies. MSP often become the customers' first contact point when comparing products online (e.g., Covomo, Tarifair, Check24) or via a mobile app (e.g., Knip, Clark). In such cases, these actors create the role of the *sales MSP*, which brokers between customers and traditional insurers (in the role of insurance product provider). Possibly, Amazon will soon claim its share in the insurance market by occupying this role (Dumm and Hoyt 2003; Grzadkowska 2018). Other insurtechs cover this role by helping independent insurance brokers to compare insurance products and manage the contracts of their customers (e.g., Bisure, BrokingX). Thus, they barge in between traditional insurance brokers and companies, narrowing the margins without direct customer interaction. Further, non-insurance related, MSP capture this role when insurance protection is beneficial or even necessary for their business, like online marketplaces for rental cars (e.g., DoYouSpain and Zurich) or holiday accommodations (e.g., Airbnb and Lloyd's of London). In either case, integrating online payment gateways might be necessary to facilitate payment transactions and reach the target customers (Lowry et al. 2006) by cooperating with digital payment platforms (Kazan and Damsgaard 2016). This requires the role of the *payment service MSP*, which further modularizes the value network (e.g., PayPal, Klarna).

However, customers benefit from a multitude of access paths to compare and purchase insurance products. Searching online for insurance products is likely to make potential customers more receptive to relevant personalized advertisement (Lambrecht and Tucker 2013; Zhu and Chang 2016). Hence, new players successfully position themselves between potential customers and traditional insurers (in their role of the marketing service provider). By promising to present relevant promotions to users who intend to buy insurance products, these players create the role of the advertisement and marketing MSP (e.g., Google, Facebook, Instagram). Such MSP place themselves between insurers and customers by leveraging their enormous platform capacities, their immediate proximity to their users' daily lives, and consequently, their massive knowledge of (potential) insurance customers (Pousttchi and Hufenbach 2014). Other insurtechs have specialized in assisting insurance customers with the management of losses and take care for the entire communication, coordination and monitoring among insurers, insurants and external services providers for loss assessment and removal in the case of an accident (e.g., Spearhead, Unfallhilfe24). This requires the role of a *loss management MSP*.

New players do also emerge on the sourcing side of traditional insurers and further modularize the value network. Some players mediate between insurers and reinsurers and create the role of the *reinsurance product MSP* (e.g., IRMI). Other players broker – sometimes via simple smartphone applications – between insurers and capital providers (e.g., finanzen.net), which requires the role of a *financial services MSP*. When it comes to collaborating and researching on industry-wide or cross-industry challenges, insurers occasionally co-found R&D platforms like, for instance, the mutual blockchain R&D platform b3i (Wills 2017). Such MSP often are not-for-profit but undertake specific tasks which result in a distinct role in the value network: *R&D collaboration MSP*.

Although many insurtechs or other companies yield new technologies, products, or solutions that might be of considerable interest for insurers (Wilson 2017), MSP are not prominent in the sourcing or provision of IT resources so far. However, the increasing share of cloud-based services (Weidmann et al. 2010; Beimborn et al. 2011) might lead to the emergence of *IT services MSP*, which broker between insurers and IT service suppliers. Similar developments are conceivable with new players that help traditional insurers to explore and exploit new data sources – particularly in the view of big data, which offers numerous opportunities for customer engagement (Bijmolt et al. 2010), personalized marketing (Rust and Huang 2014), supply chain management (Chen et al. 2015), fraud detection (Ngai et al. 2011), ex-post ratemaking (Boucher and Inoussa 2014) or several other insurance services (Lehrer et al. 2018). Players, which are able to provide traditional insurers with a variety of valuable data from various sources, could create the game-changing role of an *external data MSP*. Nowadays, reinsurers and other data service providers assume this role to moderate extent, but the predictive power of big data is yet unexhausted.

In either case, such digitally-empowered players exploit the potential of digital technologies. They benefit from automated, streamlined processes to offer easy-to-purchase online products (either standardized or customized) by leveraging advanced channels for product distribution and customer communication which people can access from any device, at any place and any time. They gain competitive advantage in terms of value creation, value proposition, or customer interaction by positioning themselves between the traditional insurers and other parties, participating in the business, intensifying competition and increasingly modularizing the value network. Figure III.1-7 shows the resulting reference model for the future insurance value network, including the identified existing and potential MSP roles therein.

One success factor of customer-oriented insurtechs is based on their modern, innovative applications, which appeal to digital customers who miss such interaction and communication tools from their (traditional) insurance companies. Such insurtechs typically occupy two or more roles as they provide (online-)consulting, comparison, distribution (sales MSP), customer care and claim receipt (customer support service provider), and assistance in the case of an accident (loss management MSP). Commonly, their business models zero in on both acquisition and portfolio commissions (e.g., Clark, Knip). Other customer-oriented insurtechs concentrate on either sales or customer relation with an emphasis on younger customers (e.g., Virado). This raises the question if traditional insurers might be able to catch up with such innovative products, services, applications and interfaces. Otherwise, the new players in the market might sustainably retain their leads. A special case occurs, when an MSP acquires all three roles of sales, customer support *and* marketing. At this, an MSP gains entire customer ownership, i.e., it is the one-and-only contact point for their affiliated customer segments. The actual insurance product provider only exists in the background and might be even barely visible to the customer. Such strategically important players capturing all customer-oriented roles can become a threat for traditional insurers, which mostly still draw upon their brand awareness. By forfeiting customer ownership, they run risk of being reduced to a plain and replaceable insurance product provider. A popular example is Airbnb that indirectly sells and promotes insurance products as an integral part of its platform service and also takes care of customer claims (i.e., from hosts as well as from guests). Customers are unaware of the actual insurer behind.

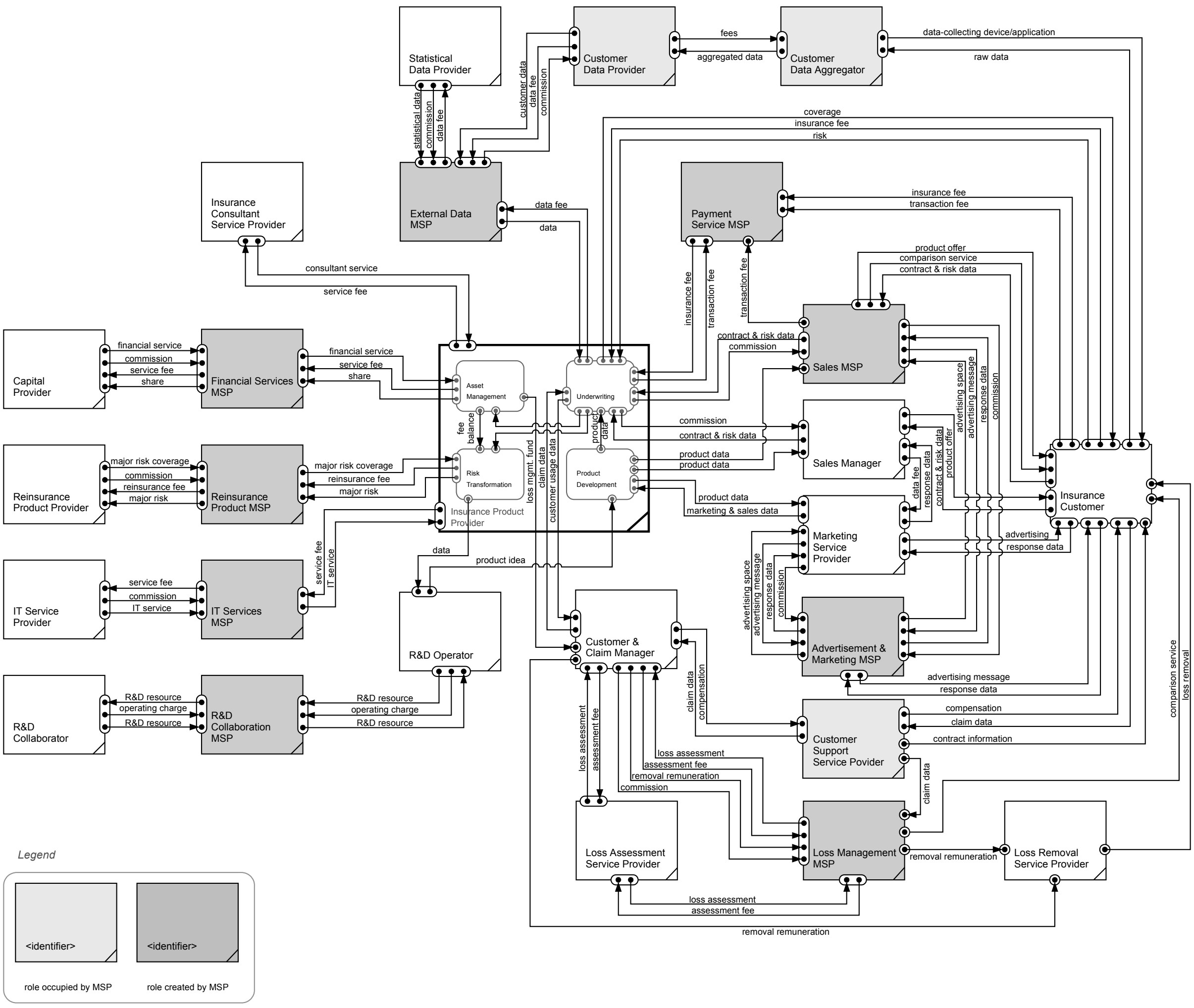

Figure III.1-7: Future Insurance Value Network

Altogether, our findings imply that traditional insurance companies are entirely encircled by innovative, digitally empowered players, which exhibit distinct MSP characteristics and bear considerable impact on both competition and value creation. The advent of these new roles and actors elevates specialization, modularization, and the occurrence of niche suppliers. This raises complexity of the market structure and reveals three main effects:

(1) Customers have a multitude of channels and providers to access information from, to compare or purchase insurance products, and to directly or indirectly contact the traditional insurers. It can be expected that customer behavior and interaction will be impacted lastingly (Cassab and MacLachlan 2009; Polo and Sese 2016). Since in future traditional insurance brokers will not be the only (and most important) distribution channel, insurance companies will have to redesign their customer interaction models. This implies new distribution or communication structures and processes, particularly in terms of multichannel or omnichannel strategies (Jeansson et al. 2017; Klumpes and Schürmann 2011).

(2) Likewise, traditional insurance companies have to reassess their position in the changing market. In the light of a digital, data-driven economy, innovative insurance services and products are required to satisfy the changing customer needs. That means, traditional insurance companies have to redesign their value proposition models (Hedman et al. 2016).

(3) Traditional insurance companies will have to reassess their part in the value network regarding their core competencies. Digital channels, products and interaction require adequate IT capabilities, data-processing abilities, and organizational structures in the back-end. Hence, traditional insurance companies need to refresh their value creation models and their strategies accordingly (Grover and Kohli 2013; Ross et al. 2016). This implies new structures and processes on the one hand (Loebekke and Picot 2015), as well as appropriate and deliberate sourcing (Mani and Barua 2015), cooperation (Korhonen et al. 2006) and innovation networks (Lyytinen et al. 2016) on the other hand. All in all, value creation in the insurance industry is highly affected due to digital technologies. MSP with their innovative business models are likely to have their stake in this transformation process, maintaining separated relationships to traditional insurance companies and customers.

4.2 Taxonomy of MSP in the Insurance Industry

As the previous section indicates, MSP affect value creation in the insurance industry in many different ways by occupying or creating roles in different areas within the value network. Often, MSP affect the interaction between insurance companies and customers. Although the MSP seem very similar in their very nature, a comparison among them reveals distinctions. Hence, the aim of this section is to develop a taxonomy of MSP from empirical cases that helps distinguish these players by means of their distinct characteristics.

MSP differ regarding *contact initiation* at customer-oriented activities, i.e., which party takes up communication. For instance, if a customer books a flight and is offered a travel cancellation insurance, the contact is initiated over the platform. Conversely, a potential insurance customer might start his product search on his own at a price comparison MSP (Pousttchi and Dehnert 2018). Depending on the business model, an MSP aims obtain *customer ownership*, i.e., controlling the customer in terms of marketing (e.g., Google), sales (e.g., Check24), CRM (e.g., Haftpflichthelden), two of them, or even all combined (e.g., Clark). Further segments of customer ownership are payment (e.g., Paypal), loss management (e.g., Unfallfuchs), and data (e.g., Apple). For that purpose, corresponding roles need to be *occupied* or newly *created* by MSP in the value network. Moreover, MSP might have different *impact on insurers' profits*. Some MSP can be profit-increasing, for instance, when they co-develop products (e.g., Schutzklick) or enable access to new customer segments (e.g., Airbnb) while other MSP induce an adverse, profit-reducing relation. The latter occurs, when MSP accumulate insurance customers in order to gain group advantages and beat down the insurers' margins (e.g., Crowdheroes). This also implies a differentiation of occurring *network effects*, namely same-side or cross-side. Particularly, peer-to-peer insurance MSP leverage same-side network effects to negotiate more favorable terms (e.g., Friendsurance) while price comparison MSP depend on cross-side network effects, since they have to attract both enough customers and insurers (e.g., financescout24).

characteristic	instances										
Contact Initiation	Insurance customer	Insurer	MSP	Broker/Agent	Other						
MSP Customer Ownership	Sales	Marketing	CRM	Loss Mgmt.	Payment	Data	Other	None			
Role Occupied	Customer Support Service Provider	Customer Data Aggregator	Customer Data Provider								
Role Created	Loss Mgmt. MSP	Adv. & Marketing MSP	Sales MSP	Payment Service MSP	External Data MSP	Financial Services MSP	Reins. Prod. MSP	IT Services MSP	R&D Collab. MSP		
Impact on Insurer Profit	Profit-increasing	Neutral	Profit-reducing								
Network Effects	Same-side	Cross-side									
Revenue Source	Insurer	Brokers/ Agents	Insurance customers	Specialized service prov.	Other customers	Other parties					
Revenue Type	Insurance fee	Acquisition commission	Portfolio commission	Service fee	Product fee	Other					
Revenue Frequency	Onetime	Repeatedly	Periodically								
Distribution Type	Direct sales	Intermediation	Add-on	None							
Vertical Range of Insurance Production	Sour-cing	R&D	Prod. Dev.	Under-writing	Risk Transf.	Asset Mgmt.	IT	Marke-ting	Sales	CRM	Claim Mgmt.
Relation towards Insurer	Toughening competition	Fostering coordination	Acting in cooperation	Enhancing collaboration							

Figure III.1-8: Taxonomy of MSP in the Insurance Industry

Moreover, MSP in the insurance industry have different *revenue sources* and *revenue types*. Depending on the business model, they generate revenues with insurers, brokers or agents, insurance customers, specialized service providers, or other customers or parties. For instance, sales MSP most commonly charge acquisition commissions (e.g., Covomo) whereas MSP in their role of a customer support service provider receive portfolio commissions (e.g., wefox). While the latter is paid periodically, the former constitutes a onetime payment (*revenue frequency*). Such revenues can occur repeatedly whenever a customer decides to purchase a new insurance product. Mainly, such insurance products are *distributed* by MSP through intermediation (e.g., Schutzklick) or as product add-ons (e.g., Kasko). However, direct sales are probable in the future. Especially, if sales MSP additionally begin to develop own licensed insurance products (Schlenk 2017). These developments will also have an effect on MSP' *vertical range* *of insurance production* and thus on the value network. Finally, MSP expose different kinds of *relationship towards traditional insurers* and consequently change competition and cooperation structures within the insurance market. Depending on the business model, MSP can either toughen competition among insurance companies (e.g., price comparison MSP), foster coordination among different roles in the value network (e.g., between customer and insurer), cooperate with insurers or even help insurers to collaborate with other actors in the market. Figure III.1-8 summarizes the above-mentioned MSP characteristics and their respective instances by means of a morphological box (Zwicky 1966).

4.3 MSP Standard Types in the Insurance Industry

MSP change value creation within the insurance industry by creating and capturing value adding roles, thus expanding and modularizing the insurance value network. However, the nature of MSP can vary hugely. This accounts especially for the characteristic feature of MSP: being a platform and mediating among insurers and different parties in the market. In some cases, MSP mediate between customers, brokers and insurance companies by seizing the roles of sales, marketing or customer relationship (e.g., sales MSP, loss management MSP). Often, these MSP zero in on commissions paid by the insurance companies or – rarely – on fees paid by the respective customer. In other cases, MSP occupy similar roles, but mediate among completely different groups and cooperate with insurance companies to complete their core business (e.g., Airbnb). As our taxonomy indicates, MSP affect insurers fourfold: competition, coordination, cooperation, and collaboration. In order to gain a deeper understanding of these effects, this section aims to examine and segregate the four different ways MSP mediate among insurers and other parties.

In many cases, MSP toughen *competition* by providing price comparison to the insurance customers (e.g., Verivox, Tarifcheck) and occasionally even modify the rules. For instance, if a customer chooses an MSP to search for alternatives, the MSP assumes control over the products being offered, while the customer might be indifferent to the chosen insurance company – conventional selection criteria like brand or service quality might become a less relevant factor in purchasing decisions. In some cases, these new players incline to occupy the one-for-all customer interface (e.g., Clark), pushing the actual insurers into the background. This would not only imply a shift of the insurers' customer orientation, but also a strategic realignment of the insurers' processes, strategies, and endeavors. However, smaller insurance companies might take advantage from being listed by MSP (Farnung 2014). Mostly, such MSP focus on acquisition or portfolio commissions from the insurers.

In some cases, MSP do not mediate between customers and insurers for marketing and distribution purposes, but aim to foster *coordination* among customers, insurers, and external services providers for loss assessment or loss removal (e.g., Unfallfuchs, ÖRAG). In the case of an accident or damage, these MSP assist insurance customers with the loss report, the remedying of damage, the search for specialized service providers (e.g., workshops), and the entire communication process. Usually, such MSP charge their services to the account of the customer or retain a percentage of the loss payment from the insurer.

Occasionally, MSP are only loosely affiliated with the insurance industry, but depend on insurance coverage in order to successfully conduct their actual businesses (e.g., Airbnb). Hence, they act in *cooperation* with insurance companies. Typically, such MSP mediate between two different kinds of users (e.g., sellers and buyers, house hosts and guests, car owners and renters) while the insurer itself keeps in the background, entirely (i.e., white level service provider) or at least largely invisible to these users. Such a cooperation might be fruitful for insurers as they gain access to new customer segments, but they lose grip of customer ownership and – equally important – become replaceable. A prominent example here is Airbnb, which couldn't operate without insurance partners but unobtrusively includes the insurance premiums into the service fees. This is a typical example how even MSP from other industries might implicitly affect the insurance industry. While the former three scenarios mainly earmark traditional insurers in a passive mode, a fourth type of MSP enhances active *collaboration* among insurers and partner companies. Commonly, insurance companies avail themselves of the advantages of MSP to efficiently and synergistically collaborate on mutual R&D projects with competitors or firms from other industries, leveraging the available technological capabilities (e.g., Verimi, b3i (Wills 2017), Allianz and BASF (Heide 2015)).

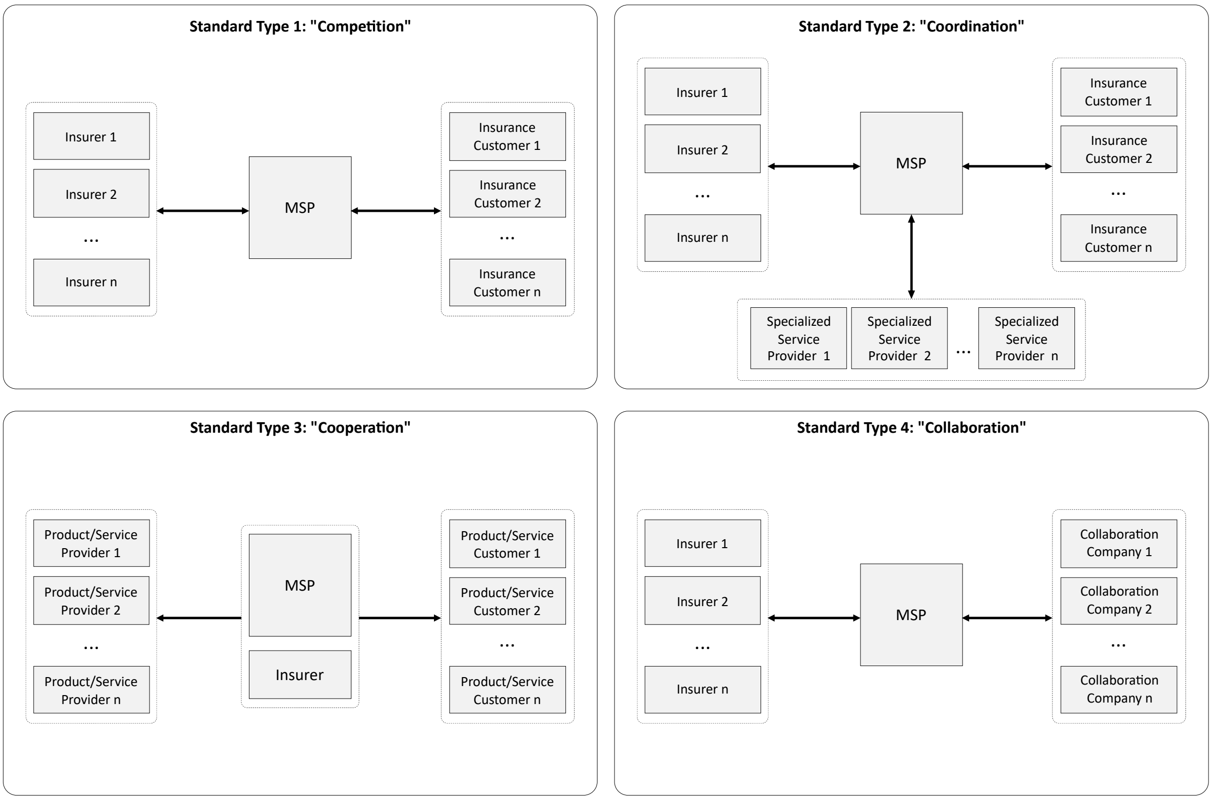

Figure III.1-9: MSP Standard Types in the Insurance Industry

Altogether, we can differentiate among four different interaction modes among MSP, insurers and other parties in the insurance industry, which finally results in four complete and disjoint *MSP standard types*: competition, coordination, cooperation, and collaboration (see Figure III.1-9). On the one hand, traditional insurance companies might benefit from the occurrence or utilization of MSP as such platforms can facilitate information flow and transactions or offer opportunities to reach new segments or customers through digital channels. Beyond that, completely new insurance-related products or services are conceivable. However, traditional insurance companies might as well suffer disadvantages if they entirely surrender the customer ownership and therefore increasingly forfeit direct customer interaction. In such cases, the brand of an insurance company might fade out in the view of the customer and become arbitrarily interchangeable. Consequently, traditional insurance companies should thoughtfully put their relationships towards MSP into question and define and pursue profound strategies.

5 Conclusion

Digital technologies and changes in customer behavior do not only force traditional insurance companies to redesign their strategies, organization structures, and processes, but also give rise to new business models and value configurations and therefore the advent of new players which exhibit common characteristics of MSP. Against this background, we applied a design-science approach to systematically analyze if and in which way MSP affect value creation in the traditional insurance industry. Our paper has three major outcomes: a role-based reference model of the insurance value network; its application for identification and analysis of insurance-related MSP configurations; and the derivation and classification of four MSP standard types in the insurance industry.

Our findings suggest that MSP affect the value configuration of the insurance industry twofold: First, MSP impact the traditional insurer's value creation in many ways by attaching themselves to several sides around its core activities. They either occupy roles in the value network formerly conducted by the insurers themselves (e.g., customer support) or create entirely new roles (e.g., loss management MSP). Second, there are four MSP standard types in the insurance industry to describe the relationship constellations between MSP and traditional insurers: MSP in the insurance value network do either (1) sharpen competition among traditional insurers, (2) facilitate coordination among insurers, customers, and other players, (3) cooperate with insurers, or (4) enhance collaboration among insurers and other companies.

Taken as a whole, value creation in the insurance industry undergoes a massive transformation due to the emergence of MSP in the insurance industry. This has three main implications for the insurance industry: specialization, modularization, and thus a higher complexity of the value network. It might become increasingly difficult for traditional insurance companies to structure and coordinate their supply chains as well as their distribution and communication activities (e.g., omnichannel). They even might cede important activities of value creation and customer interaction to MSP or other upcoming actors in the market. In the worst case, traditional players might be diminished to plain insurance product providers. In contrast, MSP in the insurance industry are likely to promote the reduction of information asymmetries among traditional insurance companies, customers and other players in the value network. Customers are provided with a multitude of providers and channels to access or assess information, compare or purchase insurance products, and contact their insurance companies. New ways of customer interaction might promote the occurrence of new products or business models. Consequently, shifts in the value network and changing customer behaviors might lead to new constellations of customer ownership.

The major research contribution of this paper is an improved understanding of how MSP affect value creation in traditional service-oriented industries in different ways by occupying and creating roles in the value network. Practitioners might apply different value network constellations to reconsider and modify their value creation, value proposition, and customer interaction activities in the market. Future research might concentrate on how the rise of multiple MSP in the insurance industry will affect the development of alternative business models. For instance, MSP might find ways to make traditional insurers superfluous (e.g., peer-to-peer insurances like Friendsurance) or start creating value themselves instead of just mediating (i.e., developing own insurance products like One with WeFox). Researchers could also adopt a more differentiated view on insurtechs and big players. Particularly, research on the development of Google, Apple, Facebook, or Amazon in this field could be promising as their data-processing abilities break ground for new ways of producing and distributing insurance coverage – or might even be used for predictive analysis to eliminate uncertainty and therefore the need for insurance at all.

III.2 An Apple a Day – How the Platform Economy Impacts Value Creation in the Healthcare Market

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Abstract: *The healthcare industry has been slow to adopt new technologies and practices. However, digital and data-enabled innovations diffuse the market, and the COVID-19 pandemic has recently emphasized the necessity of a fundamental digital transformation. Available research indicates the relevance of digital platforms in this process but has not studied their economic impact to date. In view of this research gap and the social and economic relevance of healthcare, we explore how digital platforms might affect value creation in this market with a particular focus on Google, Apple, Facebook, Amazon, and Microsoft (GAFAM). We rely on value network analyses to examine how GAFAM platforms introduce new value-creating roles and mechanisms in healthcare through their manifold products and services. Hereupon, we examine the GAFAM-impact on healthcare by scrutinizing the facilitators, activities, and effects. Our analyses show how GAFAM platforms multifacetedly untie conventional relationships and transform value creation structures in the healthcare market.*

1 Introduction

Apple CEO Tim Cook predicted in 2019: *"I believe, if you zoom out into the future, and you look back, and you ask the question, 'What was Apple's greatest contribution to mankind?' it will be about health."* The other GAFAM (Google, Apple, Facebook, Amazon, Microsoft) platforms have already placed similarly visionary statements about healthcare. This sector is not only relevant to GAFAM platforms, but also of vital importance for both society and economy. Global spending on health amounted to US$ 7.8 trillion in 2017 and continues to rise, partly because of expensive digital technologies (WHO 2019). Recently, the COVID-19 pandemic has yet again elevated the importance of digital health solutions. As a result, advanced digital and data-enabled technologies increasingly diffuse the healthcare market, which undergoes a costly and massive digital transformation (Agarwal et al. 2010; Lapão 2019; Menvielle et al. 2017; Pousttchi et al. 2019a).

Both academic and practical literature indicates that digital platforms might decisively contribute to that transformation (Chen 2019; Hermes et al. 2020c; Zenooz and Fox 2019). Digital platforms provide infrastructures to either facilitate transaction or collaborative innovation among complementary user groups (Hein et al. 2019). Big digital platforms have concentrated enormous power and radically changed our work, private and social lives. This particularly accounts for Google, Apple, Facebook, Amazon, and Microsoft, as the most successful platforms and most valuable companies in the world (van der Aalst et al. 2019). These players build upon personal data that consumers produce with their services or products, and employ these data to create personalized services or offer pinpoint advertising space to other companies. Health-related data might become another puzzle piece to complete the big picture, and recent GAFAM activities and statements underpin their ambitions strongly (Kimmell 2019b).

Available research has examined digital platforms from various perspectives and disciplinary approaches (Abdelkafi et al. 2019; Sutherland and Jarrahi 2018). However, there is comparatively little knowledge and theoretical conceptualization from a holistic standpoint on how and to what extent big digital platforms redesign entire ecosystems and markets (Asadullah et al. 2018; Hermes et al. 2020b). In particular, research has not studied the potential strategic economic and technological impact of the big digital platforms on healthcare. This is remarkable, given the economic and societal importance of healthcare and the tremendous weight of platforms in other industries (Kenney and Zysman 2016). The platform impact on healthcare has not become fully visible to date, but European attempts to access Apple's and Google's Bluetooth APIs to monitor COVID-19 infection chains have recently revealed the platform-dependency even of entire states (Vincent 2020). Stories like this typify the increasing importance of digital health in general and of GAFAM platforms in healthcare in particular, regardless of their potential benefits or risks for patients, healthcare market incumbents, and the society at large.

Against this background, we aim to explore the potential economic impact of digital platforms in the vibrant healthcare market. To limit the scope of our analysis, we focus on GAFAM platforms to examine how they affect conventional value creation structures in the healthcare market. Thus, this study contributes to a deeper understanding of how big digital platforms entangle entire markets. We approach our study from a strategic management perspective and go beyond value chains to analyze value creation through intersectoral value networks with several value-adding parts that eventually culminate into an overall value proposition in the form of final goods or services for end-users (Bowman and Ambrosini 2020; Mol et al. 2005; Pagani 2013).

At this, we rely on value network analyses of the healthcare market to explore how GAFAM services and products induce new value-creating roles and mechanisms in healthcare. Hereupon, we examine the GAFAM-impact on healthcare by scrutinizing the facilitators, activities, and effects. The rest of this paper is structured as follows: Next, we provide background information on digital platforms in healthcare and our methodical approach. Upon this, we conduct value network analyses of both the conventional and platform-induced healthcare market to analyze and discuss the GAFAM-platform impact on healthcare. We conclude with practical and theoretical implications of our contribution and provide avenues for future research.

2 Background

2.1 Theories on Digital Platforms

To explore the potential impact of GAFAM platforms on the healthcare market, we need to understand the nature of digital platforms. Research on digital platforms has obtained broad coverage in IS and Economics within the past decade (de Reuver et al. 2018; Hagiu and Wright 2015; Sriram et al. 2015; Willing et al. 2017), as the progress of digital technologies has elevated the impact of platforms considerably (Parker et al. 2016).

According to theory, all platforms exhibit two fundamental characteristics: They facilitate (1) *direct interaction* between two or more distinct sides of user groups by reducing transaction costs. Hence, platforms can control the transaction's key terms, e.g., pricing of goods, or program language. All user groups maintain an (2) *affiliation* with the platform. Hence, they make platform-related investments to engage in the interaction (Hagiu and Wright 2015). These characteristics specifically apply to big digital platforms like GAFAM that draw on large user bases and enable interaction among several user groups, which makes them capable of integrating (formerly separated) markets both horizontally and vertically (Galloway 2018, p. 186; van der Aalst et al. 2019, p. 646). So far, GAFAM platforms have largely exploited their power in consumer markets (B2C) by connecting companies (e.g., product, service, and content providers) with end-users. However, they increasingly expand to business-to-business markets (B2B), which are still rather fragmented (Dolata 2017; Hein et al. 2019), such as healthcare.

Existent theory holds two further platform-specific characteristics: (3) *Network effects*, which arise from bringing together similar or complementary user groups (Parker and van Alstyne 2005; Rochet and Tirole 2003). Thus, a platform's usefulness (and therefore value) is subject to the size of relevant participants (Eisenmann et al. 2006; Shapiro and Varian 1998). (4) *Homing and switching costs* incur for participants due to platform affiliation (Armstrong 2006; Evans et al. 2006; Kwon et al. 2017). Particularly in B2C, GAFAM platforms have carried these effects to the extreme; many companies and consumers are bound to these digital ecosystems (Bender 2020). Especially consumers rely on digital devices and channels, either to connect to the digital world (Apple, Google), maintain social relationships (Facebook), go shopping (Amazon), or be productive (Apple, Microsoft) (Baumöl et al. 2016; Pousttchi and Dehnert 2018). It stands to reason that consumers might adopt such habits or ties as patients.

Available research has yet conceptualized different types of digital platforms. Gawer (2014) provides three classes concerning a platform's orientation and sphere of activity: internal platforms (of one company and its sub-units), supply-chain platforms (for assemblers and suppliers), and industry platforms (of a platform owner and complementors). While the first two types hold limited access and innovative capabilities, the third type provides open interfaces for a potentially unlimited pool of external capabilities. Google, Apple, and Facebook represent this third type par excellence (Gawer 2014). Other research differentiates digital platforms by their purpose: transaction, innovation, integrated (or hybrid) (Abdelkafi et al. 2019; Evans and Gawer 2016). While transaction platforms facilitate exchange between different groups, innovation platforms serve as a foundation on top of which groups can develop complementary or additional technologies, products or services. Integrated platforms combine both features into a more powerful platform type. Depending on the particular service, GAFAM platforms can be assigned to all platform types, although their core services represent the most powerful category of integrated platforms (Evans and Gawer 2016).

Irrespective of the platform type, there are three building blocks of digital platforms and their ecosystems: *platform owners* and the degree of power centralization, *platform complementors* with their contributions and autonomy, and *platform value-creating mechanisms* for facilitating transactions and innovation (Hein et al. 2019). Thus, GAFAM platforms are reliant on complementary actors. This entails in healthcare, among others, patients, physicians, hospitals, and other service providers to create value. The fragmented healthcare market consequently offers business and growth opportunities to GAFAM platforms to leverage their value-creating mechanisms. Especially, market-oriented research exhibits that digital platforms have proven to provide successful business models (Abdelkafi et al. 2019) which are able to transform and burst formerly grown value chains, existing competitive structures, and entire markets (Alt and Zimmermann 2019; Pousttchi and Gleiss 2019).

2.2 Digital Transformation and GAFAM in Healthcare

The healthcare sector has moved into the digital world with some delay. On an organizational level, healthcare providers have been slow to adopt new technologies and have relied on paper-based processes for a long time (Agarwal et al. 2010). On a structural level, high costs, complex regulatory systems, and missing standards have impeded digital progress (Otto and Harst 2019). However, the healthcare sector faces an expensive and massive digital transformation (Burton-Jones et al. 2020) owing to new digital technologies and personal expectations (Menvielle et al. 2017; Safavi and Kalis 2020). Most recently, the COVID-19 pandemic has stimulated the need for digital health (Fagherazzi et al. 2020). The current progress in both research and practice underpin this impression strongly (Agarwal et al. 2010; Raghupathi and Tan 2008; Vogel et al. 2013; Wickramasinghe and Kirn 2013). Most of all, digital technologies make the promise to improve efficiency and communication, optimize or personalize medical treatment, support decision-making, empower staff, or remove boundaries, due to advances in data analytics and artificial intelligence (AI), (medical) internet of things (IoT), mobile health (mHealth) and virtualization (Dimitrov 2016; Gopal et al. 2019; Raghupathi and Raghupathi 2014; Safavi and Kalis 2020).

To date, the digital health ecosystem has several incumbent players that develop information and medical technologies for healthcare providers, including large companies like IBM, Cerner, AllScripts, or athenahealth (Correa 2020). Around these players, the market is quite scattered with thousands of small, highly specialized firms and startups (Cohen et al. 2020). The segments for hospital information systems (HIS) and electronic health records (EHR) are matured, and the big incumbents seek new segments based on other health IT solutions, especially in terms of networking, data analytics, and virtual services (Dyrda 2020; Gregg 2015). Practical evidence indicates that digital platforms might also play an important part in the digital transformation in healthcare (Chen 2019; Kuchler 2020; Pearl 2019; Zenooz and Fox 2019).

First, the market is highly fragmented, both on-demand and supply side, with many potential user groups to intermediate (e.g., healthcare providers, patients, insurers, digital health solution providers). Digital platforms might facilitate interaction among these user groups. Especially, GAFAM platforms have proven to be efficient matchmakers. Second, the digital transformation is just gathering speed, both government-driven (top-down) and consumer-driven (bottom-up). Governments might foster innovation platforms and the establishment of standards, and GAFAM platforms have proven that they can comply with healthcare industry and regulatory standards such as HIPAA (Health Insurance Portability and Accountability Act) or FHIR (fast healthcare interoperability resources) (Barbier-Feraud et al. 2016; Jindal 2019). Anyway, it is difficult to offer digital-health solutions to patients without employing the ecosystems and infrastructures of GAFAM. What is more, they possess both the required technological and economic capabilities to occupy an important part in this transformation process.

Third, digital health is a global growth market. There are several incumbent health and medical IT companies (e.g., Cerner, Allscripts, Medtronic), but in view of the emergent digital transformation, the claims are not staked and new players might enter the market. GAFAM platforms consider the healthcare market as a favorable opportunity for expanding their economic power and data pools (Chen 2019; Kuchler 2020; Pearl 2019; Zenooz and Fox 2019). They are already involved in healthcare in many ways. For instance, Apple and Google have entered into a rare partnership to co-develop a Bluetooth-based technology that facilitates contact tracing during the COVID-19 pandemic, and Facebook and Microsoft are initial members of the Public Health Tech Initiative (PHTI) from the Consumer Technology Association to explore digital solutions for future pandemics. As a basis for further analysis, we aim to describe and examine the actual business activities in healthcare of each GAFAM platform separately.

Google (or its mother company Alphabet, respectively) has gained its power basically from two platform ecosystems with tremendous market shares: Google Search (92%) with its compliant services (e.g., Maps, Mail, Analytics, Chrome), and the mobile operating system (mOS) Android (76%) as collaborative infrastructure for mobile devices and services (StatCounter 2020a; StatCounter 2020b). Accordingly, Google has gained enormous ICT capabilities, particularly in terms of intermediation, marketing, IT service design and, most of all, data analytics and AI (Galloway 2018). The healthcare market is seen to be another growth area for Google to play off these assets (CB Insights 2018; Google Health 2020). Today, Google has already several direct and indirect stakes in the healthcare market by focusing on its ICT core competencies. Google with its *Search* engine and *Assistant* is oftentimes the first contact point for patients when gathering information about symptoms or looking for physicians (Drees 2019). The tools provide findings from content created by medical experts and validated by Google (Gibbs 2015). *Android OS* (including *Google Play*) provides smartphone users access to several health-related mobile apps from third-party developers (and vice versa). Plus, Google offers *Android Things* as OS foundation for IoT devices and has recently launched *Google Fit* which helps users to monitor their activity data and wellbeing through connected wearables (e.g., *Fitbit*). All these services may support Google to approach the healthcare market from B2C.

In B2B, the company had initiated *Google Health* in 2008, an electronic PHR (personal health record) platform, but stopped this project in 2012 owing to a lack of demand and regulatory issues. Instead, Google currently develops a new *EHR tool* (Matthews 2020). Google also provides *Workspace* to healthcare providers, which is a cloud and groupware solution combining several tools for data management and collaboration. To support such solutions, Google bought *Apigee* in 2016 to provide APIs which are compatible with relevant healthcare standards. Plus, the smart home portfolio of *Nest* can help healthcare providers to observe their patients. Furthermore, Google invested a lot of money in research-oriented products and projects, such as *Cloud Life Services*, a genome database and collaboration platform for life and data science. Hence, Google laid the foundations to provide platform services in the B2B healthcare market.

Among Alphabet's subsidiaries, at least four projects are already active in the healthcare sector: *Verily Life Science* kickstarted a series of promising research projects from smart contact lenses to reactive cutlery for Parkinson's patients, *Calico* strives to unravel the mystery of human aging processes, *DeepMind* develops AI systems for automated diagnosis tools, and *Wing* shall revolutionize transportation with drones, which also might convey pharmacies, specimen or donor organs. So far, these activities might be rather of symbolic importance but underline the strategic ambitions of Google to play to their strengths and explore new business opportunities.

Apple's success primarily stems from providing an all-in-one and well-matched digital ecosystem consisting of devices, systems, and services (Galloway 2018). However, the consumer electronics market approximates saturation, and new revenue sources are sought (e.g., subscription services like Apple One). The healthcare market offers three major opportunities for Apple: (1) selling more devices, (2) selling digital health services, and (3) exploit new data sources (Coldewey et al. 2020; Kimmell 2019a).

To date, Apple has several points of contact in healthcare. From a B2C perspective, *iOS* users can download several health-related apps from the *App Store* to their *iPhones*. The *Health App* is already preinstalled and allows its users to track, trace, and analyze their activity- and body-related data from smartphones or wearable sensors, such as ECG data from the *Apple Watch*. Plus, iOS users might ask *Siri* about their health-related issues. Apple has also developed and introduced platform solutions for B2B. This includes *Health Records*, a tool for patients to share health data with healthcare providers. This ecosystem is completed by *HealthKit*, a central repository and framework for developers to manage and merge data from multiple sources. Additionally, the software frameworks *ResearchKit* and *CareKit* support the development of apps for clinical studies and the monitoring of health-related data. Mobile and smart devices like the *iPad* or *HomePod* could support medical care staff or researchers. Apple even erected two employee-exclusive health clinics close to the headquarter in 2018, *AC Wellness*, which provide a suitable environment for the development and testing of new devices or digital health solutions.

Facebook is the predominant social media ecosystem in the Western society. Thus, Facebook knows about the communication and interests of billions of users. After the company tried in vain to develop own mobile devices or launch an own mobile operating system, it mainly concentrated on marketing (Galloway 2018). However, the healthcare market might be seen as a new playground to catch up with Google or Apple. Here, Facebook particularly concentrates on advances in AI and virtualization.

Facebook's activity range in healthcare is comparatively narrow but yet impactful. For instance, (especially chronically ill) patients refer to social media such as *Facebook* or *WhatsApp* to communicate with physicians or fellow sufferers (Househ et al. 2014). Likewise, WhatsApp is widely used among healthcare professionals in hospitals (De Benedictis et al. 2019). Data from their social network services help Facebook to promote AI-based projects (e.g., for suicide prevention). The initiatives of Facebook's AI research institute FAIR include the *fastMRI* project with the NYU School of Medicine to improve and accelerate radiological techniques. In terms of virtualization, Facebook operates its Reality Labs consisting of five research facilities to develop new solutions based on virtual and augmented reality (VR/AR). Exemplarily, the *CTRL-kit* provides a non-invasive neural interface platform that allows for new types of human-computer interaction (HCI). Moreover, the *Oculus* VR glasses have proven useful for educational purposes in medicine and surgery.

Amazon is the most successful marketplace platform in the Western world (Galloway 2018), and while many companies will not survive the COVID-19 pandemic, Amazon could even capitalize on the crisis (Semuels 2020). And although the marketplace platform generates the greater part of Amazon's revenue, its cloud solutions account for the big profits (Chan 2020). Therefore, the healthcare market is not only another marketplace for Amazon but also an opportunity to demonstrate their capabilities in logistics and ICT (infrastructure, cloud, data analytics).

Amazon captures the healthcare market from several sides by exploiting its economic and technological capabilities. First, Amazon offers its market-leading cloud solution *Amazon Web Service (AWS)* to participants in healthcare and provides the AWS tool *Comprehend Medical*, which is a natural language processing (NLP) service to extract relevant medical information from unstructured text. Second, Amazon plays to its strengths in B2B and B2C commerce as both *Amazon Business* and *Amazon Marketplace* offer a broad range of medical devices and products, and control the delivery processes (*Amazon Logistics*).

Complementarily, Amazon launched *Basic Care* in 2017, an own brand for over-the-counter (OTC) medicine, and acquired *PillPack* in 2018, an online pharmacy which specialized in personalized, pre-sorted drug blisters. Third, Amazon has successively expanded the *Echo* and *Alexa Assistant* ecosystem by health-related services and applications through digital-health startup cooperations (e.g., *Livongo*). To explore new horizons, Amazon has pursued the health insurance project *Haven*, which was a joint venture with Berkshire Hathaway and JPMorgan Chase. Moreover, Amazon has launched a virtual medical clinic for employees in 2019, *Amazon Care*.

Microsoft has its core assets in the provision of software and cloud-based solutions (e.g., *Windows, Office*) for consumers and companies, but is virtually non-existent in the mobile world (Enderle 2019). Hence, the healthcare market might be seen as an opportunity to gain ground on the other big platforms (especially, Google and Apple). At this, Microsoft strives to exploit its technological capabilities to enhance public health. Microsoft's initiative *Healthcare NExT* focuses on the support of healthcare innovations with AI and cloud computing, such as the *Healthcare Bot* for automated first-contact communication. The bot service is available via Microsoft's *Azure Cloud*, which also complies with FHIR.

Just like Google, Microsoft has recently shelved its PHR platform *HealthVault*. Instead, the company provides its patient-centered EHR solution *ehCOS EHR* but mainly focuses on bringing its collaboration services *Microsoft 365* (incl. Office) and *Teams* to the healthcare market. Concerning hardware, the *Surface* line-up (incl. Windows and 365) shall address the need for portability in healthcare. Additionally, Microsoft has developed its *HoloLens* (i.e., AR glasses) with several possible applications in healthcare such as real-time ultrasound simulations or virtual training lessons for medical staff.

Altogether, GAFAM platforms already pursue manifold activities in healthcare, even though the market is highly regulated. Many activities do not appear to be platform-specific or core-business related on their face. However, they help GAFAM platforms to collect data for providing and brokering personalized services, and thus contribute to their overarching strategies. Apart from that, the mere range and scope of GAFAM activities give reason to analyze their impact on the socially and economically important healthcare sector. For one thing, they exhibit the necessary financial and technological capabilities to develop digital health solutions or acquire those through mergers and acquisitions (M&A). Particularly, this applies to (big) data analytics and AI, cloud infrastructures and services, virtualization of products and services, and new forms of HCI. For another thing, GAFAM platforms can build upon their existing consumer relations and proximity to capitalize on the patient-driven part of the digital transformation in healthcare. Thus, they might throw a bridge from B2C to B2B. Figure III.2-1 summarizes the healthcare-related business activities from all five GAFAM platforms, and illustrates in what sub- and cross-segments they are already active in healthcare.

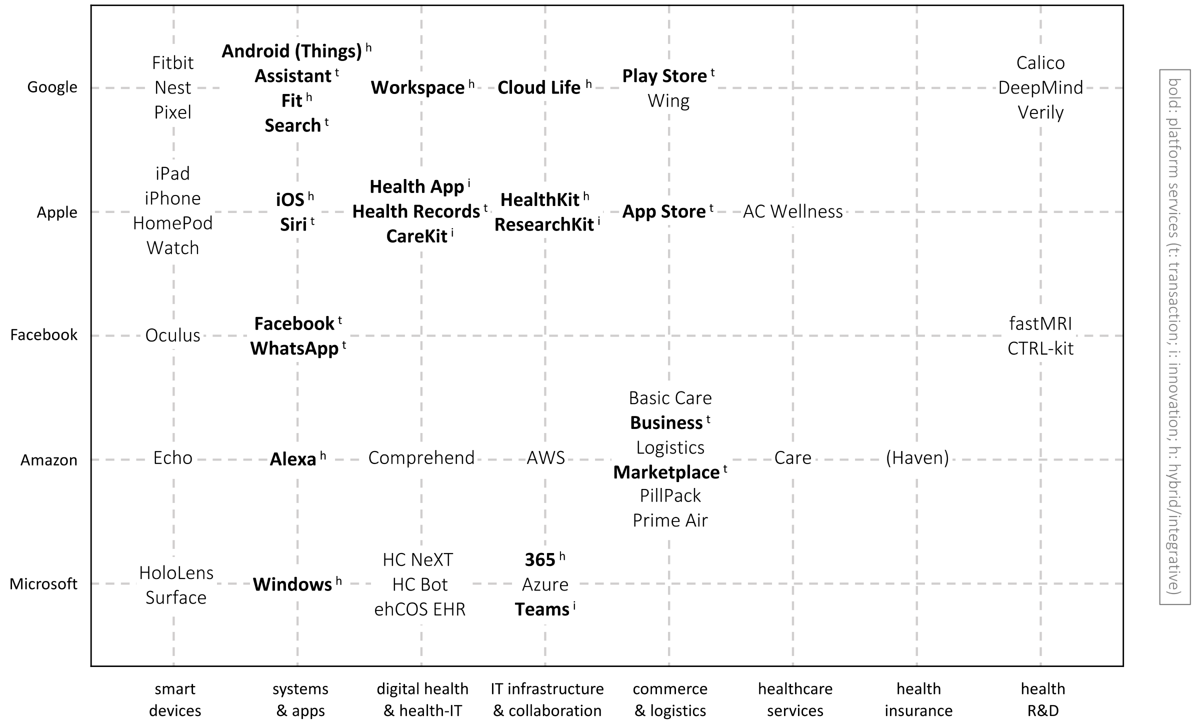


Figure III.2-1: GAFAM Activities in the Healthcare Market

2.3 Literature Review: Digital Platforms in Healthcare

Big digital platforms, especially GAFAM, play a crucial role in our everyday lives and have powerful implications for society and economy (Alt and Zimmermann 2019; Kenney and Zysman 2016; van der Aalst et al. 2019). However, in light of the ongoing massive digital transformation in healthcare and the insinuated platform-related developments, comparatively few contributions within IS have yet explored the potential impact of digital platforms on the healthcare market. Basically, available research on digital platforms explores the phenomenon from three perspectives (Hein et al. 2019): While the *market-based perspective* pays attention to the economic dimension of digital platforms (Tan et al. 2015), the *technological perspective* regards digital platforms as an extensible codebase of software-based systems providing a core functionality with complementary modular services which interoperate through shared interfaces (Tiwana et al. 2010). At last, the *user-centric perspective* concerns platform government mechanisms and actor relations.

From a *market-based perspective*, the demand side of healthcare platforms can be broadly subdivided into three user groups, i.e., patients, healthcare service providers, and payers. Platforms do not only interconnect these three parties with each other, but also with companies on the supply side which offer products, services, or digital applications (Fürstenau and Auschra 2016). Upon this, Fürstenau et al. (2019) developed a platform management framework to understand the interdependencies of a healthcare provider-led platform. The study allows the inference that incumbent market players in healthcare (e.g., hospitals or ICT providers) might struggle to successfully provide digital platform solutions for the entire healthcare sector, which affords big tech players a great opportunity to enter the market. Particularly, digital platforms might successfully address two main problems in healthcare – namely, high fragmentation and low innovation – by enabling shared data repositories, interoperability, and the integration and innovation of new services (Fürstenau et al. 2019). Recently, Hermes et al. (2020c) have investigated the digital transformation of the healthcare industry by analyzing 1830 healthcare organizations. Their study revealed technology-induced shifts in value creation in healthcare, resulting in new market segments, roles, and value streams. Digital platforms contribute to that shift, which gives reason to explore the GAFAM impact in-depth and in greater detail.

From a *technological perspective*, the healthcare system could profit from platform openness like no other industry, both in a technical and semantic sense (Estrin and Sim 2010), which implies issues like interoperability of technical standards as well as the provision of data from all stakeholders. More specifically, Vesselkov et al. (2019) focused on data production and consumption at mobile health platforms. Important aspects include data scope, data sharing, platform design, and platform governance, which all represent core assets of GAFAM companies. Generally, there is a need for technological progress in healthcare, particularly in terms of information infrastructures and applications to facilitate intra- and inter-organizational collaboration (Aanestadt et al. 2019).

From a *user-centric perspective*, some contributions have already addressed the emergence of large digital platforms in the healthcare market. Gu and Hong (2019) explored the dissemination of health misinformation on social media apps. As the use of online social networks affects health-related behaviors, this has a lasting impact on the wellbeing and health status of their users (Durst et al. 2013). Kuebel et al. (2015) examined the adoption of smart home platforms and emphasized the importance of complementary assets like services, infrastructures, or brand image. Further research is rather patient-centric and levels out on the issues of PHRs, health and fitness apps, social media use, or specialized platforms which provide services for communication, information, diagnosis, or treatments (Bandyopadhyay et al. 2012; Huang et al. 2018; Kordzadeh and Warren 2017; Liu et al. 2020; Schaarschmidt et al. 2017; Zhang et al. 2019).

Table III.2-1: Literature Review on Platform Potentials in Healthcare

Perspective	GAFAM Platform Potentials in Healthcare	Reference
market	- need to connect different stakeholders - incumbents' inability to provide meta-platforms - high fragmentation and low innovation - rise of new market segments and value streams	Fürstenau and Auschra 2016 Fürstenau et al. 2019 Fürstenau et al. 2019 Hermes et al. 2020c
technology	- need for openness and interoperability - need for data and platform competences - need for information infrastructures and applications	Estrin and Sim 2010 Vesselkov et al. 2019 Aanestad et al. 2019
user	- increasing relevance of social media - increased relevance of personal health (apps) - diffusion of IoT and smart home technologies - relevance of personal health records - relevance of patient empowerment - relevance of online communities - relevance of digital services (e.g., consultation)	Gu and Hong 2019; Liu et al. 2020 Huang et al. 2018 Kuebel et al. 2015 Bandyopadhyay et al. 2012 Schaarschmidt et al. 2017 Kordzadeh and Warren 2017 Zhang et al. 2019

Altogether, we find a vast amount of general literature on the platform economy (Sutherland and Jarrahi 2018; Hein et al. 2019), growing research interest in this area (Alt and Zimmermann 2019), and the undeniable social, economic and technological impact of (particularly) big digital platforms (van der Aalst et al. 2019; Kenney and Zysman 2016). The presented literature provides several opportunities for GAFAM platforms to challenge the healthcare market (Table III.2-1). However, there is yet surprisingly little research that conceptualizes how digital platforms transfer and leverage their genuine services, economic assets, and technological capabilities into the healthcare market. Such a holistic, strategic view on the impact on entire markets and historically evolved ecosystems is yet missing (Asadullah et al. 2018).

2.4 Methodology

We address the research gap and aim to examine how GAFAM platforms affect value creation in the healthcare market. We rely on value network analysis, which is particularly suitable to analyze digitalized, networked market structures (Peppard and Rylander 2006) and the role of new entrants within (Christensen and Rosenbloom 1995). At this, a value network is a dynamic cluster of economic entities with distinct tasks and responsibilities, which collaboratively co-produce and deliver value for the end-consumer in terms of offerings (Pagani 2013; Lusch and Vargo 2006). Such collaborative co-production is represented by the exchange of such offerings (i.e., value linkages). This market-oriented perspective of value networks refers to the transitional concept from goods- to service-dominant logic that focuses on the successive value delivery of services and offerings and their dynamic co-production across value chains (Lusch and Vargo 2006).

Our research design follows three superordinate parts: (I) Value network development and analysis of the *conventional healthcare market* to depict the initial situation without GAFAM platforms, (II) Value network development and analysis of the extended *platform-induced healthcare market* as systematic foundation for the illustration and examination of the platform-induced implications, and (III) Systematic derivation and analysis of the strategic impact of GAFAM platforms on value creation in the healthcare market, culminating into a *GAFAM-impact framework* (see Figure III.2-2).

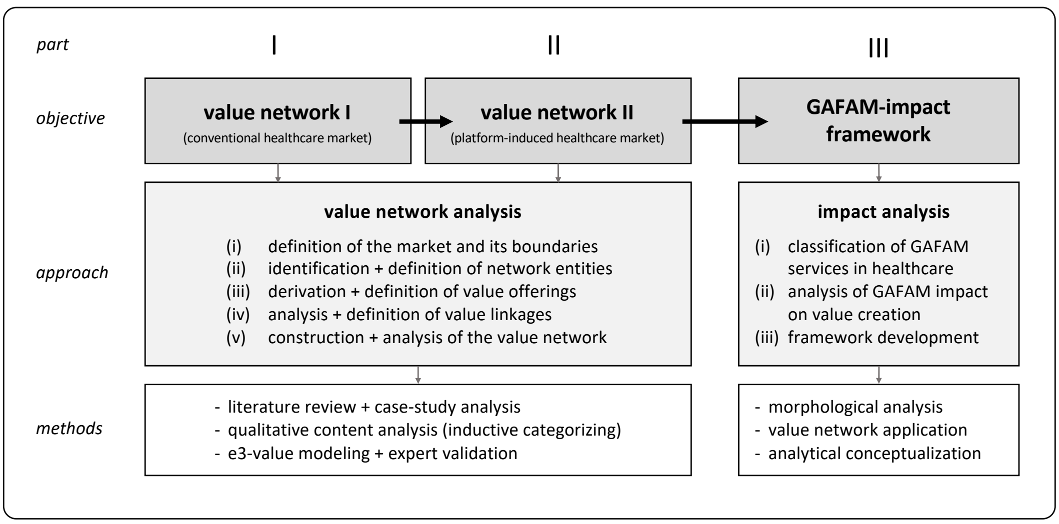


Figure III.2-2: Research Design (GAFAM in Healthcare)

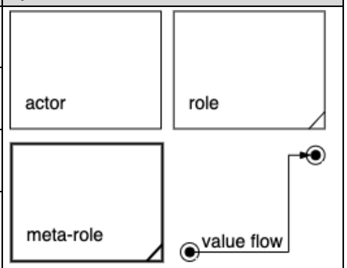
Thus, part I and II imply the development of two value networks as a proper foundation to contrastingly analyze the GAFAM impact on the healthcare market. For the purpose of an appropriate value network development and analysis, we stick to the five-step process from Peppard and Rylander (2006). First, this includes the (i) definition of the market and its boundaries. In view of our research aim, we consider the European and U.S. healthcare market. However, we disregard the regulatory body to reduce complexity and enable generalizability as national regulation is very specific.

Further steps of the value network analysis imply the (ii) identification and definition of the network entities and (iii) their value offerings. Here, we applied an exploratory, qualitative-empirical approach to gain a deeper understanding of the phenomenon from a market-based perspective (Myers 1997; Orlikowski and Baroudi 1991). Regarding the conventional healthcare market, we initially conducted a literature review on value creation and value networks in healthcare to identify different entities like consumers, service or product providers, suppliers, and peripheral supporters (Basole and Rouse 2008). We scanned scientific databases for the search string "(health*) AND (value OR network)". We complemented this by a multiple-case study analysis to empirically explore and contextualize further required entities until theoretical saturation, i.e., further cases do not produce further entities (Yin 2009). This includes the review of healthcare-specific directories and reports, which we retrieved through an online search. Regarding the platform-induced healthcare market, we identified new entities and value offerings from the GAFAM business activities in healthcare (as presented previously in the background section). Here we rely on information from the company websites, articles from newspapers or magazines, and industry reports, which we collected from extensive online research. In order to generalize and conceptualize our literature- and case-based findings to network entities and their value offerings, we rely on Mayring's method of qualitative content analysis for inductive category development (2000).

The final steps of the value network analysis consist of the (iv) definition of the value linkages among the entities, and the (v) construction of the value networks. Using our conceptualized and categorized empirical findings, we apply a design-science oriented approach to construct the two value networks. Based on practice- or theory-based insights, design science research (DSR) allows the generation of new knowledge through the design of novel artifacts such as models, concepts, or constructs (Hevner et al. 2004; March and Storey 2008; Vaishnavi et al. 2019). Following these principles, we apply a specific modeling method for the construction and representation of value networks. Our method basically rests upon e3-value, a systematic modeling approach to illustrate and analyze the value linkages among actors in business models (Gordijn et al. 2000) and multi-actor value networks in digitalized service environments (Hotie and Gordijn 2017). At this, value-adding activities are aggregated and assigned to actors, and their exchanged value offerings (e.g., data, money, product, service) are represented by value flows (Pousttchi 2008; Gordijn et al. 2000).

To provide more generalizability, we employ an extended version of e3-value (Pousttchi 2008). Given the dynamics of such complex markets, the entities within our value networks are not represented by actual market actors but by generic *roles*, which provide distinct value deliveries and aggregate several value-adding activities for exchange with other roles. For the purpose of analysis, actual market actors can be assigned to one or more of such roles (Pousttchi 2008; Pousttchi and Hufenbach 2014). For reasons of generalization and specialization, similar roles can be aggregated to meta-roles. Table III.2-2 presents the notation elements. Hence, our value networks fulfill the function of reference models. Reference modeling allows the inductive or deductive development of simplified or idealized system representations (Wilde and Hess 2007). In this context, our value networks do not represent a desired state, but support structuring and orientation for the purpose of universal applicability (Becker and Schütte 2004; Fettke and Loos 2007). Thus, both value networks can be considered as "abstract framework[s] for understanding significant relationships among the entities of some environment" (OASIS 2020), as in our case, roles representing entities within healthcare (Bernus 1999).

Table III.2-2: Notation of Role-based e3-Value Modeling Technique

Notation Element	**Description**	**Symbols**
actor	specific market player (e.g., person, company)	
role	symbolic market player with a distinct set of value deliveries	
meta-role	subsumption of roles with similarities (for reasons of simplification)	
value flow (w/ value ports)	representation of the value linkages among roles and/or actors	

In order to assure the functional performance and suitability of our artifacts (Kuechler and Vaishnavi 2012), the value networks have been validated twofold: For one thing, we conducted an interdisciplinary workshop with academic researchers (from Informatics, BI, IS, Healthcare) at a digital health congress in 2019, which was organized by two special interest groups for digital health and mobile systems of the GI (German Informatics Society). For another thing, we conducted workshops and discussions with healthcare practitioners representing a broad range of healthcare actors: CIOs and Heads of IT from hospitals (i.e., *inpatient* healthcare), the board member of a regional association of statutory physicians (i.e., *outpatient* healthcare), and managers from regional healthcare cluster initiatives, health insurances, health-IT providers and health startups (i.e., *peripheral* healthcare actors). In the course of these activities, our value networks have been iteratively adjusted and refined.

These foundations support part III of our research process, i.e., analyzing the potential impact of GAFAM on value creation in healthcare. Here, we rely on the usefulness of reference models to generate theoretical and practical relevance in terms of description, explanation, and prediction (Fettke and Loos 2004; vom Brocke 2007; Gregor 2006). In this regard, the conventional healthcare market is of descriptive nature representing the status quo based on empirically derived roles from healthcare market actors. Contrastingly, the value network of the platform-induced healthcare market is rather hypothetical with an explanative and predictive nature, based on empirically derived and integrated roles from GAFAM business activities. Hence, the value networks aim to illustrate the differences owing to platform-induced value-offerings.

In order to analyze the resulting impact, we employ our reference models to systemize the GAFAM-related business models and to conceptualize the platform-induced impact on value creation in healthcare. Regarding the business models, we systematically decompound the platform-induced roles and value flows by employing the morphological analysis, a highly systematic method to structure multi-dimensional problems. It involves the identification and definition of the investigated phenomenon's essential characteristics and the assignment of relevant instances to each characteristic. The aggregate of all critical characteristics and instances is represented by a morphological box, which allows for further analysis, systematization, and comparison of complex phenomena (Ritchey 2013; Zwicky 1966). Following these steps, we condensed the potential characteristics of GAFAM business models in healthcare into a morphological box. Based on these conceptual foundations, we analyze, theorize, and discuss the actual GAFAM impact on the healthcare market (Gregor 2006). We illustrate our analytical key inferences which culminate in a conceptual GAFAM-impact framework in healthcare.

3 Value Network of the Conventional Healthcare Market

3.1 Definition of Conventional Roles and Value Offerings

To conceive the impact of big digital platforms on value creation in healthcare, we need a basic understanding of how value is usually created and delivered in the healthcare market. Thus, we first develop the generic value network of the conventional healthcare market. Following the guidelines from Peppard and Rylander (2006), this entails the identification and definition of relevant value-creating and value offering entities in healthcare, and the value flows among them. The artifacts are inductively developed through a qualitative content analysis of healthcare literature and cases (Mayring 2000). Given our value network's function as a reference model, the entities are represented by generic roles.

In a first approximation of value creation in healthcare, we refer to the central relationship between the *patient* who receives a healthcare service (e.g., curative or preventive medical treatment or information) from a physician, clinic, or hospital, which requires the role of a *medical care service provider* (SP). If the patient is uninsured, the service is charged to the patient's account. If a healthcare service is covered by health insurance, it is either charged directly to the insurer's account or reimbursable against receipt. Health insurance might be offered, e.g., by a public or private health insurance or maintenance organization from the employer, which is why we combine the affiliated tasks to the role of the *payer*. The payer usually defrays these expenses from insurance premiums from the shared-risk community. Thus, we basically find a triangle relationship between the *patient* (as service recipient), the *medical care SP* (as service provider), and the *payer*, which is common in many developed countries (Fürstenau and Auschra 2016).

Since the patient is seen as a final service recipient in our value networks, this entity is labeled as an actor. In view of the actual healthcare market, the roles of the payer and the medical care SP can be further partitioned. Depending on a patient's insurance plan, healthcare treatment costs are either paid by the insurance company directly to the medical care SP (*Direct Cost-Takeover Payer*) or indirectly, i.e., the patient goes in advance and requests a return from the insurance (*Reimbursement-Oriented Payer*). This differentiation might become important in the next years with regard to process flexibility of reimbursing digital healthcare services (Gerke et al. 2020).

In terms of the medical care SP, some healthcare services are ambulant (i.e., often acute, sporadic, or routine) and can be managed quickly (CDPH 2020; GoHealth 2017; Niemann and Burghardt 2016), while others require overnight stays and a longer treatment duration, which allows continuous monitoring of the health status and provides the possibility of immediate medical interventions. Hence, we differentiate between an *outpatient medical care SP* (e.g., registered physicians, clinics, or urgent care centers) that administers the ambulant medical care of day patients, and an *inpatient medical care SP* (e.g., hospitals) that processes the inpatient medical care of overnight patients who are either chronically ill or seriously injured on a temporary basis. Figure III.2-3 depicts the value linkages among these roles through a value network excerpt based on e3-value. The roles of the payer and medical care SP are aggregated to meta roles to allow for generalization and specialization.

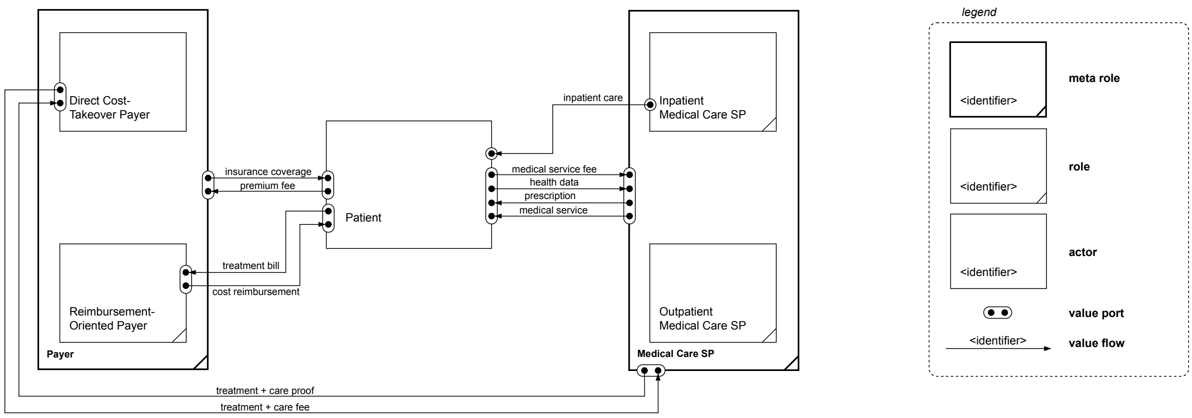


Figure III.2-3: Value Network Excerpt of the Healthcare Market

Both of these medical care SP roles carry out direct and indirect value-creating activities. Direct activities include medical services such as (preventive) consultation, information, diagnosis, and therapy, while indirect activities imply tasks such as procurement, patient administration, or internal logistics of patients and materials (Kawczynski and Taisch 2010; Myllärniemi and Helander 2012; Weissinger 2014). Sometimes, chronically ill or seriously injured patients who are incapable to live alone and need full-time care. The required role of an *inpatient nursing care SP* is usually assumed by (special) care homes. Similarly, an *outpatient nursing care SP* manages the ambulant nursing care of chronically ill people who suffer from permanent minor diseases and run their households, or seriously injured but convalescent patients. For the purpose of generalization, medical care SP and nursing care SP can be subsumed to a *healthcare SP*. Table III.2-3 summarizes the identified and defined healthcare-related roles.

Table III.2-3: Healthcare-related Roles

Meta-	Role	Value Delivery	Exemplary Market Actors
payer	direct cost-takeover payer	provision of insurance coverage (by direct cost transfer)	health insurance firms, like United Healthcare (USA), Allianz (EU), or Achmea (EU)
	reimbursement-oriented payer	provision of insurance coverage (claim approval based)	
healthcare SP	outpatient medical care SP	provision of ambulant medical care (e.g., diagnosis)	registered physicians
	inpatient medical care SP	provision of residential medical care (e.g., treatment)	hospitals
	outpatient nursing care SP	provision of ambulant nursing care (e.g., bathing services)	home-care companies
	inpatient nursing care SP	provision of residential nursing care (e.g., bathing services)	care homes

Professional healthcare services often rely on pathology tests from clinical specimens to obtain information about the health status of a patient and make evidence-based diagnoses. This requires further roles in the value network. For one thing, the role of the *medical laboratory SP*, which administers the tests and analyses, and a *laboratory courier SP*, which safely conveys both the specimen and reports with test results (Pinna et al. 2015; Walters and Jones 2001). Another important logistics-oriented role is the *patient transfer SP*, which carries patients under medical supervision from their homes or places of accidents to a healthcare SP. Another important contribution to value creation in healthcare is the production and provision of pharmaceuticals and medical devices (Pitta and Laric 2004), which requires additional roles in our network.

Accordingly, medical devices need to be produced and distributed, which involves five basic roles: *medical device manufacturer* and *medical device distributor*. At the distribution of drugs, we need to differentiate between drugs, which are subject to medical prescription, and those, which are obtainable over the counter (OTC drugs). Hence, we distinguish the roles of the *prescription-drug distributor* and the *OTC-drug distributor*. Both drug types are produced by the *drug manufacturer*. Since the shipping of pharmaceuticals is liable to severe restrictions and regulations, we propose the apposition of a *drug logistics SP*. Additionally, healthcare relies on continuous scientific progress and infrastructures, and therefore on the role of a pharmaceutical, biotechnological, medical, and technological *research SP* (Table III.2-4).

Table III.2-4: Healthcare-support Roles

Role	Description	Exemplary Market Actors
medical laboratory SP	provision of clinical (pathological) tests/analyses from specimens	Alere (USA), SynLab (EU)
laboratory courier SP	fast transfer of specimen and test results	LabLogistics (USA), GO! (EU)
patient transfer SP	emergency/safe transfer of patients from and to healthcare SP	MTM (USA), Green Cross (EU)
drug manufacturer	development and production of drugs and medicine	Pfizer (USA), Roche (CHE)
prescription-drug distributor	sales of prescription drugs to patients or healthcare SP	pharmacies: Walgreens (USA)
OTC-drug distributor	sales of OTC-drugs to patients or healthcare SP	drug stores: dm, (EU)
drug logistics SP	safe transfer of drugs and medicine to pharmacies or drugstores	Kühne+Nagel, DHL (EU)
med. device manufacturer	development and production of medical devices	MedTron (USA), Fresenius (EU)
med. device distributor	sales of medical devices	McKesson, Vitality (USA)
research SP	provision of research findings and infrastructures	specialized R&D companies

In order to facilitate a comprehensive treatment across different healthcare SP (with different specializations), the provision of an adequate ICT infrastructure is crucial (Bharadwaj et al. 2013; Kagermann 2015; Myreteg 2015). Hence, further roles are required in the value network. On the side of the healthcare service providers, this involves specialized health information and administration systems which ideally (1) orchestrate and support internal processes and organization, (2) allow the capture, import, storage and export of treatment data, (3) provide specialized clinical or medical IT applications and (4) enable the exchange of information and communication data with other stakeholders in the value network (Agarwal et al. 2010; Schlichter et al. 2014). For the provision and maintenance of such systems and applications, we propose the role of the *Health-IT SP*, as conventional hospitals run hundreds of IT systems and applications simultaneously. As many of these applications are not operated on-premise (Kaletsch and Sunyaev 2011; Schneider and Sunyaev 2015), we propose the role of a *cloud SP* to flexibly hold required storage and computing capacities available. For processes of billing and communication between payers and medical care SP, the market actors rely on EHRs that enable the storage of patient-related data and their sharing among healthcare providers and insurance companies (Blechman et al. 2012; Dehling and Sunyaev 2014). Thus, we introduce the role of an *EHR operator*. Table III.2-5 summarizes the identified and developed ICT infrastructure roles in healthcare.

Table III.2-5: ICT Infrastructure Roles

Role	Description	Exemplary Market Actors
health-IT SP	provision of specialized healthcare systems and applications	Cerner (USA), Dedalus (EU)
cloud SP	provision of flexible storage and computing capacities	IBM (USA), Telekom (EU)
EHR operator	storage, processing and transfer of clinical health records	GE, Epic, AllScripts (USA)

3.2 Construction of the Conventional Healthcare Market Value Network

Based on the derived roles, we apply value flow analysis and the extended e3-value modeling method to develop a reference model of the healthcare market value network. Thus, we derive and define the relevant value linkages among the roles which serve as foundation for the value flows, and therefore the construction of the value network. The basic value exchange in healthcare is constituted by the value linkage between patient and medical care SP. Uninsured patients have to bear such costs themselves. Insured patients can refer to their payer which pays for the service (directly or by reimbursement). Thus, we find several value linkages among the entities: For a proper, preventive or therapeutic, treatment, both patient and medical care SP rely on supporting and peripheric products and services. Patients demand drugs, medical devices, transfer services, or information, which are either self-paid or covered by the payer's benefits (depending on the healthcare service and the patient's insurance status). A payer pools the risks of all patients and has to equalize all health expenses with the total amount of insurance premiums. Table III.2-6 exhibits exemplary value linkages as foundation for the value network.

Table III.2-6: Excerpt of Defined Value Linkages in the Conventional Value Network

From Role/Actor	Value Linkage	To Role/Actor
patient	service fee; data (e.g., health information, insurance proof)	medical care SP
medical care SP	medical treatment or health service	patient
medical care SP	treatment proof	payer
payer	fee/reimbursement for patient treatment	medical care SP
…	…	…

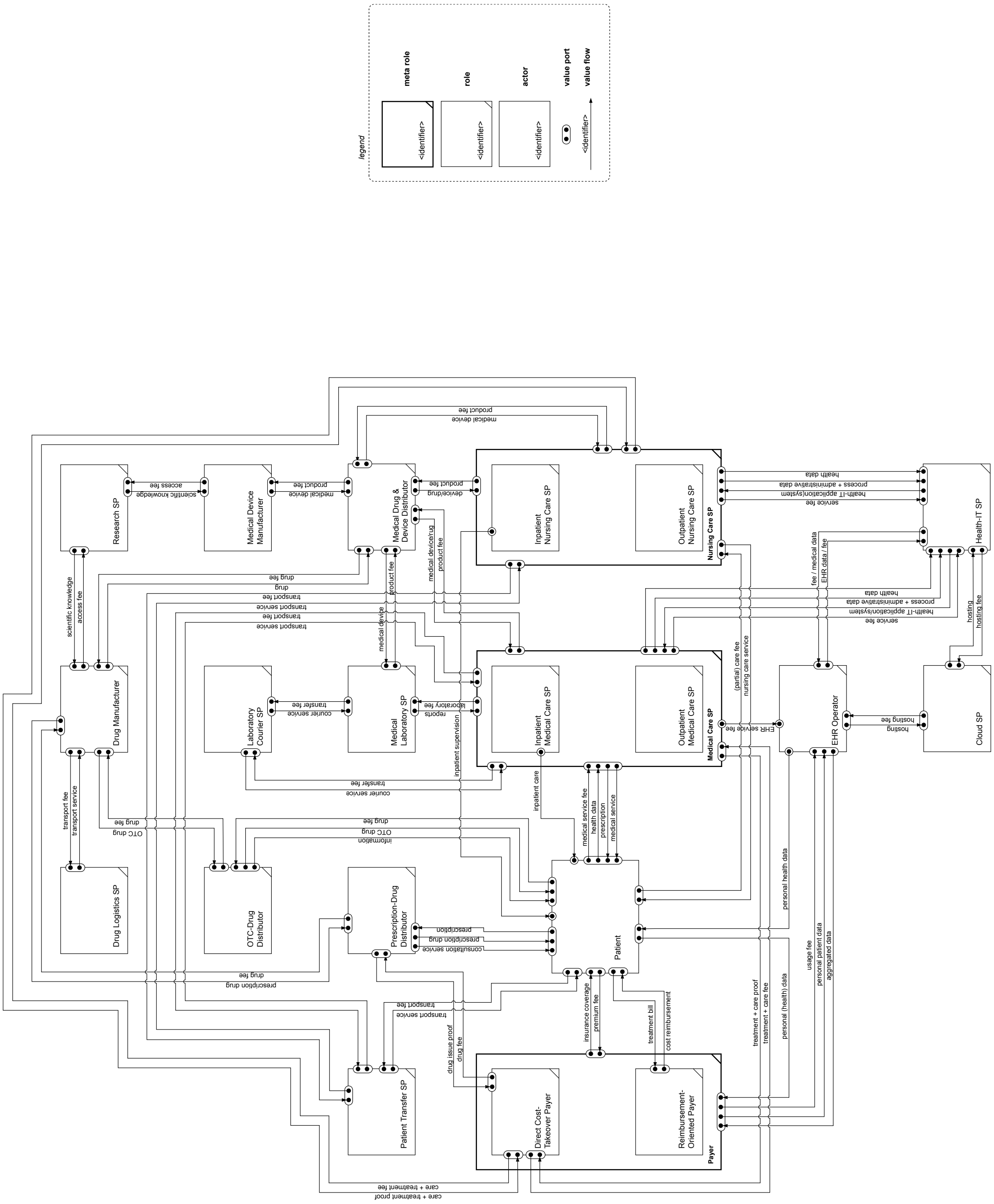


Figure III.2-4: Conventional Healthcare Market Value Network

Similarly, a medical care SP (e.g., hospital) demands drugs for its value-adding activities (e.g., diagnosis, treatment, and monitoring), which is bought at a drug distributor (e.g., pharmacy). Additionally, the purchase and implementation of ICT components and services aim to support and optimize the provision of healthcare services along the entire healthcare cycle and from admission to dismission. To operate the facility economically, a medical care SP needs to factor in such costs to calculate the prices of their treatment services or – if such prices are subject to regulation – make their processes more profitable either way. Suppliers of drugs, medical devices, or ICT solutions are reliant upon upstream service or goods providers to create value themselves.

Through carefully connecting all these value linkages by value flows among the entities, we are able to construct a resulting role-based value network of the conventional healthcare market (see Figure III.2-4). Given its nature of a reference model, roles can be assigned to different real-world market actors depending on the considered scenario. For instance, a dentist (as outpatient medical care SP) could treat the patient using an endodontics system from the company Dentsply Sirona (as medical device manufacturer). Likewise, the value network can be used to analyze value flows of an infected patient who is carried by a patient transfer SP to the hospital (inpatient medical care SP), where the patient undergoes a screening, while the specimens are analyzed by an external medical laboratory SP. In view of our research aim and our following sections, the value network serves as foundation and starting point to analyze platform-induced changes in value creation in the healthcare market.

4 Extension to a platform-induced value network

4.1 Derivation and definition of platform-induced roles

In order to explore and understand how the value network of the healthcare market is affected by big digital platforms, we analyze the GAFAM business activities in healthcare presented in the background section. By means of a qualitative content analysis of the GAFAM business activities, we inductively derive and develop new platform-induced roles which affect the conventional value exchange in various ways, and thus value creation in the entire value network. As GAFAM activities concern different tie points in the value network, we sort and present these roles along with three inductively developed categories: patient, healthcare SP, and infrastructure.

4.1.1 Patient-healthcare Related Roles

Several products and services of GAFAM platforms aim at directly fostering or supporting the patient's healthcare processes. Some systems offer fast and easy access to (qualified or certified) health-related information or initial consultation (either automated or face-to-face). For instance, Google Search provides verified health content to certain health-related search queries and helps patients to quickly find, contact, or rate physicians in the vicinity. For such low-level and sporadic patient support, we propose the role of a *health orientation SP* which comprises activities such as the provision of health-related information, health system orientation, automated initial consultancy, or patient steering.

Other applications support the patient more continuously and provide services for data storing, monitoring, and analysis. Apple Health App combines personal health-related data from different apps to provide information on the individual health status. Likewise, similar applications facilitate peer communication rooms for exchanging experiences, as e.g., Facebook theme groups. Such services empower the patient to actively manage their health issues, which is why we propose the role of a *health assistant SP.* This role encompasses the provision of patient (decision) support for monitoring, analyzing, and sharing activity-related, physiologic, and medical data or feelings. Such services often require active commitment from the patient and demand their data for purposes of further processing. Other services, like Amazon Care, provide (direct or brokered) access to professional medical consultation from clinical staff. Such services more or less digitalize the traditional patient-physician relationship and have various manifestations. Thus, we propose the role of a *digital health SP* to provide medical services or content (either directly or brokered).

Likewise, Amazon enables patients to purchase both their required drugs and medical devices online from various suppliers, which is why we propose the roles of a *B2C drug marketplace* and *B2C medical device marketplace* to facilitate the provision of (brokered) drugs and medical devices, respectively. Amazon complements these services by a fast and convenient delivery of medical supplies for patients (Prime Air), which requires the role of a *drug delivery SP*. Table III.2-7 summarizes all newly generated healthcare-related roles.

Table III.2-7: New Healthcare-related Roles

Role	Value Delivery	Exemplary GAFAM Activity
health orientation SP	provision of health-related information, health system orientation, automated or personal initial consultancy, and patient steering	Apple Health App, Google Search, Facebook
health assistant SP	provision of patient (decision) support for monitoring, analyzing, sharing activity-related, physiologic, and medical data or feelings	Apple Health App, Facebook
digital health SP	provision of (brokered) professional medical consultation/content	Amazon Care
B2C drug marketplace	provision of (brokered) drugs and medicine for patient's use	Amazon Marketplace
B2C medical device marketplace	provision of (brokered) medical devices for patient's use	Amazon Marketplace
drug delivery SP	provision of quick supply of (OTC or prescription) drugs	Prime Air

4.1.2 Healthcare SP Support Roles

The GAFAM platforms do not only provide products and services which target the patients. Many of their services rather focus on supporting the work of the healthcare SP, and thus on B2B. This requires further roles in the value network. Some services aim to optimize, automate, and facilitate clinical collaboration. For instance, Microsoft 365 has rolled out several tools and applications to support clinical staff in their daily tasks. To bundle such activities, we propose the role of a *groupware SP*, which comprises the provision of application systems with communication or collaboration tools for staff from healthcare SP. Other platform services support the government and monitoring of the healthcare SP's IT landscape. For instance, Microsoft Azure Service Health provides a dashboard to monitor and control service updates and outages, planned maintenance, or issues from integrating other services or applications. Thus, we propose the role of an *IT Support Solutions SP* for the provision of application systems and tools to monitor, govern, and safeguard the operation of the clinical IT landscape.

Further platform services support clinical processes and decisions through automated documentation, processing, analysis, or sharing of data like, e.g., Amazon Comprehend Medical, an NLP service to extract relevant medical information from unstructured text. Such activities can be combined to the role of a *clinical support SP.* Additionally, GAFAM platforms provide holistic solutions for the provision of digital storage, exchange, and archiving of the patient's entire medical records across payers, healthcare SP, and indications. For example, Apple Health Records enables hospitals to connect their EHRs to the patients' mobile health apps for exchanging and aggregating data. Thus, we introduce the role of a *PHR operator* for the digital storage, exchange, and merging of a patient's entire medical records.

Besides supporting IT services, GAFAM platforms also provide complementary technical devices based on advanced technologies. This includes the development of AR or VR glasses for improved diagnoses or surgery education, such as Facebook's Oculus or Microsoft's HoloLens. For such activities, we introduce the role of an *advanced devices provider*. Likewise, GAFAM platforms can help streamline the purchasing processes of healthcare SP. At this, new platforms like Amazon Business for ordering medical devices have risen recently, which requires the role of a *B2B medical device & drug marketplace* to ensure the provision of (brokered) medical devices and drugs for the healthcare SP's use. Table III.2-8 summarizes the defined healthcare-support roles.

Table III.2-8: New Healthcare-support Roles

Role	Value Delivery	Exemplary GAFAM Activity
PHR operator	connector of digital storage, exchange and archiving of a patient's entire medical records across patients, payers, healthcare SP	Apple Health Records
clinical support SP	provision of medical staff (decision) support through automated documentation, processing, analysis, or sharing of data	Amazon Comprehend Medical
groupware SP	provision of application systems with communication or collaboration tools for staff from healthcare SP	Microsoft 365 and Teams
IT support solutions SP	provision of application systems and tools to monitor, govern and safeguard the operation of the clinical IT landscape	Microsoft Azure Service Health
advanced devices provider	provision of advanced technological devices and applications for medical or educational purposes, e.g., AR/VR	Facebook Oculus, Microsoft HoloLens
B2B medical device & drug marketplace	provision of (brokered) medical devices for healthcare SP's use	Amazon Business

4.1.3 Infrastructure roles

GAFAM platforms comprise large technological capabilities to provide digital services and maintain the underlying infrastructures, especially in terms of data processing (Galloway 2018, p. 188; Petit 2016, p. 56). Hence, many platform-related business activities in healthcare focus on offering digital services, ecosystems, or infrastructures. In order to reach patients nowadays, healthcare SP rely on mobile devices and environments. Hence, the provision of mOS and smart devices is inevitable to bring services or content to the patient. Apple (iOS) and Google (Android) virtually form a duopoly for mOS, and thus have become a gatekeeper for any health-related mobile service. Thus, we propose the role of an *mOS provider* for the provision of digital infrastructure ecosystems (including frameworks, apps, and app stores), and the role of a *smart device provider* for the provision of connected cyber-physical systems (e.g., smartphones, wearables, smart home systems) with consumer interfaces to run the OS and corresponding applications mainly developed by third parties. In view of the IoT trend in healthcare, other data-collecting and processing with distinct OS might emerge and extend this role accordingly (e.g., Android Things, Nest).

However, mOS do not cover all patient-related data alone, since other applications or services (e.g., Amazon Marketplace, WhatsApp, or the Microsoft Healthcare Bot) collect and process a number of further health-relevant data, which need to be aggregated, stored, and prepared for further circulation and analysis. This requires the role of a *patient data & relationship SP* for patient communication and the collection, storage, and preparation of patient-related communication data from various devices, systems, and applications.

Some services have specialized in the standardization and harmonization of such data as well as the provision of suitable interfaces to allow a sharing of information among different stakeholders in the market. For instance, Apple Health App aggregates the patient health records from multiple institutions alongside their patient-generated data, which requires respective standardization procedures. Likewise, Microsoft provides an API to manage health-related data with Azure services. These activities require the role of a *data processing & exchange SP*. Many platform services comprehensively collect, store, prepare, and process large amounts of clinical and medical data sets for analytical purposes and rely on AI algorithms. For instance, Facebook's FAIR initiative aims at supporting clinical IT solutions and processes with machine learning. Hence, we propose the role of an *AI support SP* for the provision of specialized health-related AI systems, applications, and algorithms. Table III.2-9 summarizes all newly generated infrastructure roles.

Table III.2-9: New Infrastructure Roles

Role	Value Delivery	Exemplary GAFAM Activity
mOS provider	provision of a data-processing infrastructure ecosystem, including frameworks, apps, services, and app stores	Alexa, iOS, Android
smart device provider	provision of connected cyber-physical systems with consumer interfaces, e.g., smartphones, wearables, smart home systems	Alexa, iPhone, Apple Watch
patient data & relationship SP	software-based patient communication interface and collection of patient-related data	Alexa, iOS, Apple Health App, Microsoft Healthcare Bot, Amazon Marketplace
data processing & exchange SP	storage and standardization of patient data and API provision	Alexa, iOS, Apple Health App, Microsoft Azure API
clinical data processing SP	collection, storage, preparation, and processing of large and cross-sectional clinical or medical data sets for analytical purposes	Amazon Comprehend Medical, Facebook FAIR, Microsoft Azure
AI support SP	provision of specialized health-related AI systems, applications, and algorithms	Amazon Comprehend Medical, Facebook FAIR, Microsoft Healthcare Bot

4.2 Construction of the Platform-induced Value Network

The resulting platform-induced roles need to be thoughtfully integrated into the healthcare market value network with special regard to their relationships with other roles. Therefore, we refer again to value flow analysis and the extended e3-value modeling method to develop the value network of the platform-induced healthcare market based on the defined roles and their value linkages. For instance, the mOS provider gives patients access to their platform (and thus, to various services from other providers). In return, a patient transfers data and payment fees. Table III.2-10 exhibits exemplary value linkages within the value network of the platform-induced healthcare market.

Table III.2-10: Excerpt of Defined Value Linkages in the Platform-induced Value Network

From Role/Actor/Segment	Value Linkage	To Role/Actor
patient	access/service fee; data	mOS provider
mOS provider	OS access and infrastructure; access to services and products	patient
mOS provider	access to patients and devices	digital health SP
digital health SP	access/commission fee	mOS provider
…	…	…

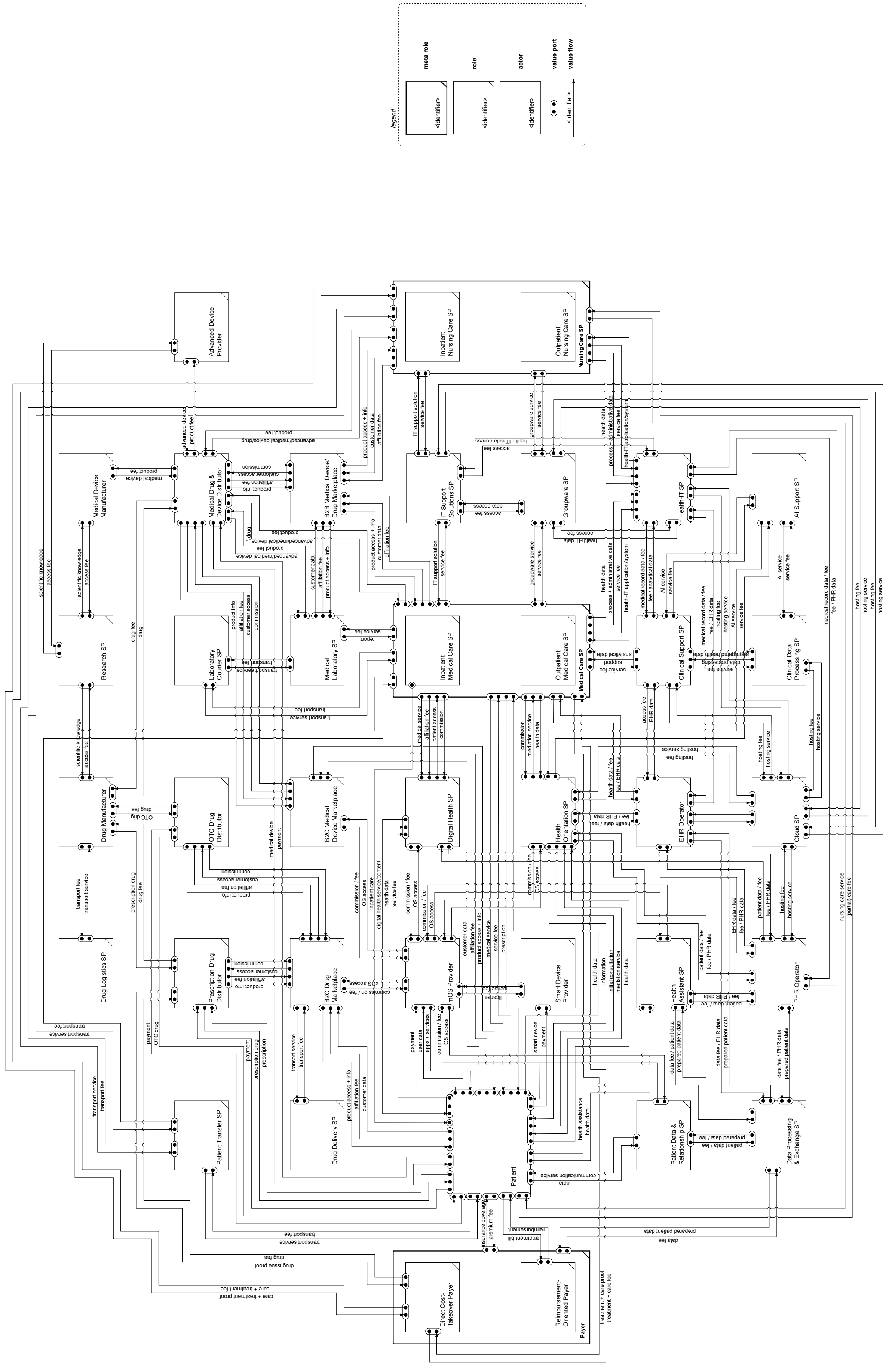


Figure III.2-5: Platform-induced Healthcare Market Value Network

Through carefully connecting all these value linkages among the entities, we are able to construct the resulting role-based value network of the platform-induced healthcare market (see Figure III.2-5). In the center, we find the patient who demands a healthcare service. The ubiquity of digital technologies in general and GAFAM platforms in particular enables new and more complex patient pathways. If digitally empowered (through mOS and smart devices), patients are given several opportunities which neutralize the necessity of contacting healthcare SP directly. New roles between this traditional relationship evolve and do not only provide patient-oriented ecosystems but also low-threshold orientation and access to information or consultation, mostly in exchange for data and usage fees. Conversely, healthcare SP (voluntarily or not) access these platforms from the opposite side to get in touch with patients or offer digital services themselves (e.g., telemedicine).

From a B2B perspective, GAFAM platforms offer fee-based services for healthcare SP which facilitate the health-related and administrative business activities (e.g., clinical support SP, groupware provider, PHR operator). Consequently, the products and services of GAFAM platforms orbit patients and healthcare SP likewise, which breaks ground for a central and intermediary position in the value network and enables the successive connection to other value-creation segments in the network (e.g., drug and medical device market platforms). In combination with third-party developers and service or content providers, GAFAM platforms might pursue full-service approaches for patients (and for healthcare SP). GAFAM platforms also supply relevant infrastructures, ecosystems, and advanced services that lay the foundation for comprehensive and interconnected products and services (e.g., mOS provider, patient data aggregator, AI support SP).

GAFAM platforms are not limited to creating value in healthcare by enabling transaction, but also provide information and facilitate interaction among different stakeholders (both B2B and B2C). As the value network analysis illustrates, data might play a key part in the GAFAM-related actions in the healthcare value network, especially in terms of value collection, exchange, and analytics. On the one hand, this enables platforms to provide various digital and data-driven service types such as intermediation, content delivery, or communication. On the other hand, GAFAM platforms can support and facilitate physical service types along the entire healthcare process cycle and for all kinds of healthcare services from monitoring to therapy. Plus, GAFAM platforms exploit their existing customer relationships, networks, and ecosystems to interact with different user groups from different market segments. Besides, their technological capabilities allow for various kinds of customer and network interaction from automated chats to face-to-face video calls.

Both patients and healthcare SP conduct value exchange (data, money, services, products) with GAFAM platforms at different tie points. Hence, value streams rise in frequency and complexity, making data an important (or even decisive) competitive factor. The defined value exchange linkages are represented through the value network of the platform-induced healthcare market. With respect to our research aim, we employ this value network in the following sections to illustrate, analyze, and discuss the platform impact on value creation in healthcare.

5 Analysis of GAFAM Impact on Healthcare Value Creation

5.1 Classification of GAFAM Healthcare Services

To analyze the platform-induced impact on the healthcare market systematically, we first apply the morphological method. We conceptualize and typologize the business models of the examined platform healthcare services and the substantiated roles and value flows in the reference model. Thus, we derive appropriate characteristics for classifying platform healthcare service types and assign them to the three dimensions of digital transformation, i.e., value creation model (VCM), value proposition model (VPM), and customer interaction model (CIM) (Pousttchi 2017; Täuscher and Laudien 2018). While the VCM refers to a firm's architecture and processes that enable and ensure the value generation, the VPM explains how the generated value can be offered and transformed into revenues and profits, including its revenue streams and sources. Complementarily, the CIM describes how the generated value is sustainably delivered to the customers, including the channels and segments (Abdelkafi and Täuscher 2016; Johnson et al. 2008; Pousttchi 2017).

We first approach this structuring process deductively and draw on available literature. While Osterwalder (2004) and Pousttchi (2017) provide categorizing items of digital business models in general, Täuscher and Laudien (2018) propose distinct attributes of marketplace business models in particular, e.g., key activities, key value- proposition or key revenues. Since big digital platforms in healthcare are not limited to marketplaces, the derivation of further distinct characteristics requires an iterative process with an interplay of inductive and deductive elements. Thus, we grasp apparent features from the collected GAFAM activities in order to reflect, refine and substantiate those with available research on platform characteristics and business models (Eurich et al. 2011; Fehrer et al. 2018; Hein et al. 2019; Parker et al. 2016) as well as processes and market specifics in healthcare (Bergman et al. 2011) or relevant stakeholders (Donaldson and Preston 1995). This way, we derive and develop distinguishing characteristics and their range of possible instances of platform-induced roles in the healthcare market. The results are conceptualized to a morphological box and subdivided into the three dimensions of digital transformation (see Figure III.2-6).

Value Proposition Model. Regarding in the VPM, we can define the service's *key value proposition*, i.e., either enabling transaction (e.g., B2C drug marketplace), facilitating interaction (e.g., digital health SP), fostering innovation (e.g., mOS provider), or providing information (e.g., health orientation SP). Upon this, we can determine the platform service's graspable *value delivery*, which can be either physical or digital. Physical value deliveries imply tangible products (e.g., medical devices, smart devices, pharmaceutical drugs) or intangible professional services (e.g., health consultation), while digital ones imply distinct digital services (e.g., cloud services), brokering services (e.g., app store), bundling services (e.g., drug sales including delivery) or accessible content (i.e., standardized information like training videos) and context (i.e., personalized information like PHR). Although GAFAM platforms conventionally focus on digital value deliveries, our analyses reveal how they noticeably shift and connect to the physical world in healthcare with their (medical) devices and services, or hospitals and health insurance companies.

Further differentiation applies to the revenue model. At this, *revenue streams* can be direct or indirect (depending on who pays) and transaction-based (e.g., one-time fee) or recurring (e.g., monthly fee).

Remarkably, GAFAM platforms receive their revenues both directly from the users (i.e., patients or hospitals) and indirectly from advertisers or insurances. *Revenue types* depend on the product or service and can be instantiated into commission, subscription, advertisi,ng and sales. GAFAM platforms basically generate revenues from brokering services (commission) and analyzing customer preferences (advertising), advanced healthcare services might be subject to subscription, especially in the context of B2B. Moreover, each platform service can directly or indirectly be assigned to a *healthcare phase* (i.e., prevention, treatment, care, after-treatment, support) and a *healthcare service type* (e.g., documentation, diagnosis, monitoring).

Value Creation Model. In terms of the VCM, platforms generate value through leveraging *network effects*, same-side or cross-side. For instance, the mOS provider creates both network effect types by connecting patients both among themselves (same-side) and to digital health or healthcare SP (cross-side) via access to portals for mobile applications. Moreover, big digital platforms create value by exploiting the power of (patient) data, which vary in their type, device, origin, and handling.

Regarding the *data type*, GAFAM platforms collect and process meta-data by their very nature, including information on what applications consumers use when and where, or exchange with whom. Additionally, GAFAM platforms can gather basic, communication, usage, and billing data from consumers: Facebook with its social network and WhatsApp, Apple with iOS and Google with Android (including messenger, call, and mobile-payment services), Amazon with Alexa and its marketplace, Microsoft with Windows. Stepping into the healthcare market and capturing new roles (e.g., health assistant SP), GAFAM platforms broaden and diversify their data pools to lay the foundations for more holistic big data approaches. To collect data (and process it on-premise), the platforms rely on a distributed infrastructure of *device types*, which they either provide themselves (e.g., Apple iPhones) or in cooperation (e.g., Google Android and Samsung). Generally, such devices include smartphones, tablets, or wearables. However, they increasingly provide medical devices or extract data from the same. The data can be either entered into the devices by humans (i.e., patients or staff) or generated automatically by the inherent applications. Thus, the *data origin* varies. Depending on the role in the value network (and therefore the required set of activities), GAFAM platform services pursue different purposes of *data handling*, e.g., the focus might be capturing and processing data (mOS provider) or storing, transforming, and exchanging data (patient data aggregator and data processing & exchange SP). Consequently, value creation from GAFAM platforms is highly reliant on the exploitation of data.

Customer Interaction Model. With respect to the CIM, we can specify the platform service's *customer segment* (among business, consumers, and administration) and *market segment*, which can be close to the patient (healthcare) or at the periphery (i.e., ICT, retail and logistics). While GAFAM platforms have mainly arisen through their technological and data-processing capabilities (Google, Apple, Facebook, Microsoft) or logistic optimization (Amazon), our network analyses exhibit that they successively delve into directly healthcare-related activities from different corners in the value network. Plus, they diffuse all customer segments likewise, and therefore increasingly connect B2C and B2C. Irrespective of who pays for a service, different *user groups* might be involved and serviced. For instance, a telemedicine service might be charged to the payer but used by patients and physicians. Hence, several stakeholder types have to be taken into consideration when offering a health-related service. *User interaction* might also take place through different channels, depending on the technical capabilities and contextual requirements. For instance, a telemedical diagnosis service might require a high-resolution video stream between patient and physician, while a symptom checker might work chat-based. GAFAM platforms have the technological capacities to develop and offer such channels and services successfully, also with regard to the required minimum user base.

	characteristic	instances								
VPM	*platform service core VP*	transaction	interaction	innovation	information	none				
VPM	*value delivery*	physical product	physical service	digital service	brokering service	bundling	content	context		
VPM	*revenue stream*	direct transaction-based	direct recurring	indirect transaction-based	indirect recurring					
VPM	*revenue type*	commission	subscription	advertising	service sales					
VPM	*healthcare phase*	prevention	treatment	care	after-treatment	support				
VPM	*healthcare service type*	orientation	documentation	consultation	communication	diagnosis	therapy	monitoring	assistance	
VCM	*network effects*	same-side	cross-side	none						
VCM	*data type*	metadata	basic data	health data	billing data	usage data	communication data	other		
VCM	*data device*	smartphone	tablet	PC	wearable	IoT/sensor	medical device	other		
VCM	*data origin*	patient	physician	nurse	clerk	application	system	database	other	
VCM	*data handling*	capture	store	process	transform	exchange	analyze	other	none	
CIM	*customer segment*	B2B	B2C	C2C	A2C	A2B				
CIM	*market cross-/ sub-segment*	healthcare	ICT infrastructure	retail	logistics					
CIM	*involved user group*	patient	healthcare SP	care SP	payer	ICT SP	logistics SP	manufacturer	distributor	researcher
CIM	*user Interaction*	chat	video	call	e-mail	application	website	face-to-face	automated	other

Figure III.2-6: Classification of Platform Business Models in Healthcare

Altogether, GAFAM platforms offer a broad range and diversity of healthcare-related products and services to both patients and healthcare SP. Plus, these services do not necessarily constitute platform-specific value offerings. However, all GAFAM platforms and their products and services either rely or zero in on the collection, processing, analysis, or exchange of data.

5.2 Analysis and Discussion on GAFAM Impact in Healthcare

The value network analysis of the platform-induced healthcare market reveals that GAFAM platforms affect value creation in healthcare multifacetedly since they do not simply extend the conventional value network from various tie points but also raise its complexity through modularization. Furthermore, our morphological analysis of the GAFAM platform services in healthcare demonstrates how GAFAM platforms exploit their technological and data-processing capabilities as well as their large and diversified user bases to offer a broad spectrum of service types directly or indirectly related to healthcare. On that basis, this section aims to analyze and conceptualize the digital-platform impact on the healthcare market.

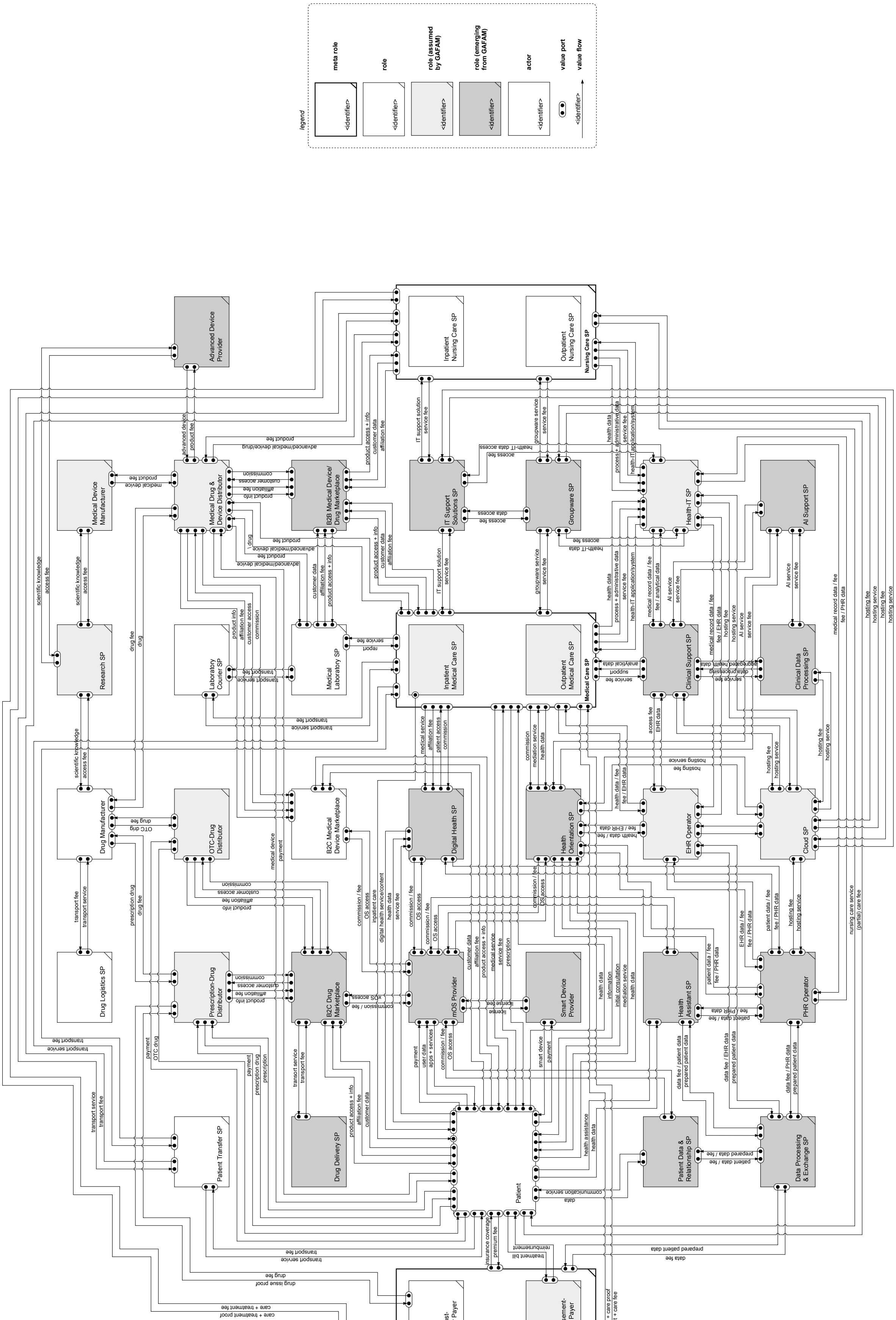


Figure III.2-7: GAFAM Roles in the Platform-induced Healthcare Market

In order to understand the platform impact on value creation in the healthcare market in greater detail, we employ the platform-induced healthcare market value network as a starting point and tool for our further analysis (Figure 5). We now ascribe GAFAM business activities to their respective roles in the value network to illustrate 1) which new roles have emerged from GAFAM, and 2) which conventional roles have been occupied by GAFAM (as depicted in Figure III.2-7). We find that GAFAM platforms mainly create new roles in the core and the ICT infrastructural periphery of the value network to connect or support conventional roles. Unsurprisingly, their core services represent digital gatekeepers to the patient. This primarily applies to the mOS provider (i.e., mainly Apple and Google), which interlinks all digitally-enabled services from the SP to the patient device, and thus combines much of the gathered data. What is more, other GAFAM services above the OS also tend to platformize and digitalize the B2C healthcare market by either bundling data from services and devices (e.g., Apple Health App), or intermediate services and products to the patient (e.g., Google Assistant, Amazon Marketplace).

However, GAFAM platforms also provide digital solutions for the healthcare SP, and thus compete with incumbent health IT companies. Either way, GAFAM platforms come from their core industries (i.e., ICT, data, retail, logistics) and rely on their core assets (i.e., technological and data-processing capabilities, consumer relationships). This way, GAFAM platforms might throw a bridge between B2B and B2C in the healthcare market.

More surprisingly, GAFAM platforms even capture conventional roles beyond their actual core industries and assets. For instance, Amazon may occupy the role of a payer (based on the project insights of Haven), and Apple and Amazon platforms accomplish the tasks of medical and care SP with their clinics, hospitals, and telemedicine services (AC Wellness and Care). This way, they penetrate the healthcare market both horizontally and vertically by extending their original service scope. Consequently, GAFAM platforms seize large parts of the healthcare market value network, break up existing relationship structures, and modularize value creation through intermediation or supportive functions. Altogether, GAFAM platforms affect the healthcare market in many ways, which requires a comprehensive organization of our findings. Thus, we develop a conceptual framework that structures and contextualizes the *facilitators* of the increasing platform occurrence in healthcare, enabled *GAFAM-specific healthcare activities*, and resulting *GAFAM-induced effects* on the healthcare market.

Facilitators. First, we propose six co-dependent facilitators which promote the prevalence of big digital platforms in healthcare according to our literature and value network analysis. (1) GAFAM platforms can exploit their *existing strong customer relationships* to offer health-related services to a broad user group: Apple provides a harmonious and comprehensive ecosystem of OS and customer devices (iOS, macOS), Google maintains the most widespread non-proprietary mOS and predominant information portals (e.g., Search, Maps), Facebook owns the most popular social network and messenger service (WhatsApp), Amazon is a global market leader for online shopping (Marketplace) and cloud services (AWS), and Microsoft runs the most successful office and collaboration software with integrated cloud services (Microsoft 365). On the one hand, people are used to the services and trust these actors. On the other hand, the success relies on homing and switching barriers. The manifold tie points to the patient in the platform-induced value network support this assumption. What is more, such strong customer relationships might spill over to B2B, if employees adopt their consumer behavior to work.

(2) GAFAM platforms have an enormous global ubiquity, pervasion, and *cross-sectional market power*, which goes back to the winner-takes-all phenomenon in platform markets. They can offer their ICT and data-based solutions (e.g., cloud services) to different markets, and thus achieve economies of scale by leveraging further network effects for their user groups. This implies a great bargaining power over other stakeholders (i.e., competitors, market participants, legal authorities, potential partners) to assert their claims and interests, or in terms of undertaking M&A transactions. This inference is indicated by the disparate business market segments (e.g., logistics, ICT) that GAFAM platforms target in the value network, bringing a multitude of different services to the patient and healthcare SP.

(3) The literature and morphological analyses exhibit that GAFAM platforms have tremendous *technological* and (4) *data collection and processing capabilities* which they can realize in healthcare. Especially, Google and Apple can draw on the most variable and voluminous data sets of content and metadata from their users. However, Amazon (billing data), Facebook (communication data), and Microsoft (online usage data) can almost hold their pace since services get increasingly extended (e.g., Alexa) and entangled (e.g., cookies). The GAFAM companies have proven to be able to manage such great amounts of data successfully, and for other market participants it might be challenging to match up.

(5) As stated in the background section, the healthcare market is quite fragmented. The health IT sector has some big incumbent players (e.g., Cerner, AllScripts), but thousands of specialized IT SP. Apart from that, we find a plethora of hospitals, clinics, physicians, payers, or specialized manufacturers, and service providers (i.e., complementing participants) in the healthcare market. Thus, the (digital transforming) healthcare market provides an atomistic competition on the demand and supply side, which in turn is a fruitful basis for platform activities. Our value network analysis reveals that GAFAM platforms have several tie points to the healthcare market, and they will find several new roles in the healthcare market to control (i.e., occupy or interconnect), which might result in new value creation structures. While the GAFAM platforms mainly focus on their core assets (i.e., capabilities and market power), they also put efforts into research and development to discover future health technologies timely.

(6) The literature review revealed that digital technologies and data will play a vital role in the future of healthcare. The value network analysis illustrates that data turns out to be a key element of the platforms' value exchange as GAFAM platforms mainly do not create value themselves but either intermediate or support others' value-creating activities with their data processing and technological platform capabilities. On the one hand, the combination and quality of these capabilities are hardly imitable. On the other hand, their capabilities are sufficiently generic to cover, support, or connect a plethora of digitally enabled services in the healthcare market. In effect, GAFAM platforms might play a relevant part as data becomes of increased economic relevance.

Recent discussions on tracking and tracing COVID-19 infection chains have unfolded how those six facilitators intertwine and pertain in practice. Governments have realized soon that they would need (6) digitally gathered data to trace contact chains. However, it was virtually impossible to develop a technological solution without (1+2) Apple's or Google's ubiquitous mobile ecosystems and (3+4) their data collection and processing capabilities. Thus, (2) their market power allowed them to decide about opening the Bluetooth API, making entire states dependent on their goodwill. Google and Apple promptly decided on a tracking concept, (5) while other publicly financed collaboration initiatives were still debating about whether or not centralizing the storage of data (e.g., PEPP-PT). Hence, GAFAM platforms enter a promising field in which they can successively play off their strengths despite the regulatory issues and seemingly established market structures.

Activities. Second, we identified and propose three main co-dependent activities that sufficiently explain why GAFAM platforms might be successful in healthcare. (1) Typical of platforms, they smoothly edge into existing value-exchange relationships and make transactions more convenient or efficient. As the platform-induced value network analysis indicates, this particularly applies to the traditional patient-physician relationship. For instance, platforms can help patients to find physicians or hospitals and facilitate digitally enabled healthcare services (e.g., digital health SP). However, other supporting and transactional relationships are also subject to new intermediation services (e.g., B2B and B2C marketplaces for drug and medical devices, health data exchange between healthcare SP and digital health SP). Thus, it is remarkable to what extent GAFAM platforms place themselves in-between to break existing structures and *untie conventional relationships*.

(2) The value network analysis of the platform-induced healthcare market indicates that GAFAM platforms pounce on the healthcare market from several corners with direct (e.g., consultation, information, treatment, decision-support) *and* indirect healthcare-related business activities (e.g., administration, infrastructure, commerce) to underpin their market dominance. Thus, they both screw in-between existing relationship structures (e.g., patient and healthcare SP) and assume supportive or infrastructural roles in the periphery (e.g., Cloud SP, Research SP, AI Support SP, Logistics SP). Therefore, GAFAM platforms are not limited to a specific market segment (e.g., health, ICT, retail) but cover a broad spectrum of segments to offer their products and services. This way, GAFAM platforms can ensure full-service by expanding horizontally (regardless of whether they offer the actually demanded service themselves or not).

(3) What is more, GAFAM platforms are no longer limited to create value by enabling transaction (in terms of intermediation) among market participants, but also by providing products and content themselves (e.g., advanced device provider) that go beyond their core services. For instance, Apple provides the Health App as an upscale (platform) service based on iOS and corresponding devices. At the same time, it offers Health Records to clinics, and development kits to researchers and developers. Thus, GAFAM platforms can provide full-service approaches by extending their service range and expanding vertically through ecosystems of products, services, and content.

Altogether, GAFAM platforms pursue a product- and market-oriented growth strategy: They bring their existing products to the healthcare market (e.g., Microsoft 365), develop new services and products for healthcare providers and patients (e.g., Amazon Comprehend Medical or Basic Care), or develop entirely new value deliveries for future market segments (e.g., Facebook CRTL-kit or Calico).

Effects. Third, we uncovered and propose three main effects that result from the digital-platform impact on the healthcare market. (1) The platform-induced value network analysis shows that GAFAM platforms are about to control customer (or patient) relationships in several ways: As a first contact point for patients, they can govern the relationship between patients and healthcare service providers.

Thus, they exploit their existing customer relations to untie conventional relationships in healthcare. Further governed relationships include and are not limited to: patient to patient, healthcare SP to healthcare SP, patient to manufacturers, healthcare SP to manufacturers, patient to digital health providers. Patients might hardly be able to avoid digital platforms when requesting digital (or digitally enabled) healthcare services. Likewise, other market participants might be dependent on digital platforms to reach the patient or access digital healthcare-related services. As a result, GAFAM platforms *monopolize the patient and customer ownership* and gather all possible data.

(2) What is more, GAFAM platforms might foster the *digitalization and platformization of healthcare services*. On the one hand, this implies the consumer-driven digital transformation in healthcare. GAFAM platforms do either provide digital health services themselves (e.g., Google Assistant and Fit) or platform access to remote digitalized services (e.g., Amazon Care, PillPack), as the value network analysis reveals. On the other hand, GAFAM platforms provide digital services and infrastructures for healthcare SP, and thus promote the digitalization and platformization from B2B. For instance, Microsoft provides an entire ecosystem of services that support clinical management (ehCOS EHR), IT management (Azure), collaboration (Windows, Teams, Surface), customer interaction (Healthcare Bot), and research and education (HoloLens).

(3) Our value network analysis demonstrates that GAFAM platforms also raise the complexity of healthcare value creation by fragmenting and modularizing the value creation processes. The increase of new roles within the platform-induced value network supports this assumption strongly. Thus, patients have a multitude of possibilities to access healthcare services and pass through digitally-enabled pathways. For one thing, this favors the development of new services. For another thing, conventional services can be offered and conducted in several ways. Likewise, healthcare SP is reliant on a proper ecosystem of ICT infrastructures, systems, and services to upheave healthcare into the digital era.

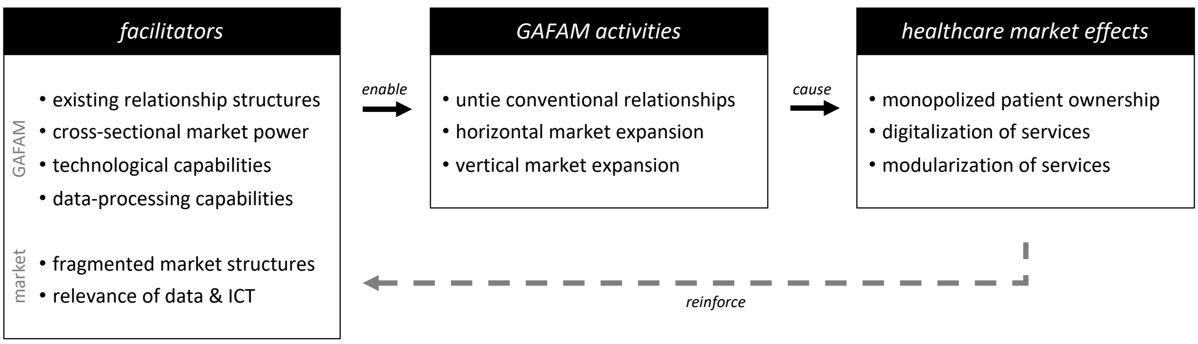


Figure III.2-8: Healthcare GAFAM-Impact Framework

Altogether, we propose that big digital platforms might exploit their capacities and assets as facilitators to expand their business activities manifold to healthcare, and leverage powerful effects to the market in terms of customer interaction, digitalization, and service modularization (see Figure III.2-8). What is more, these effects might even reinforce the facilitating factors through the exploitation of further network and homing effects. In particular, the monopolized consumer ownership supports the existing relationship structures and cross-sectional power of GAFAM platforms, if both patients and healthcare

SP might receive everything from one source or touchpoint. The gathered health-related data and new requirements in healthcare might strengthen the data-processing and technological capabilities of GAFAM platforms, which in turn might further increase the relevance of data and health IT. Plus, new platform market segments with modular services might further affect the market fragmentation with a multitude of specialized product service providers.

Our findings substantiate available research on digital platforms and digital transformation in healthcare and extend the current knowledge by connecting the tie points of both research avenues from a holistic standpoint. For one thing, our findings fit in seamlessly with existing observations and theories on the transformative impact of the platform economy on entire established markets and industries in view of their infrastructure and intermediation capabilities (Bakos et al. 2008; Parker et al. 2016; Hein et al. 2019). Particularly, GAFAM platforms have developed such capabilities that they can poly-directionally bring in to healthcare as our value network analysis illustrates. Hence, they might exploit their control over the consumer interface to tap new sources of data and revenue, and explore new opportunities for growth (which are rendered by current developments in healthcare).

For another thing, in reflection of the existent research on digital platforms in healthcare, our results confirm that GAFAM platforms could both solve and arouse different problems of the ongoing transformation in this sector. As central infrastructure providers and efficient intermediators, they help addressing the identified problems concerning interoperability, networking, and inter-sectoral communication (Estrin and Sim 2010; Fürstenau and Auschra 2016; Aanestad et al. 2019). Thus, GAFAM platforms could help innovating and coordinating the highly fragmented healthcare market (Fürstenau et al. 2019) but, on the contrary, they modularize the markets and attain control over critical digital resources (e.g., mOS, app stores, device interfaces) which might impede collaborative innovation. In so doing, they co-develop new market segments and value streams (Hermes et al. 2020c), but largely either at the expense of the healthcare providers or the patients (in monetary or privacy terms). The patients foster these developments themselves through the increasing usage of digital-health apps, which supports recent literature in this research domain (e.g., Gu and Hong 2019; Huang et al. 2018). However, as research on digital health has mainly concentrated on the potentials of digital platforms in advancing collaboration and healthcare per se, we extend this knowledge by providing some contrasting insights into the potential threats to value creation in the healthcare market through the poly-lateral integration of the GAFAM platforms.

What is more, our findings support the state of research and practice on digital transformation in healthcare and the part of big digital platforms in it. Digital technologies will diffuse the healthcare market, and GAFAM platforms possess the economic and technological power to help address infrastructural issues in terms of standards, interoperability, collaboration, orchestration, or datafication. The fragmented healthcare market might be particularly receptive to such platform technologies and services, and GAFAM platforms are increasingly shifting to B2B markets. What is more, digital transformation in healthcare is patient-driven to a great extent and our value network analysis undermines how GAFAM platforms control access to patient-related digital services and data.

Consequently, our results and inferences help to explain how GAFAM platforms might transform value creation in the healthcare market by not only introducing new roles in the value network but also by assuming formerly existing ones. This supports the assumption that GAFAM platforms probably will play an important part in the (digital) transformation of the healthcare market.

6 Conclusion

The starting point of our consideration was the notion of increasing digital-platform activities in healthcare, which already undergoes a massive (digital) transformation. But despite the vast extent of platform literature and the risen research interest in the field of digital health, available research provides little insight on how big digital platforms transform value creation in healthcare. Against this background, our paper aimed to explore the economic impact of the five most powerful and valuable platforms, namely Google, Apple, Facebook, Amazon, and Microsoft, on the healthcare market. For that purpose, we relied on value network analyses of the healthcare market to explore how GAFAM services and products induce new value-creating roles and mechanisms in healthcare. Hereupon, we examined the GAFAM-impact on healthcare by scrutinizing the facilitators, activities, and effects, which we condensed into a conceptual framework.

Our findings suggest that GAFAM platforms are about to affect value creation in healthcare in various ways as they edge into existing structures by not only enabling transaction and interaction but also providing content and products themselves. At this, they target several market segments from direct healthcare and digital health to peripheral activities such as logistics, retail, and R&D, which results in ubiquitous platform involvement in the entire healthcare market. Platforms control customer relationships and network structures from all sides – and right from the midst of the patient-physician relationship. The appearance of big digital platforms ascribes data a key part in future value propositions and value linkages. All combined, the digital platforms simultaneously centralize the customer relationship and modularize value creation in healthcare by introducing new roles to the value network. To leverage these effects, GAFAM platforms highly benefit from their cross-sectional market power, pervasiveness, and existing customer relationships and network structures in their core industries, which helps them to successively infuse the healthcare market. Additionally, the platforms reveal enormous data collection capacities (in both scope and variety) they can combine with high-end data processing and analytics, which is advantageous in this highly fragmented healthcare market.

Taken as a whole, GAFAM platforms might affect value creation in healthcare severely and bear the potential to transform at least parts of the market. Patients are facing a multitude of new services and channels to manage their health condition, and new ways of patient interaction might stimulate the occurrence of new business models. At the same time, healthcare service providers increasingly become dependent on platforms in terms of their value creation, value proposition, and patient interaction. Consequently, shifts in the balance of powers within the value network and changing customer behaviors will lead to new constellations of customer relationship.

As a contribution to research, we connect and extend current knowledge about digital platforms and digital transformation in healthcare by providing a new holistic perspective on how big digital platforms might transform value-creation structures in this market. Particularly, we explain how GAFAM platforms contribute to this transformation by exploiting their cross-sectional and technological capacities. Thus, we provide a new standpoint when assessing the potentials and threats of digital platforms in approaching the challenges of digital health. Furthermore, we add new insights into the transformative impact of big digital platforms on conventional, service-oriented markets and confirm research findings from other industries. Our reference models might be employed for further analyses to either explore new business models for and beyond platforms in healthcare or to examine the platform-induced socio-economic impact on traditional healthcare structures (e.g., patient-physician relationship). Thus, our contribution adds another puzzle piece in understanding the complex coherences among economy, society, and technology of platform-induced shifts in entire markets. As a contribution to practice, we might sensitize managers and policymakers in healthcare about the increasing and ubiquitous influence of platforms on their domain, and emphasize the importance of collaboration and shared standards. Hence, practitioners could employ the reference models to assess platform-related threats and opportunities or redesign their business models and tap new (data-driven) revenue sources.

Our study has several limitations. First, the scope of our study is limited to GAFAM platforms. Thus, our findings and inferences might not be fully applicable to other digital platforms, be it smaller platforms in the Western economy or big digital platforms of the Asian economic area (e.g., Tencent, Alibaba). Second, our qualitative research design, including the value network development and analysis, is reliant upon the subjective selection, coding, and interpretation of the authors. In awareness of this limitation, our findings build upon reliable research sources and practical evidence. Plus, we validated our findings with both industry and academic experts. Third, we have not investigated how incumbent players, both healthcare and technology providers, should strategically respond to the digital transformation in general and the emergence of GAFAM platforms in particular. Forth and most importantly, we acknowledge the willful neglect of the regulatory body for reasons of generalizability, which entails barriers for both GAFAM platforms and incumbent players in healthcare.

We see three avenues for future research. First, it could further elaborate on the potential implications of *GAFAM platforms in healthcare*. In particular, we should investigate the role of data and personalized services to formulate platform strategies for incumbent players in healthcare. At this, we could rely on available findings or long-term studies from other industries. Likewise, we should factor in regulation and liability in healthcare, which might provide insights for platform regulation in other industries. Second, future research could explore the impact of digital platforms *beyond GAFAM in healthcare* since the emergence of digital technologies might leverage further dynamics within the conventional value creation structures. This applies to a more technological standpoint on how digital platforms might effectively contribute to the digital transformation in healthcare. Third and more holistically, future research could explore the socio-economic impact of *GAFAM platforms beyond healthcare*. After all, it is remarkable how GAFAM platforms have infused entire industries, and how they might honeycomb the healthcare market almost unnoticed and from different tie points. Possibly, big digital platforms might turn from market participants to market owners. This again gives reason to expect equally severe economic shifts in value creation structures of other conventional markets, which could be substantiated with econometric models.

III.3 Identifying the Patterns: A Systematic Approach to Digital Platform Regulation

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Abstract: *Digital platforms have proven to be efficient matchmakers in our networked economy and society. However, their tremendous potential has two sides, and concerns about their malpractices and negative impact have risen remarkably in the past years. In light of the practical relevance, interdisciplinary research on digital platform regulation (DPR) has gathered speed only recently. Although IS research considerably theorized on the nature and mechanisms of digital platforms and thus could contribute to understanding and explaining the problems at the confluence of society–economy–technology, the discipline has barely grazed the issue of DPR. Particularly, there is no contribution that at least explores the causal problems systematically and comprehensively. Against this background, we aim to draw on empirical evidence, interdisciplinary DPR research, and IS knowledge to conceptualize and understand the problems with digital platforms in order to derive regulatory options. At this, we analyze 128 cases of platform-induced problems and 83 historical regulation cases in due consideration of platform and regulation theory. The outcome of this paper is twofold: First, we provide a conceptual classification of digital platform problems. Second, we derive regulatory options and develop a taxonomy of digital platform regulation. Our findings show that digital platforms capitalize on both platform- and monopoly-related problems to assert themselves in different markets. This way, they even have become serious challengers to the regulator in governing markets through controlling market access, key conditions and resources. At this, they rely on the efficient use of data and digital technologies to govern participants and their transactions.*

1 Introduction

Digital platforms have proven to be successful and powerful players in our networked and digitalized economy and society. In recent years, they have radically changed our work, private and social lives. Digital platforms enable users to find and get what they (believe to) need. At the same time, they offer companies and governments an exclusive, carefully targeted access point to customers and citizens, acting as a gatekeeper (Pousttchi and Hufenbach 2013). At this, they affect the three dimensions value creation, value proposition, and customer interaction (Pousttchi and Gleiss 2019; Gleiss et al. 2021).

Particularly Google, Apple, Facebook, Amazon, and Microsoft (GAFAM) – as the most successful platforms and most valuable companies in the world (van der Aalst et al. 2019) – build upon consumer data from their personalized services and products. On the one hand, this makes them perfect matchmakers among the most diverse user groups. On the other hand, it implies enormous economic, political, and societal power, which does not only challenge the authority of national states but also entails unprecedented dependencies. Recent events included European efforts to monitor COVID-19 infection chains (Vincent 2020) proving to be impossible without Apple's and Google's cooperation (and resulting in ad-hoc integration of full and uncontrolled user contact tracing into their smartphone operating systems) or Donald Trump's suspension on Twitter (Sparrow 2021).

Consequently, public concerns and debates about power and influence of digital platforms have risen, and governments around the world attempt to catch up on their neglects in the past decade to curb platform dominance, including the EU, UK, Russia, Australia, as well as the US on a national and state level (Nylen 2020). However, given the dynamics of digital and networked markets, we require comprehensive and sustainable regulatory approaches that successfully address the concerns with digital platforms on the one hand, and maintain their matchmaking efficiency on the other hand.

The interdisciplinary landscape provides a bouquet of practical and scientific pieces that address digital platform regulation (DPR). Despite the increasing relevance of DPR, there is no contribution that explores the underlying problems with digital platforms systematically and comprehensively. Especially, the IS research community has humbly effaced itself so far from the academic discourse on DPR (Gozman et al. 2020), which is noteworthy and surprising for three reasons: First, information technology and systems (IT/IS), including users, data, and digital technologies, have played a great part in contributing to the growth of digital platforms (Zuboff 2015). Second, IS research has yet put much effort into understanding the very nature of digital platforms from a technical, socio-technical and market-oriented standpoint (Abdelkafi et al. 2019; de Reuver et al. 2018; Tilson et al. 2012). Third, the realm of IS at the confluence of society–economy–technology has all the makings to valuably contribute to describing, explaining, and designing DPR.

In this regard, we aim to draw on empirical evidence, interdisciplinary DPR research, and IS knowledge to explore and understand the problems with digital platforms in order to systematically derive regulatory options. Concretely, we seek answers to the following research question: *How can we classify negative impact patterns of digital platforms and relate them to appropriate regulatory measures?* In response, we pursue a qualitative, exploratory three-step approach: First, we rely on empirical cases, available literature, and publicly available documents to research and conceptualize problems and impact connected with digital platforms, resulting into a classification of digital platform, which we synchronize with regulation and platform theories. Second, we refer to historical regulation cases and practical DPR proposals and measures to derive appropriate regulatory options. Third, we draw on design science to develop a taxonomy of DPR based on our findings.

The remainder of the paper is structured as follows: In Section 2, we present the interdisciplinary foundations of DPR and describe our methodical approach. In Section 3, we systematically explore and classify problems related to digital platforms. In Section 4, we systematize the impact and indicate regulatory options to the identified problems. In Section 5, we conclude with implications, limitations, and future research avenues.

2 Background

2.1 Digital Platform Theory

Baldwin and Woodard (2008) define a platform as a modularized architecture that governs the interactions of its components and participants. Basically, there are three building blocks of digital platforms and their ecosystems: *platform owners* and their degree of power centralization, *platform complementors* with their contributions and autonomy, and *platform value-creating mechanisms* for facilitating transactions and innovation (Hein et al. 2019).

Successful platforms are reliant on (efficiently governing) the complementary actors (Parker and Van Alstyne 2008). At best, they are efficient matchmakers that provide and govern infrastructures for *direct interaction* (i.e., transaction or collaborative innovation) among complementary user groups (Caillaud and Jullien 2003; Hein et al. 2019; Rochet and Tirole 2003). Thus, platforms control the transactions' key terms (e.g., pricing of goods, or program language) and govern the mechanisms among the user groups which are *affiliated with the platform* (e.g., fees, registrations) to engage in the interaction (Hagiu and Wright 2015).

However, increased interaction and affiliation entail usage and membership externalities (Evans and Schmalensee 2008; Rochet and Tirole 2004) of two kinds: First, *network effects*, which arise from perfectly bringing together similar or complementary user groups (Parker and van Alstyne 2005; Rochet and Tirole 2003). Hence, a platform's usefulness (and therefore value) is subject to the size and fitness of complementary participants (Eisenmann et al. 2006; Shapiro and Varian 1998). Second, *homing and switching costs* incur for participants due to their affiliation, i.e., users are bound to the platform (Armstrong 2006; Evans et al. 2006; Kwon et al. 2017).

Altogether, platform markets are different from traditional pipeline business, which increases competition complexity and leads to new competition paradigms in four ways (Parker et al. 2016, pp. 60 and 204 et seqq.). First, platforms compete with pipeline companies on their markets. However, as goods or contents on platform are mainly provided by complementors, bound resources are outsourced while variety increases. Second, platforms might compete with their complementors by offering similar value propositions or capturing the value (e.g., data). Third, complementors compete against each other on platform markets. Forth, in view of network effects and switching costs, platforms compete against each other on winner-takes-all markets.

2.2 DPR in Research

Although IS research provides theories to explain the technological artifacts, governance mechanisms, and economic implications of digital platforms, digital platform regulation (DPR) remains a blind spot. Some contributions focus on *negative effects* of platform governance and activities, such as high market dominance, anti-competitive behavior, or harm to competitors, complementors, and users (Clarke 2020; Clemons and Madhani 2010; Foerderer et al. 2018), illegal or immoral platform behavior (e.g., Zhang et al. 2017), and concerns about data privacy, ownership, or portability (Blaseg et al. 2020; Fadler and Legner 2020; Korunovska et al. 2020).

However, only few IS contributions actually put emphasis on the regulatory dimension. Those that do provide evidence that governmental regulation can diminish the *platform dominance* to reorganize relationships between platforms and their users (e.g., Bazarhanova 2020; Zuboff 2015) or affect *negative externalities and innovation* (e.g., Han 2020; Tripathi and Kyriakou 2020; Wu and Geylani 2020; Yu et al. 2020). Hermes et al. (2020a) have explored platform ecosystem growth in both the USA and China to derive three regulatory *strategies* for similar systems in the EU, including more financial support, new regulatory approaches, and intense European cooperation. Governments have to find ways between *over- and under-regulation* to maintain the efficiency of digital platforms (Zhang et al. 2018) and factor in measures for *user sensitization* (Baccarella et al. 2020). Altogether, IS research has theorized on digital-platform issues, but holistic and interdisciplinary regulatory approaches that build upon the underlying problems caused by digital platforms are still missing.

Beyond IS research, other disciplines have already tackled the issues of DPR to a broad extent alongside the three relationship dimensions of digital platforms and the economy, the consumers, and the state as the regulatory body (Figure III.3-1).

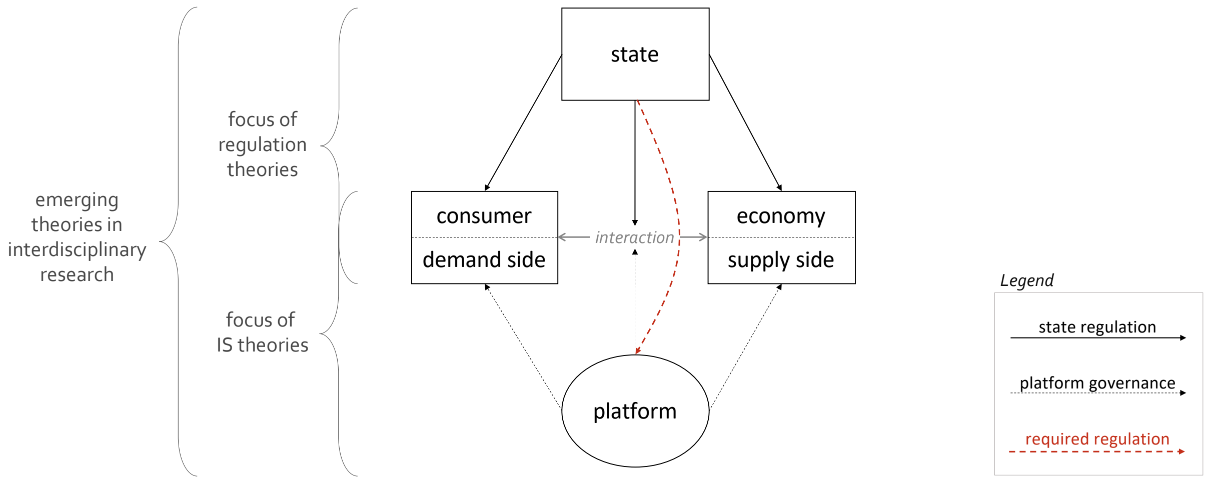

Figure III.3-1: Relationship Dimensions of Platforms, Users, and the State

Concerning the *platform-economy* relationship, available literature spotlights the problems occurring from novel platform markets that undermine basic competition principles beyond the regulators' spheres of influence. This involves antitrust constellations in the digital economy (Melamed and Petit 2019; Orbach 2014) or the definition of relevant markets (Peitz 2020; Prat and Valletti 2019). Especially, the formation of monopolies has been object of many studies, e.g., Didi Chuxing and the taxi market in China (Xing and Sharif 2020). Other contributions particularly focus on GAFAM platforms in view of antitrust issues and emphasized the market dominance of Google and Facebook in online advertisement (Srinivasan 2019a; Srinivasan 2019b), or monopolies and critical digital infrastructures of Microsoft, Amazon, and Apple (Economides 2001; Khan 2017; Kotapati et al. 2020). Plus, several contributions examine negative implications of mergers and acquisitions (M&A) by large digital platforms that impede the diffusion of innovation and growth of potentially disruptive competitors (e.g., Bryan and Hovenkamp 2020; Katz 2021; Kokkoris and Valletti 2020; Kwon and Marco 2021).

Concerning the *platform-consumer* relationship, literature on DPR mainly discusses the role of platform governance (Perrons 2009) and behavioral economics. i.e., user's contradictory attitudes and behavior towards data privacy (Reyna 2018), or their willingness to pay for free-to-use platform services (Sunstein 2020), and how this affects competition and regulation in digital markets (Luguri and Strahilevitz 2019; Utz et al. 2019).

In view of the *platform-state* relationship, DPR research discusses the governing role of digital platforms as an emerging counterpart to state governance and regulation (Cammaerts and Mansell 2020; Frenken et al. 2019; van Dijck 2020) that refers, for instance, to content moderation and shaping of public opinion (De Gregorio 2020; Napoli 2015). In this context, the political theory of the firm proposes that digital platforms tend to accumulate state(-like) capabilities, and influence political, economic, and societal developments through their enormous financial and technological resources. Thus, the concentration of power through a handful of private firms might help them enforcing their interests, rules, and standards, which is why new regulatory perspectives are required (Zingales 2017). Other contributions theorize on how regulators should frame and assess competition and innovation making within and among platform(-impacted) markets in a digital age, including the role of data (e.g., Blind et al. 2017; Giuliani 2018; Haucap and Heimeshoff 2014; Krämer and Wohlfarth 2018).

Upon these reflections, interdisciplinary research analyzes concrete DPR measures and proposals (Batikas et al. 2019; Gal and Aviv 2020; van de Waerdt 2020; Rösner et al. 2020). Those include rather soft measures like fiscal assessment of platform input factors such as data (Ben-Shahar 2017), labor (Rogers 2016) or public infrastructures (Rahman 2018); regulation of algorithms (Di Porto and Zuppetta 2020) and prices (Loertscher and Marx 2020); or enforcement of platform interoperability (De Hert et al. 2018) and neutrality (Krämer and Schnurr 2018). According to Borrás and Edler (2020), the state can approach novel ecosystems differently (e.g., observing, enabling, gatekeeping, moderating). However, radical measures are also suggested, such as disclosure of algorithms (Gal and Petit 2021) or the segregation of digital infrastructures and downstream services (Khan 2019).

After all, several research contributions from multiple disciplines signpost regulatory problems with digital platform markets, and provide food for thought about DPR. They indicate that digital platforms cause problems for economy and society and that governments increasingly experience difficulties in regulating these players (Nemitz and Pfeffer 2020; Staab 2019). However, comprehensive approaches that systematize the problem patterns are still missing. Particularly, IS research has not embedded its knowledge of digital platforms into the academic discourse on DPR. Therefore, new perspectives on DPR are required (Nooren et al. 2018) that factor in the interdisciplinary complexity of digital platform markets and digital technologies (Nambisan et al. 2020; Schwarz 2017).

2.3 DPR in Practice

By their very nature, practical papers and reports reflect the tension between the priorities of public and private interests. Amidst these publications, we identified three major areas of regulatory action. First and most recently, many publications address *competition and antitrust* in digital markets and the impact on the economy at large. Such analyses guide governmental DPR and spotlight potential implications of digital platforms for economy and society. The main issues include the definition and assessment of markets, data value and sharing, interoperability, taxation, and monopoly structures (Lancieri and Sakowski 2020).

Second, many publications discuss problems and approaches of *social media* regulation, which zeroes in on content regulation and consumer protection (e.g., through upload filters) and tackles issues of copyrights, disinformation and fake news, social harms, polarization, or terrorism (e.g., APC 2018; Balkin 2020; UK Government 2020). Third, several publications specifically address the challenges of regulating the *sharing economy*. Critical issues in this area relate to labor and contracting, liabilities of users, safety and insurance, industry standards and legislation, and negative externalities to consumers, providers, and affected third parties (Dervojeda et al. 2013; Munkøe 2017; Zuluaga 2016). At this, recent discussions entail more structural solutions as, for instance, regulatory oversight by authorized agencies (Marsden and Podszun 2020; Wheeler et al. 2020).

Some regulators have recently addressed DPR. In the U.S., the Committee of the Judiciary initiated investigations to examine the dominance and malpractices of Google, Apple, Facebook, and Amazon. The recently published majority report recommends legislative action to strengthen antitrust and competition laws (Nadler and Cicilline 2020). Meanwhile, the EU approached issues of data privacy (General Data Protection Regulation: GDPR), copyright infringements (Directive on Copyright in the Digital Single Market), distribution of illegal content (Digital Services Act: DSA), and competition in digital markets (Digital Markets Act: DMA). Also, the Australian government developed a roadmap to strengthen the position of media over Google (ACCC 2020). However, criticism has been voiced that such interventions are isolated and draw on vague definitions and imperfect understandings of platform markets. Thus, cannot address the core of the problems comprehensively (Broadbent 2020; Caffarra and Scott Morton 2021; Graves 2020).

2.4 Applicable Rationales of Regulation Theory

In understanding and explaining regulatory deficiencies with platform markets, we basically underpin our research with applicable rationales from regulation theory. Basically, we draw on interest-based rationales. Here, *public-interest* theory assumes that monopolies and externalities can cause market failures in open markets, while governments are willing and capable to correct these failures – in pursuit of the public interest – through regulation (Baldwin et al. 2012, p. 15; Shleifer 2015). As markets with platform participation exhibit problems and imperfections that call for an external corrective, public interest theories provides rationales that might explain different kinds of market failure (Table III.3-1).

At times, public interest is hardly obtainable. In some of these cases, regulatory failure might be explained by *private-interest theory* that assumes that actors are selfish and interested in maximizing their own benefits. As a result, regulation is seen as processes characterized by collective action problems that drown out diffuse interests (Baldwin et al. 2012, pp. 43 et seqq.). In other cases, regulatory failure might be explained by *ideas-based rationales*, which propose that regulators make false assumptions about underlying cause–effect relationships, or *institutional rationales*, which assume flaws in the (inter-)institutional structures, arrangements, and processes (Baldwin et al. 2012, pp. 77).

Table III.3-1: Traditional Market Failure Rationales (adapted from Baldwin et al. 2012)

Market Failure	Description	Regulation
Monopolies	One company supplies an entire market	Prohibitive
Windfall profits	Significantly cheap access to a valuable resources for one actor	Prohibitive
Externalities	A good's price does not reflect the true costs of production/consumption	Prohibitive
Information inadequacies	Sellers have information advantages over consumers	Prohibitive
Anti-competitive behavior	Unhealthy competition through illegal or irrational company behavior	Prohibitive
Moral hazard	Disproportionate consumption of public goods and infrastructures	Prohibitive
Unequal bargaining power	Abuse of a negotiating party's plight	Prohibitive
Goods unavailability	Unequalled socially desired levels of continuity and availability of goods	Facilitative
Scarcity and rationing	Necessary regulatory allocation of goods in short supply	Facilitative
Inefficient coordination	Necessary centralized regulation of inefficient transaction	Facilitative

2.5 Methodical Approach

Based on these theoretical underpinnings, we applied a mixed-methods research approach (Given 2008, p. 528) to purposefully address our research question by conducting three steps (see Figure III.3-2).

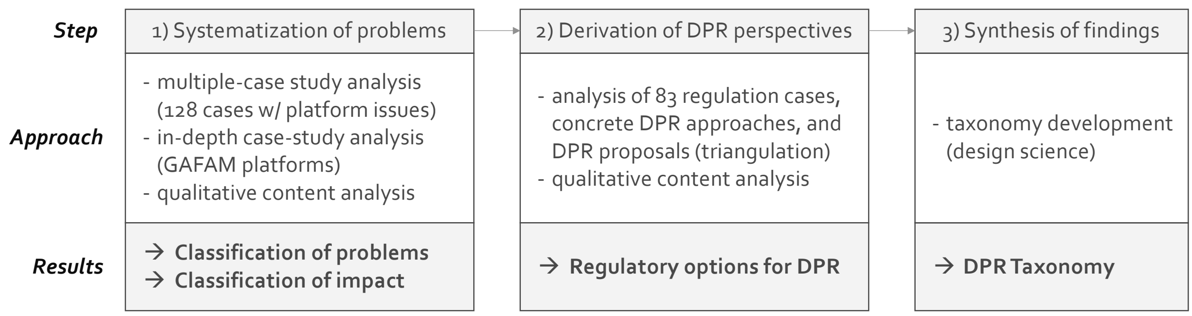

Figure III.3-2: Research Design (Digital Platform Regulation)

Systematization of digital platform problems. First, we aimed to explore and conceptualize the problems with digital problems from empirical data to attain a comprehensive picture. We conducted a multiple-case study analysis as proposed by Eisenhardt (1989). We examined 128 cases where digital platforms raised legal or ethical issues (i.e., they either acted illegally or were accused to do so by public authorities or specific interest groups). Here, we rely on the rich amount of publicly available online sources, such as newspaper articles, policy reports, and some academic papers that have examined and discussed concrete cases with platform-induced problems. Such documents are appropriate to investigate cases of public interest and help to retrieve a broad coverage through a diverse and clearly defined sample selection with a deliberate degree of heterogeneity of problems, segments, and affected stakeholders (Yin 2009, p. 101). For each case, we analyzed at least two different sources for reasons of corroboration. In order to classify platform-typical problems for economy and society, we pursued a group characteristics sampling strategy (Patton 2015, p. 428) until theoretical saturation, i.e., adding more cases would not yield further constructs.

We applied a qualitative content analysis to identify the actual problems caused by digital platforms from a regulatory perspective. The qualitative content analysis is particularly suitable to explore the underlying and causal relationships of social and economic phenomena. While this method is interpretive, it is useful for extracting both conscious and unconscious messages within documents (Rothbauer 2008). To increase reliability and objectivity, two independent coders developed the categories separately, and coding deviations were extensively discussed within the research group until consensus. First, we conducted a within-case analysis to inductively develop and categorize problem types ("What is the problem?"), underlying problem causes ("Why did the problem occur?"), impact ("Who was affected and how?"), and the role of IT/IS ("How did IT/IS provoke or amplify the problem?"). Second, we conducted a cross-pattern analysis and several replications to calibrate and consolidate our constructs (Eisenhardt 1989). In proceeding with the conceptualization of the problems and the impact, we put special emphasis on analyzing the role of IS in provoking or increasing regulatory issues. This step led to an initial classification of platform- and monopoly-related problem classes, which we collated with well-known market and regulatory failure rationales in theory (Baldwin et al. 2012, pp. 16 et seqq., pp. 72 et seqq.). Altogether, we identified 50 problem types (cf. case overview in the appendix) that result from 17 problem causes within 6 problem classes.

To corroborate the differences among certain problem classes, and to theorize on potential dependencies, we extended our analysis by a causal-pathway case-sampling (Gerring 2007, p. 5). At this, we first analyzed the business models of the 15 largest (Western) digital companies by market capitalization (as of November 2020) for the problems to find that these particularly apply to the five largest digital platforms (i.e., GAFAM). Thus, we proceeded with an in-depth analysis of the GAFAM platforms from a regulatory perspective to understand the growth history, the actual market power scope of GAFAM platforms, and the regulatory problems in greater detail. Here, we first analyzed their business portfolios including their M&As from business reports. Then, we reviewed both the majority and minority staff report on the investigations of competition in digital markets that comprise a synthesis of 1,287,997 documents and communications, testimonies from 38 witnesses, hearing records that span more than 1,800 pages, 38 submissions from 60 antitrust experts from across the political spectrum, and interviews with more than 240 market participants, former employees of the investigated platforms, and other individuals totaling thousands of hours. As Microsoft was not part of this investigation, we refer to other reports for this company. Based on these insights, we refined our constructs and developed a classification of digital platform problems and classified the impact of these problems. In a final step, we reflected on the available academic literature to compare our constructs with conflicting and similar knowledge to substantiate and refine our classification scheme (Eisenhardt 1989).

Derivation of DPR perspectives. After having conceptualized the problems and their impact, we aimed to provide new perspectives for DPR. Here, we again conducted a qualitative content analysis to identify potentially suitable regulatory options. This time, we refer to the triangulation of three different data sources to maximize and substantiate the grounding for potential regulatory options, i.e., 83 historical cases of intensified governmental regulation, 16 policy and expert papers that plan partial solutions for platform-specific problems, and current international regulatory approaches and objectives (particularly, EU, USA, UK, and Australia). We chose to draw evidence from multiple different data sources to increase credibility and maximize the number of potentially suitable approaches through different insights (Rothbauer 2008).

Synthesis of findings. Upon this basis, we develop a DPR taxonomy DPR from a public-interest viewpoint, i.e., in pursuit of public interest-related objectives (Baldwin et al. 2012, p. 40). At this, we rely on the paradigms of design science research (DSR). Generally, DSR focuses on the creation and utility of artifacts (constructs, models, methods, or instances) to solve identified problems in specified environments, i.e., the artifacts shall change the occurring phenomena (Hevner et al. 2004). We follow the principles of explanatory DSR to employ the conceptual problem classes and impact as a profound conceptual basis for outlining probable regulatory options (Baskerville and Pries-Heje 2010). Building upon causal foundations enhances the design theory, and thus the scientific explanation of its inherent mechanisms (Hovorka and Gregor 2010). Hence, our design theory contains an explanatory nature (i.e., "why and what to regulate") closely connected to the identified and conceptualized problems with digital platforms for specifying general requirements for DPR through a static taxonomy of problems and regulatory options. We evaluated the functionality of the taxonomy through the hypothetical application of the cases, and refined the taxonomy accordingly (Hevner et al. 2004).

3 Systemizing the Problems with Digital Platforms

3.1 Classification of Problems

First, we explored the underlying problems induced by digital platforms through a multiple-case study analysis following the guidelines from Eisenhardt (1989) as described in the methods section. Our analysis revealed that we need to distinguish two basic problem-class dimensions: *(1) platform-related problems* that arise from imperfect behaviors and interactions among the platform, the regulator, and the users, and thus enable platforms to play off their strengths or exploit external deficiencies; *(2) monopoly-related problems* that arise from the increased market power of digital platforms in their core markets and beyond, and foster further anti-competitive platform behavior (Table III.3-2).

Table III.3-2: Overview of Conceptual Problem Class Dimensions

	Problem Class	Description
Platform-related	Regulator behavior	Deficiencies of the regulatory system that digital platforms have exploited to enforce their interests
	Platform behavior	Any conduction of purportedly undue activities by the platforms themselves
	User behavior	Any user activity that strengthens the platform's position over the regulator, its competitors, or the users
Monopoly-related	Core-market monopoly	Significant market domination in the platforms' primarily affiliated markets
	Cross-market monopoly	Additional gatekeeper positions in other markets (or market segments) beyond the platform's core market
	User-base monopoly	Gatekeeper positions towards the end-user bases that spreads above markets

3.2 Platform-related Problems

Many problems within the analyzed cases arise from platform-related problems, which means problems stem either from the exploitation of deficient regulator behavior, undue platform behavior, or unmindful user behavior.

Regulator behavior comprises all deficiencies of the regulatory system that digital platforms exploit to enforce their interests (e.g., growth, popularity, cost savings). Here, we identified and categorized three different problem causes (Table III.3-3).

Table III.3-3: Problems through Regulator Behavior

Problem Cause	Typical Resulting Problems	Failure	Case Ex.
Weak cross-border cooperation	localization of value creation; cross-border tax inspection and transparency; competition among governments	regulatory {collective action; inter-institutional structures; false assumptions}; market {information inadequacies; anti-competitive behavior}	# 4,7, 9,12
Legal loopholes	taxation of data collection; valuation of data pools; precarious working conditions		# 2, 10,97
Ineffective law enforcement	slow inspection by authorities; data privacy violations; youth protection violations; mild penalties		# 55,120, 122,128

First, as big platforms operate globally, *weak cross-border cooperation* often impedes transnational regulation. Hence, platforms may enjoy de-facto immunity from national processes – or are regulated by their country of origin in a way that de-facto protects their international operations. Instead of addressing platform-related problems jointly, countries sometimes even compete for platforms ideal to settle down, including shelter from other countries' prosecution. Thus, we identified a lack of joint applicable laws or agreements among countries to regulate or prosecute platform-induced problems or violations. For instance, this implies the taxation of locally generated user data (Grindberg 2020), willingness-to-cooperate by international law enforcement agencies (Greive and Riedel 2019), or the impact of American laws and norms on private governance (e.g., content moderation) of globally acting digital platforms (Bloch-Wehba 2019). The spatial and temporal ubiquity of IS helps platforms to easily offer their services globally (Pousttchi 2017) and our cases show how this hampers cross-national collaboration among regulators (OECD 2018). Thus, DPR is a global geopolitical issue (Finck 2017; van Dijck 2020). Private-interest theories may explain weak cross-border cooperation as a result of inter-institutional problems of collective action (Baldwin et al. 2012, p. 77).

Second, platforms do also benefit from regulatory deficiency on a national level when *exploiting legal loopholes.* As their business differs from traditional value creation, factual or putative breaches of rules or ethics remain uncovered by the regulatory systems. Thus, they may disregard legal requirements that apply to traditional market actors. For instance, §88 of the German telecommunications act obliges network providers to secrecy of communications (i.e., content *and* metadata of telephone calls or SMS), while the law leaves out internet-based instant messenger services like WhatsApp. This is a competitive advantage for Facebook over network providers, while at the same time, Facebook exploits their telecommunication infrastructures. Hence, legal systems fail to cover anti-competitive behavior, which either (a) *could* be illegal following a different legal interpretation (e.g., Uber is officially a chauffeur service in Germany), (b) *would* be illegal in another context or industry (e.g., Facebook disregards the journalistic due diligence of the content), or (c) *should* be illegal according to other market participants' views (e.g., hotel owners complain about Airbnb practices; Amazon uses seller data to optimize its product portfolio). From a market view, the case analysis shows that platforms benefit from ambiguous definitions of the relevant market (Russo and Stasi 2016). In interdisciplinary research, the assignment and definition of digital markets (Peitz 2020; Prat and Valetti 2019), the inapplicability of existing legal systems (e.g., Rogers 2016), and extensive lobbying (Haenschen and Wolf 2019) have also been issued. From an IS view, the novelty, velocity, complexity and mutability of digital and data-based infrastructures, markets, networks, and processes might at least complicate the work of the legislative body in the definition of regulatory frameworks (Constantinides et al. 2018; Lee et al. 2021). In regulation theory, such loopholes might be explained by blackspots in regulatory systems due to false assumptions about market mechanisms or the regulatees' practices (Baldwin et al. 2012, p. 77).

Third, the same applies to platforms that benefit from *ineffective law enforcement*. Here, we need to distinguish two different variants: (1) In some cases, regulatory systems exist, but platforms can break them without being prosecuted. This happens if governmental authorities either do not comprehend potential violations or simply run out of capacities to pursue all violations in strong terms. For instance, German Airbnb hosts are – just like hotels – legally liable to install smoke detectors in their flats which can hardly be monitored by state authorities. Moreover, some cities require legal permission to offer flats on short-term rental platforms like Airbnb (e.g., Paris, Barcelona) or ban such practices at all (e.g., Singapore). Although all flats are visible and accessible online, actual bookings are not, which results in information asymmetries in favor of the platforms. In combination with the mere number of platform entries, state authorities are not capable to cope with a consequent prosecution. Consequently, IT/IS play an important role in causing and addressing the problems (Avital et al. 2015; Clarke 2020; Gozman et al. 2020). (2) In other cases, regulatory measures are applicable and effectuated. Financial penalties, however, are insignificantly low to sustainably obtain disciplinary effects or set warning examples. Thus, platforms benefit from the ineffectiveness of fines for violations. For instance, Facebook earned much profit in 2019 despite a $5bn fine for the Cambridge Analytica scandal. The ineffectiveness of regulatory structures and measures has also been issued in literature (van Dijck 2020) or theory, i.e., imperfect institutional structures and arrangements (Baldwin et al. 2012, p. 77).

Platform behavior entails any conduction of purportedly undue activities by the platforms themselves. Here, we identified and categorized three different problem causes: information asymmetries, network and lock-in effects, and platform governance (Table III.3-4)

Table III.3-4: Problems through Platform Behavior

Problem Cause	Typical Resulting Problems	Failure	Case Ex.
Information asymmetries	third-party access to platform data; bargaining power over complementors; opacity about platform decisions	regulatory {false assumptions}; market {anti-competitive behavior; externalities; information inadequacies; coordination; rationing}	# 84,105
Network + Lock-in effects	transfer of social costs and risks to platform users; reinforcement of polarization tendencies		# 89,100
Platform governance	undue preference of specific content or goods; prevention of complementors' participation and interests		# 61,93

First, platforms benefit from *information asymmetries*. Especially, non-transparency of platform governance is an important issue (Perscheid et al. 2020), not only affecting different user groups but also impeding regulatory authorities as our cases reveal (taxation or consumer protection). Digitalization can complicate the information asymmetry problem (Ghose 2009) and platforms can exploit this for anti-competitive behavior against other parties (Zhu and Liu 2018). It is not entirely graspable to what extent data is collected, proceeded, or even sold without the users being aware of it. Particularly, Apple and Google have created powerful ecosystems by collecting and processing a plethora of user data with their smartphone operating systems (Zuboff 2015) and recent investigations have shown that "Google used the Android operating system to closely track usage trends and growth patterns of third-party apps" (Nadler and Cicilline 2020, p. 378). Plus, platforms do not conventionally conduct value creation but support it through intermediation, making their share in value creation and capture hardly quantifiable (Hein et al. 2019; Parker et al. 2016, pp. 106 et seqq.). According to regulation theory, the exploitation of information asymmetries to achieve competitive advantage can result in market failure. Both our cases and interdisciplinary research indicate that platforms employed IT/IS to obfuscate their activities and processes for users, complementors, and the state (e.g., Dolata 2017; Nooren et al. 2018).

Second, platforms exploit *network and lock-in effects*. If the platforms prove to be efficient matchmakers and early gain critical masses of users at all participant sides, they create network effects and thus become useful for their users. This, in turn, attracts more users to affiliate with the platform. At a certain point, it might become not worthwhile for users to leave this platform, and lock-in effects occur. These phenomena and effects are extensively conceptualized in IS literature (Maicas et al. 2009; Parker and van Alstyne 2005; Song et al. 2018). Research refers to the notion of "tipping points" when lock-in effects lead to a monopoly position over its rivals (Katz and Shapiro 1994), and thus to market failure (Liebowitz and Margolis 1995). Digital platforms leverage these effects through the design of their services and the implementation of dark patterns or gamification elements to knowingly confuse their users, making them addictive and dependent and causing externalities (Luguri and Strahilevitz 2019). For instance, Uber exploits such psychological manipulation techniques to make their drivers working longer and harder (Scheiber 2017), while on the reverse, digital platforms make the consumer side home to their services (MacGuineas 2020). Particularly, GAFAM platforms exploit these effects to the extreme, making multi-homing unattractive for their users through a plethora of services (Hill 2020), which allows for anti-competitive behavior. Apple provides a bunch of pre-installed apps on iOS (Nadler and Cicilline 2020, p. 352), and Google introduced a new widget for Meet inside Gmail when Zoom entered the market (Bergen 2020) to leverage such homing effects. Consequently, the platforms' use of IT/IS has highly impacted the regulatory relevance of this problem cause.

Third, problems result from the fact that digital platforms imperiously *govern* the markets they provide. At this, the purposeful employment of data and technologies is critical for successful platform governance (Gorwa et al. 2020) to orchestrate the users' and complementors' interactions, define sets of rules (e.g., codes of conduct), monitor their compliance, and enforce penalties in the case of violations (i.e., coordination and rationing). In a weak form, this may entail auto-play functions at YouTube and thus, the decision on what the users watch next (MacGuineas 2020). More severely, Apple autonomously decides about the conditions for access and payment to the AppStore, which results in a disadvantage for complementors competing with Apple's services (Furman et al. 2019). Likewise, social media platforms give a ruling on who may publish what content, and thus privatize public duties (Belli et al. 2017), e.g., the blocking of the former US President Donald Trump. Similarly, "Amazon's third-party sellers and most of its vendors are subject to a pre-dispute, binding ("forced") arbitration clause, requiring them to sign away the right to their day in court if a dispute with Amazon arises" (Nadler and Cicilline 2020, p. 273). Consequently, platforms exert power over terms and conditions, access to users and resources (Perscheid et al. 2020), and over participants and markets (Halckenhaeusser et al. 2020). In this regard, platforms function as regulators themselves (Dolata 2017), conducting rationing and coordination, which makes platform governance to a complex issue for the regulator (Croitor and Adam 2020; Khan 2019; Krämer and Schnurr 2018).

User behavior contains any unmindful user activity that strengthens the platform's position over the regulator, its competitors, or the users themselves (Table III.3-5).

Table III.3-5: Problems through User Behavior

Problem Cause	Typical Resulting Problems	Failure	Case Ex.
Frivolousness	undermining of official ID card monopolies; undifferentiated and unilateral consent declarations	regulatory {false assumptions}; market {externalities}	# 37,110
Subjective norm	low support for privacy-compliant alternatives; contracts with underage platform users		# 76,127
Misuse	uncontrolled distribution of copyright violations; integrity and security of services and products		# 78,118

Here, we identified and categorized three different problem causes. First, platforms benefit from the *frivolousness* of their users. Here, the free provision of many platform services constitutes a low inhibition threshold for usage (Sunstein 2020), leading to unmindful, shortsighted, or laziness-driven usage and data provision of platform services. On the one hand, the cases show that platform users act quite unmindful with the platform services, e.g., by sharing their data or critical content. IS research has shown that users indeed act careless with their data (e.g., Hey Tow et al. 2010), that their mindfulness can be manipulated (Thatcher et al. 2018), how platforms may exploit this (e.g., Zuboff 2015), and what negative effects for society can emerge (e.g., Kitchens et al. 2020; Qureshi et al. 2020). On the other hand, even if users are aware of the consequences, they contravene these concerns with their laziness if the platform services are extremely convenient, in particular when using mobile devices (Pousttchi and Goeke 2011). Many Amazon customers are either not aware of or simply ignore the consequences of Amazon's immoral practices including working conditions for and monitoring of employees as well as impairment of labor union movements (Corkery and Weise 2020; Sainato 2020). Either way, users unconsciously strengthen platform power through increased usage time, which again attracts more users (von Briel and Davidsson 2019; Zuboff 2015).

Second, users are bound to *subjective norm* when using IT or platform services (Bhattacharya et al. 2015; Eckhardt 2009), especially in a mobile context (Palka et al. 2009). If their peer groups use platform services, users might feel pressured to use these services as well. Particularly, young people increasingly transfer their interactions to social media (Décieux et al. 2019). At this, platforms leverage network and lock-in effects. For instance, WhatsApp users are reliant on the service to reach their peer groups (Nguyen 2021). As a result, more privacy-compliant alternatives (e.g., Threema) have difficulties to catch up.

Third, platforms also benefit from deliberate *misuse* (i.e., legal conduct) by their users. In such cases, users have exploited the opacity of digital platforms for the regulatory body, and thus promoted their popularity and growth. For instance, Airbnb hosts deliberately broke the law knowing that municipalities were unable to prosecute them (Lieber 2012). Likewise, uncontrolled content distribution and according copyright infringements is a major regulatory issue (Else 2018). This problem cause is confirmed by existing IS literature (e.g., Chai et al. 2020), and particularly discussed in contributions from media and law sciences (e.g., Marique and Marique 2020).

The pervasiveness of digital devices, applications, and services (and thus IT/IS) might have boosted the socio-economic impact and relevance of user behavior, and therefore issues of DPR. From regulation theory, we can refer to externalities of the platforms' products and services, which do not reflect the actual costs to the society (Baldwin et al. 2012, p. 18).

3.3 Monopoly-related Problems

Our analysis shows that users, regulators, and platforms have jointly provoked platform-related problems. With significant market power, monopoly-related problems appear, first through the *core-market monopoly*, then through *cross-market monopoly* until *user-base monopolization*.

Core-market monopoly implies significant market domination in the platforms' primarily affiliated markets (e.g., Airbnb in the short-term home rental market). This allows for anticompetitive behavior and thus might cause market failure. Here, we identified three problem causes (Table III.3-6).

Table III.3-6: Problems through Core-market Monopolies

Problem Cause	Typical Resulting Problems	Failure	Case Ex.
Skim-off effects	unfair behavior against complementors	market {anti-competitive behavior; unequal bargaining power}	# 83
Undue privileging	undue preference of in-house goods/services; failure to ensure the freedom of speech	market {coordination; anti-competitive behavior}	# 60,102
Cross-subsidization	impossible valuation of data pools; strong monopolization tendencies	market {anti-competitive behavior}	# 10,57

First, a dominant market power enables digital platforms to *skim off* margins from their complementors or payment reserves from the consumers, respectively. At this, platforms avail themselves of information asymmetries and platform governance, which leads to market failure through unequal bargaining powers and anti-competitive behavior. For instance, booking.com and Expedia can charge high fees due to their market dominance (Espinoza et al. 2020), while some exhaust their power to the extreme, for instance, food delivery platforms like Uber Eats towards restaurants (Owen 2020), or ride-sharing platforms like Lyft towards drivers (Kerr 2021). The development of dominant platforms has been addressed in IS research (Hermes et al. 2020a) and pricing strategies are well recognized (Wan et al. 2017), but yet barely discussed as an objective of regulatory action as digital platforms are neither actual competitors nor principles of their complementors (Gal and Petit 2021; Rogers 2016).

Second, a dominant market power facilitates *undue privileging* of platform goods over those from complementors (Gilbert 2020; Khan 2017), which cannot easily switch to other marketplaces (through lock-in effects). Hence, exclusive information about transactions or consumer preferences (information asymmetries) allows for coordination and anti-competitive behavior. The use of data and IT/IS plays a decisive role in preferencing goods or content (Hermes et al. 2020b; Khan 2019). Plus, through vertical integration they can offer complementary upstream and downstream goods, which otherwise could be provided by complementors. Most prominently, "Amazon's dual role as an operator of its marketplace that hosts third-party sellers, and a seller in that same marketplace, creates an inherent conflict of interest" to the disadvantage of third-party sellers (Nadler and Cicilline 2020, p. 16).

Third, capitalization of core market dominance allows for *cross-subsidization*, either of complementary goods on the platform's core market (through vertical integration) or of other goods in adjacent markets (through horizontal diversification). Consequently, these products or services can be offered low-priced or for free, which explains market failure through predatory pricing. For instance, Google has promoted its video conferencing tool Meets as a free service after Zoom was launched (Bergen 2020). IS and economics research discusses cross-subsidization mainly in terms of pricing strategies (Kung and Zhong 2017), while other research disciplines critically discuss the development of such gradually entangled structures (Dolata 2017).

Cross-market monopoly refers to problems that build upon gatekeeper positions in other markets (or market segments) beyond the platform's core market. Such a dominance allows for predatory pricing through cross-subsidization and fosters the portfolio and user-base convergence. Here, we identified three problem causes, namely infrastructure, coopetition, and innovation (Table III.3-7).

Table III.3-7: Problems through Cross-market Monopolies

Problem Cause	Typical Resulting Problems	Failure	Case Ex.
Infrastructure	excessive exploitation of publicly paid infrastructures; horizontal/vertical expansion fosters user engagement	market {coordination; externalities; goods availability; externalities}	# 62,115
Coopetition	negative effects for competitors and third parties; political influence through lobby work	market {unequal bargaining power; anti-competitive behavior}	# 64,72
Innovation	GAFAM killer acquisitions prevent potential competition; danger to the autonomy of academia	market {unequal bargaining power; goods availability}	# 53,74

Infrastructure-related problems are two-faceted. (1) From a technical perspective, digital platforms avail themselves of the ubiquity and availability of public and private digital infrastructures, such as the internet and telecommunication networks. Particularly, GAFAM platforms excessively benefit from such infrastructures (i.e., moral hazard, externalities). In regions with insufficient infrastructures, GAFAM platforms simply provide them themselves: Google, Facebook, and Microsoft lay subsea internet cables across the Atlantic Ocean (Burgess 2018; Ong 2017), making IT/IS a prerequisite of this problem cause. (2) From a socio-economic perspective, big digital platforms provide essential infrastructures themselves by supplying and connecting various market actors across industries to substantiate their economic and societal power (Hein et al. 2019; Tilson et al. 2010; van der Aalst et al. 2019), such as marketplaces and the appertaining services (e.g., Amazon), operating systems including app stores and development frameworks (e.g., Apple iOS, Google Android), or collaboration ecosystems (e.g., Google Workspace, Microsoft 365). Such infrastructures involve vertical and functional integration, horizontally and across industries (Parker et al. 2016, p. 33; van der Aalst et al. 2019), making IT/IS an amplifier of this problem cause. Integrated mOS (iOS, Android) with app stores and wallets are gatekeepers to countless apps and services from other industries (Fukuyama et al. 2020). While IS research has explored such expansion strategies to a certain degree (e.g., Staykova and Damsgaard 2016) and investigates the infrastructure provision in view of platform openness (e.g., Setzke et al. 2019) or collaborative innovation (e.g., Slavova and Constantinides 2017), the regulatory aspect is yet underexplored. However, such dynamics of infrastructuralization and cross-sectorization might give regulator-like control over goods availability and coordination (Van Dijck 2020).

Coopetition refers to problems occurring from the market dominance by GAFAM platforms at various (and partly central) segments in the digital economy, namely OS including app stores (duopoly of Google and Apple), social media and advertising (significant market shares by Facebook and Googge), non-food online retailing (significant market share by Amazon), or search engines (quasi-monopoly by Google). GAFAM platforms barely challenge each other's segments, and research has shown that strategic expansion into the rivals' segments is disadvantageous (Bar-Gill 2019). For instance, Google had unavailingly attempted to establish another social network platform (Google+), and Facebook and Amazon failed to provide successful mOS. Plus, GAFAM platforms collaborate in various ways. For example, Apple draws on AWS (Dang 2020), and Google pays billions of dollars to Apple to provide the default search engine in iPhones (Novet 2016). What is more, GAFAM platforms conclude cartel-like agreements: Google and Facebook in the U.S. advertisement market (Tracy and Horwitz 2020), Apple and Google in the labor market through anticompetitive employee solicitation agreements (US Justice Department 2010), or all GAFAM platforms through joint arrangements "to remove content or actors from their services without adequate oversight cartels" (Douek 2020). Consequently, GAFAM platforms jointly defend their monopolies to build up market-entry barriers for other players, which is why recent theories refer to "moligopoly" constellations with unequal bargaining powers (Petit 2020)

Innovation refers to problems through gatekeeping mechanisms of GAFAM platforms in terms of research and development (R&D) in three ways. First, GAFAM platforms have shown to entice high-skilled employees or scientists across different disciplines from other companies or universities (Popkin 2019), such as Amazon's hiring of 150 Ph.D. economists for optimizing price and decision making (DePillis 2019). Second, GAFAM companies can exploit their financial resources to simply acquire or imitate externally emergent technologies or competitors (i.e., unequal bargaining power), such as Facebook's acquisitions of WhatsApp and Instagram (Schallbruch et al. 2019) or Google's investments in DeepMind (Shead 2019). Third, if such technologies or competitors are not available by purchase, GAFAM platforms can draw on their financial and technological capabilities to imitate. For instance, Amazon screens new ideas through camouflaged investment pitch events (Lombardo and Mattiolo 2020). Research refers to "kill zones" when VC firms bother to invest in startup innovations that can be easily copied by GAFAM platforms (Kamepalli et al. 2020), which might protract technological progress

(Argentesi et al. 2019). If only a few actors control the evolvement of groundbreaking innovations (i.e., goods availability), they can minimize the disruptive threats and maintain their market powers (Federico et al. 2019). IS research has explored the impact of digital platforms on innovation (e.g., Shuradze et al. 2015) but barely the negative manifestations. Beyond IS, research heavily engaged in such discussions (e.g., Kokkoris and Valletti 2020) and explains that big digital platforms rely on gatekeeping the innovative capabilities in and beyond their markets for their continuous success (Helfat and Raubitschek 2018; Katz 2021).

User-base monopoly refers to resulting problems that relate to a platforms' gatekeeper positions towards the user-bases. Thus, the platform dominance spreads above markets. Here, we identified two complementary problem causes: consumer ownership and data ownership (Table III.3-8).

Table III.3-8: Problems through User-base Monopolies

Problem Cause	Typical Resulting Problems	Failure	Case Ex.
Data ownership	difficulties to incorporate data as competitive factor; disproportionate financial compensation of user data	regulatory {false assumptions}; market {unequal bargaining power; anti-competitive behavior; coordination; rationing; windfall profits}	# 45,88
Consumer ownership	difficulties to determinate correct antitrust markets; difficulties to assess the extent of network effects		# 44,47

Data ownership reflects the resource view of user-base monopolization. It refers to all problems that emerge from the circumstance that digital platforms collect data from all user activities and transactions in combination with a large user base scope (i.e., coordination and rationing). This particularly applies to GAFAM companies that collect and analyze innumerable amounts of data from their users. In digital markets, data is a critical resource for success and competitiveness. GAFAM platforms have successfully monopolized the data ownership and restricted access to third parties through their platform governance and missing external regulation. At the same time, they profit from regulatory measures that force other actors to open their resources (e.g., EU PSD2 regulation, de la Mano and Padilla 2018). This power asymmetry strengthens the GAFAM platforms' position over traditional market actors (Just 2018; van de Waerdt 2020). From a regulatory perspective, they gain a monopoly on these resources which are actually created and provided by the users and complementors who do not (equally) benefit from the resulting advantages, leading to unfair competition and windfall profits through information inadequacies and unequal bargaining power (Zuboff 2015). Given the required capabilities of collecting and processing large amounts of data, the regulatory issue emerges from the effective exploitation of IT/IS (e.g., Bergemann et al. 2018; Constantinides et al. 2018; Fadler and Legner 2020). Beyond IS research, the data ownership discussion spills over to questions of privacy, security, portability and control of data (e.g., Lam and Lui 2020; Loertscher and Marx 2020).

Consumer ownership reflects the market view of user-base monopolization due to monopolies network and lock-in effects based on core- and cross-market monopolies. It refers to all problems that occur because GAFAM platforms have turned into hard-to-bypass access points to reach consumers in a digital world (and vice versa), given the ubiquity and inevitability of their digital infrastructure (van der Aalst 2019): Web pages are virtually non-existing if not appearing on Google Search, while apps are irrelevant if inaccessible through mOS app stores or incompatible with Windows or Mac. Likewise, digital advertisement is hardly possible without Facebook and Google (Srinivasan 2019b), and small sellers rely on Amazon for customer interaction. Consequently, GAFAM companies control the digital access to customers through IT/IS (i.e., coordination), while traditional companies can hardly connect digitally without employing the infrastructures of GAFAM platforms (Gleiss et al. 2021), which enables unequal bargaining power and anti-competitive behavior.

Altogether, our cases indicate that (particularly GAFAM) platforms have established monopoly-like structures in different ways that induce different types of market failure to be prohibited through regulation, such as unequal bargaining powers, anti-competitive behavior, windfall profits, information inadequacies, and moral hazard. At this, they benefit from platform-related problems. However, to address such monopolies the regulator first has to define the relevant market, which has turned out be difficult in a global, digital, networked economy (Peitz 2020) and might be explained by insufficient understanding of the characteristics of platform markets and their interplay with traditional markets. What is more, GAFAM platforms govern the resources of their platform markets, which allows for control over goods availability, rationing, and coordination, i.e., actually facilitative tasks of the regulator. Both consumer and data ownership in turn expedite lock-in and network effects, and thus consolidate the monopoly structures of the big digital platforms if existing consumers and complementors are not incentivized to change the platform. All content, products, services, and participants are accessible by the existing platform landscape (lock-in effect), and thus search and transaction costs decrease if further consumers and complementors are attracted by the platform (network effects).

3.4 The Special Case of Digital Platform Ecosystems

In the course of analysis, GAFAM platforms have assumed a special role: Not only do they cause platform-related problems to large extent, but also monopoly-related ones. What is more, the issues of cross-market and user-base monopolization have proven to be GAFAM specific. Thus, we need to take a closer look at the nature of such *digital platform ecosystem*. For this purpose, we first analyzed the business portfolios of GAFAM platforms to understand the interwovenness of their products and services along five layers (see Figure III.3-3).

The basis of the digital platform ecosystems is an *infrastructure layer*, i.e., the provision of network and processing capabilities. GAFAM platforms host and provide such resources themselves as a technical foundation for their downstream products and services. However, they heavily rely on the availability of public or third-party infrastructure (systems, networks and servers) to make their services accessible for their customers. To connect their consumers with their services, all GAFAM platforms provide physical/tangible devices and user interfaces (*device layer*). Here, particularly Apple obtains a well-marked position through the global pervasion of its hardware (i.e., MacBook, iPhone), which helps Apple to control the upper layer elements and boundary resources. However, the other GAFAM companies have gained ground (Google, Microsoft) or captured other market segments (e.g., IoT: Alexa/Echo, Nest; Gaming: Xbox).

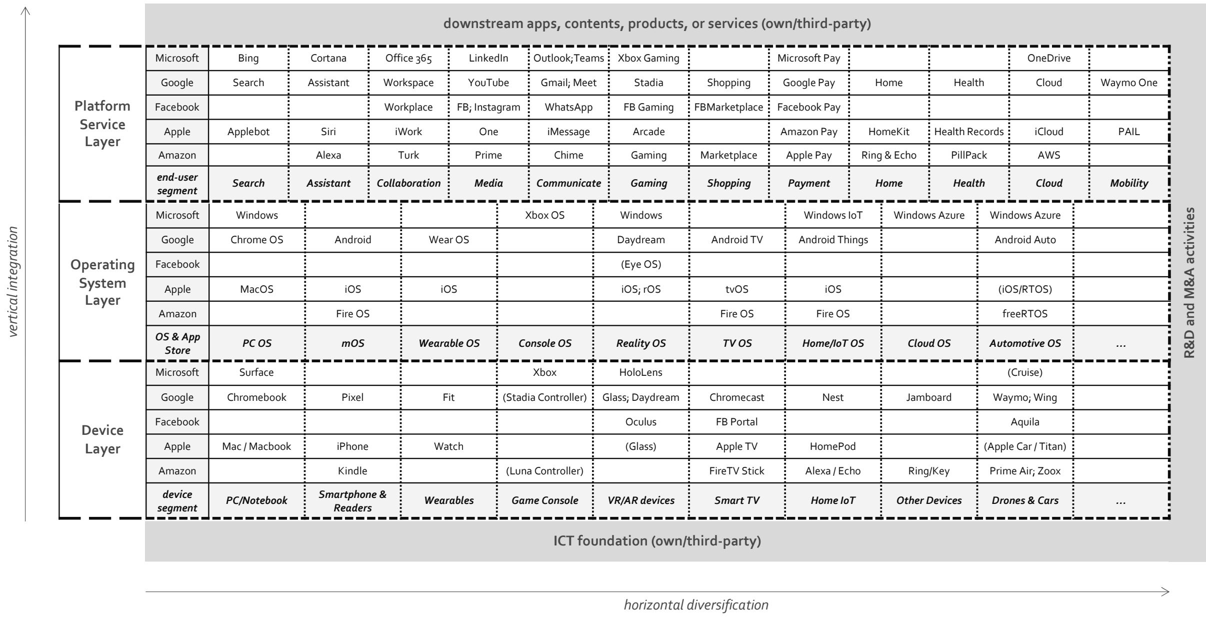

Figure III.3-3: GAFAM Business Architecture

On that technical basis, the *operating system layer* plays a strategic role as it connects the physical devices with the upper layer applications. It helps to monitor the users' activities and data, particularly in a mobile context given the high pervasion of smartphones and the extensive usage time of their users (enabling platform behavior problems). Google, e.g., employed Android to analyze usage behavior and growth patterns of apps from third-party developers (Nadler and Cicilline 2020, p. 387). Hence, governing the OS layer involves much access to data and thus, power. Upon this layer, digital platform ecosystems provide several platform services for the consumers (*platform service layer*). Here, GAFAM platforms have different market stakes in the different consumer segments through their various services that connect the users with other downstream apps, contents or services that can be provided either by GAFAM companies or by other market actors across market segments.

Altogether, GAFAM platforms exhibit a high level of *vertical integration*, i.e., offering downstream or upstream products or services along the value chain, and thus facilitating *functional integration within the markets* (Parker et al. 2016, p. 33). For instance, Google offers various services (e.g., Gmail, Workspace) upon the cloud infrastructure and Apple provides an ecosystem of hardware, OS, AppStore and downstream applications, which increases consumer and data ownership and reinforces network and lock-in effects. This, in turn, allows for platform governance, information asymmetries, skim-off effects, and undue privileging. Thus, vertical integration fosters monopolization tendencies as it enables digital platforms to increase the power on the markets they govern (e.g., AppStore) and their dominance on the markets they act in, such as iOS in the smartphone market, Google Ads in the advertising industry (Srinivasan 2019b), or Apple's combination of iPod and iTunes (Abel 2008).

What is more, big digital platforms have successfully pursued strategies of *horizontal diversification* for *functional integration across industries* by launching similar services that build upon equal infrastructures (e.g., Apple Wallet and Pay), providing complementary services that are technically integrated into one interface (e.g., Google Search, Images, Maps, News, Drive), or acquiring competitors (i.e., *horizontal integration*). Therefore, horizontal diversification helps platforms to transfer their market dominance to new service, market or business segments (i.e., cross-market monopolization), and thus creates ecosystems with lateral user-base monopolies. For example, Google has massively scaled its online video conferencing tool Google Meet during COVID-19 as part of the Workspace environment (Schaevitz 2020). The service was offered for free (cross-subsidization) to a large user base (lock-in effects) in an existing environment (infrastructure) to increase consumer and data ownerships, while competitors such as Zoom had to invest large sums of money in marketing activities (Adams 2020). This way, GAFAM platforms successively expanse to new segments or markets, such as payment (Kazan 2015) or healthcare (Gleiss et al. 2021). Hence, the marketplaces that they govern and control are not only integrated vertically across layers, but also horizontally across market segments.

Consequently, it is both the vertical *and* horizontal expansion that characterizes such digital platform ecosystems (i.e., GAFAM) and distinguishes them from "regular" digital platforms (e.g., AirBnB). Thus, digital platform ecosystems combine leverage rationales of production, innovation, and transaction (Thomas et al. 2014). The higher the level of integration and diversification, the more we experience monopoly-related problems. However, strategic factors alone may not cause or explain market dominance of a platform, we also need to technological and network-related factors (den Hartigh et al. 2016; Hermes et al. 2020b). Technological factors, on the one hand, relate to innovativeness and technical architecture including modularity, compatibility, and flexibility (den Hartigh et al. 2016), which can be supported by M&A (Karim and Mitchell 2004) and ecosystem control (Hein et al. 2019). Network-related factors, on the other hand, rely on network size, network diversity, and network structure (den Hartigh et al. 2016). All factors apply in favor of GAFAM platforms that control large and diversified ecosystems including different networks of different constellations, which allows for functional integration and network orchestration, and thus growth (Parker et al. 2016, p. 33).

The more layers and segments these digital platform ecosystems occupy, the more data they can collect and the more power they concentrate and exert as a gatekeeper in two dimensions: For one thing, they can define rules and conditions for interaction and participation. That is, they affect or control the way complementors conduct their online businesses (i.e., their value creation, value proposition, customer interaction), such as at the Amazon Marketplace (Khan 2017). For another thing, the digital platfrom ecosystems can control access to valuable resources (Parker and van Alstyne 2008), such as data, software/hardware components, or user groups. Both gatekeeper dimensions are enabled or facilitated through the efficient and effective employment of IT/IS. And there is much empirical evidence that GAFAM platforms have misused this power through, e.g., undue privileging, skim-off effects, or information asymmetries (Nadler and Cicilline 2020). Consequently, monopoly-related problems are not just another problem type – they also intensify the platform-related problems. Figure III.3-4 condenses our findings into a classification of digital platform problems.

Altogether, digital platforms benefit from platform-related problems to successfully operate and grow. If they achieve a dominant market position or a "winner-takes-all" monopoly (Katz and Shapiro 1994; Shapiro and Varian 1998) – promoted by user behavior (Zhou et al. 2020) and regulatory deficiencies (Russo and Stasi 2016; Srinivasan 2019b) – digital platforms can skim off their complementors and privilege own or certain goods or content (that might be cross-subsidized). Finally, horizontal and vertical expansion allows for cross-market and user-base monopolization. In either case, digital platforms rely on the efficient employment of IT/IS.

In regulation theory, some problems are explainable with well-known market failure rationales. However, these rationales hardly explain problems resulting from the control over (integrated) platform markets for two reasons. First, platform markets contrast strongly with traditional pipeline markets, while disentangling these markets vertically and employing data-based and digital technologies (Parker et al. 2016). Second, platforms conduct quasi-regulatory duties of coordination, rationing, and goods availability themselves, making them to counterpoises of the regulatory body. Hence, regulatory failures are present in these markets (e.g., false assumptions, ineffective structures and processes).

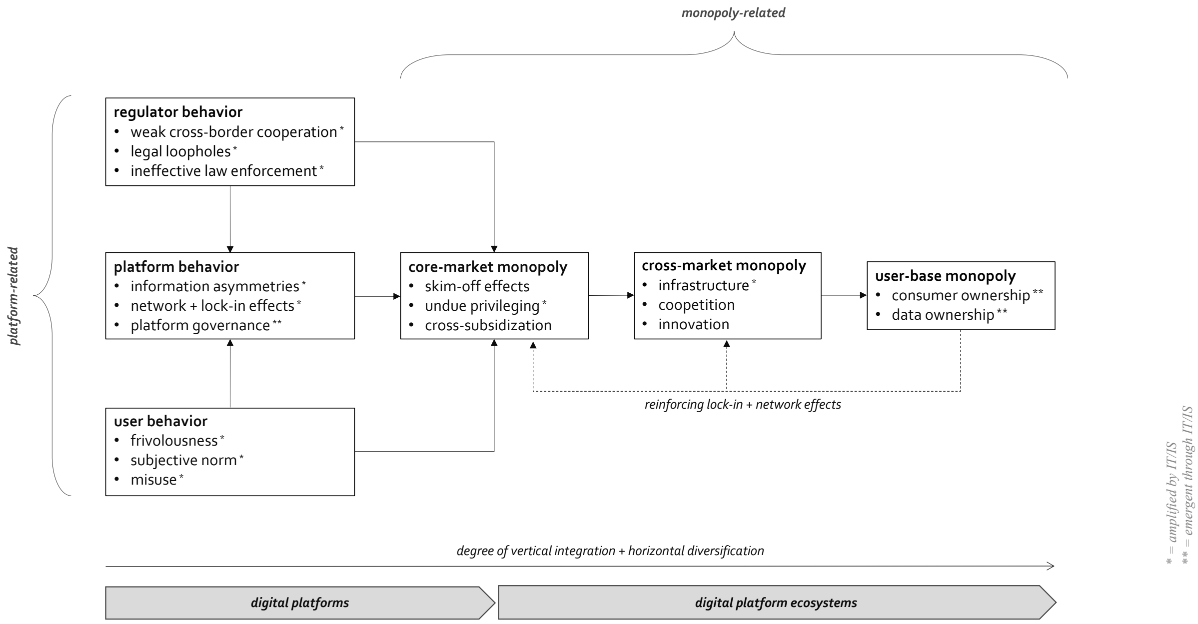

Figure III.3-4: Classification of Digital Platform Problems

Consequently, purposeful regulation needs to factor in three things: First, regulators have to recognize the distinction between platform-related and monopoly-related problems in association with regulatory and market failures. Second, regulators have to comprehend the distinction between regular digital platforms and digital platform ecosystems with a highly integrated product and service architecture where many problem classes occur at once and are hard to tell apart. Third, regulators have to lay more emphasis on the role of IT/IS in causing or facilitating problems with digital platforms.

4 Problem Impact and DPR Perspectives

Based on the classified problems, we further analyzed the cases to identify and systemize the impact as a basis for purposeful DPR. Here, we focused on two things: *Damaged parties* (i.e., users, complementors, competitors, or the state/society at large) and *gatekeeper dimensions* that the platforms controlled in each case. These include activities (of the platform, users, or complementors), valuable resources (e.g., data, technological artefacts, intellectual property, money), and economic sectors (e.g., functions, markets). In order to systematically develop purposeful regulatory options for the problems, we analyzed three complementary sources: historical regulation cases, current international regulation approaches, and current proposals from practice and research. At this, we derived regulatory measures which we applied to the 128 digital platform cases for further validation and refinement, and condensed our findings into a coherent, public-interest oriented DPR taxonomy (see Figure III.3-5).

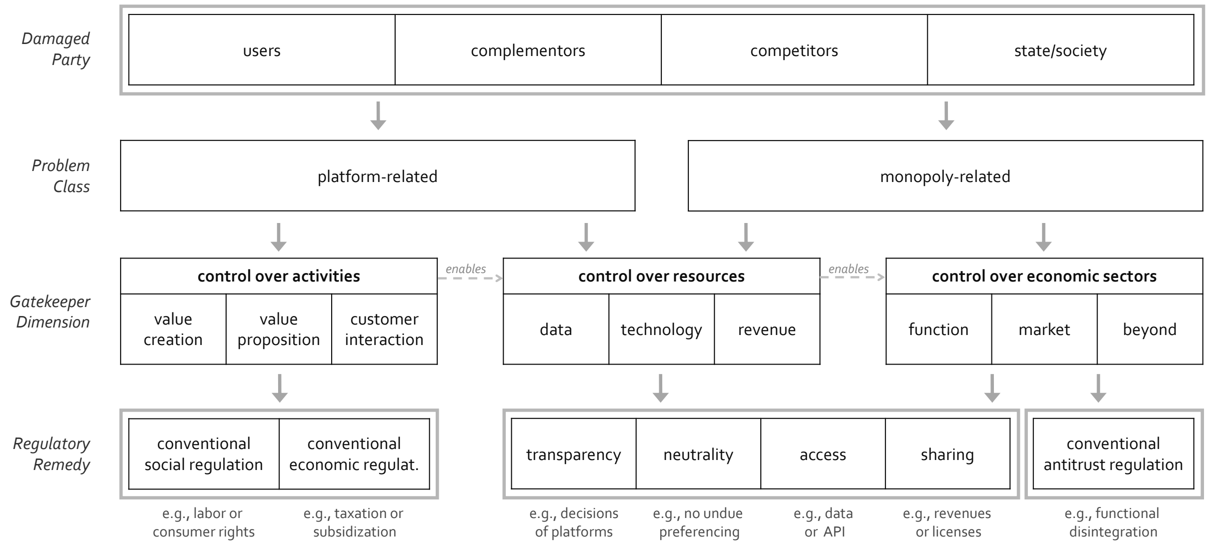

Figure III.3-5: Taxonomy of Digital Platform Regulation

Damage to involved parties. Based on abusive platform behavior, exploitation of regulatory deficiencies, or unmindful user activities, the digital platforms could undermine applicable laws or neutrality standards to directly or indirectly *damage involved parties*. In many cases, the platforms impinged upon their *users*' rights (e.g., their data, health, youth, and financial protection) or acted to their disadvantage. E.g., social media platforms that close contracts with underaged users (Müller 2018), Apple and Google did not provide updates for too old devices (Fuest 2019), or Facebook abused the user data with Cambridge Analytica (Wong 2019). In other cases, digital platforms caused harm to their *complementors.* Particularly, workplace platforms such as Clickworker or Uber were accused to foster precarious working conditions for their complementors that lever out the rationales of national labor law (Rogers 2016).

Digital platforms also got the advantage of competitors by leveraging platform-related problems. Here, platforms took advantage of legal gray areas to arbitrarily control – or intentionally not control – how they or their complementors produce their goods (value creation), what products and services they offer (value proposition), and how communication with users and complementors is organized (customer interaction). For instance, Airbnb and Uber have ignored prevailing legal norms by enabling the illegal rental of flats or the operation of taxi services without official permissions (Coldwell 2014; Ongweso and Koebler 2019). Finally, digital platforms are accused to cause damage to the *state and the society* at large, e.g., by avoidance of taxation (Bourreau et al. 2017), negative impact on affiliated markets (Duso et al. 2020) or public welfare (Barrios et al. 2019), or through issues of polarization and partisanship (De Gregorio 2020; Qureshi et al 2020).

Control over activities. Many of these problems are platform-related with the consequence that digital platforms entirely control or abuse value creation, value proposition, or customer interaction on the platform or of their complementors. In many cases, conventional *economic regulation* might help solving the problem. That means, the regulator can set statutory provisions for the platforms and their complementors that enter an industry or market (Taylor and Weerapana 2010; Windholz and Hodge 2012). Such regulatory action in the past has brought about some effect. Regarding value creation, for instance, German Uber drivers have been made legally bound to return to their starting point, just as conventional cab drivers are (Schuetze 2019). Likewise, the regulator has already has set statutory provisions for value proposition (e.g., phase-out of incandescent light bulbs in the EU), or customer interaction (e.g., PSD2 strong customer authentication) in other industries. If the issues are irrespective of the market, *social regulation* might help solving the problem (e.g., labor rights). The regulator can exert influence on value creation, value proposition, or customer interaction to correct market failures, reduce externalities, and achieve socially desirable outcomes (Shleifer 2005; Taylor and Weerapana 2010, pp. 436 et seqq.; Windholz and Hodge 2012).

Control over resources. If controlling the conditions and transactions, successful platforms are able to control over certain valuable resources (data, technology, or revenue), either as gatekeeper (to enable skim-off effects) or as manipulator (to enable undue privileging). This way, platforms can determine about prices and conditions and prioritize own services or specific content (for money or own interests). For instance, Twitter was accused to prefer liberal over republican content (Clayton 2020), and Google was designed to act in favor of the paying participant side right out of the gate (Brin and Page 1998). What is more, digital platforms shift the responsibility upon their users and complementors, referring to their purely intermediating role, such as in the context of (missing) content moderation in social media platforms (Douek 2020; Heldt 2019). Here, the regulator might enforce *neutrality or*, at least, *transparency* about the platforms practices and the content produced or displayed (De Gregorio 2020). For example, the German Network Enforcement Act forces social media platforms to delete unlawful content (Heldt 2019).

This issue of resource control increases if, at the same time, monopoly-related problems come into effect that entail undue privileging of a platform's vertically integrated services over those from the complementors (Krämer and Schnurr 2018). Particularly, dominant platforms hold access to the gathered data, technological resources and interfaces, or patents and licenses over competitors, users, or the state (Engler 2020). Consequently, the regulator should consider enhancing third-party participation in the digital platform's critical key terms and resources through *access* and *sharing*. First, it entails access to the gathered data or analyses that the users and complementors co-produce (e.g., Mayer-Schönberger and Ramge 2018). Second, it is about access to the platform's technological artifacts, such as interfaces or applications (Lancieri and Sakowski 2020). This way, inter-platform interoperability and data portability could be facilitated, which might reduce lock-in effects and monopolization structures (De Hert et al. 2018; Hovenkamp 2021).

Third, it implies the financial gain sharing in the platform's profits that root back to the users' or complementors' data and content. For instance, Google and Facebook might pay news companies for using their content (Meade 2020), or more radical, GAFAM platforms should compensate their users monetarily for their data (Duch-Brown et al. 2017; Lanier 2014). Other radical proposals include mandatory sharing of algorithmic learning; subsidization of competitors; and temporary shutdowns (Gal and Petit 2021). In either case, platform users or other affected stakeholders could participate in the governance of the digital platform and thus attenuate abusive market power. The analysis of the historical regulation cases has shown that access provision to critical resources from monopolists to other market participants has often been an appropriate regulatory approach to address market failures. For example, the U.S. Consent Decree in 1956 forced then-monopolist Bell to license all its existing patents royalty-free, which led to an innovation push in different industries (Watzinger et al. 2020).

Control over economic sectors. In some cases, such measures might remain ineffective as the data, technological, and financial superiority has advanced market power of digital platforms. As our analyses exhibit, particularly GAFAM platforms have accumulated tremendous market power and attained gatekeeper positions on the consumer base, progress of innovation, and digital infrastructures. Plus, they have established anti-competitive, coopetitive, and innovation-absorbing structures that protect them from disruptive competitors. Such digital platform ecosystems entirely control the access to their products and services, the utilization of the gathered data and employed technologies, and the determination of prices towards all platform participant sides. Besides their dominant market power in the digital economy, they increasingly impinge on the real-world economy through horizontal and vertical integration and diversification. Here, the regulator could conduct conventional measures of *antitrust regulation*, including drastic ones such as disintegration to ensure a common basis for fair competition and the diffusion of innovations (Khan 2019; Kwoka and Valletti 2020; Watzinger et al. 2020), social welfare (Autor et al. 2020), or state sovereignty (Wu 2018).

Basically, the regulator has three options here. First, regulatory measures could aim at the *functional* segregation of single products and services through vertical or horizontal disintegration, either into externally controlled and independent business units or subsidiaries or into completely autonomous companies (i.e., divestiture). In history, the regulator has already disintegrated single companies that had gained too much market power ex-post, such as Kodak (1921, 1954), IBM (1936, 1956), AT&T (1913, 1956, 1982), or the movie studios of Paramount (1948). In view of GAFAM companies, the regulator could examine vertical and horizontal product and service interrelations as we outline in the previous section (cf. Figure 3). Second, the regulatory body could foster the disentanglement of the *markets* that digital platforms operate on. This segregation can either concern industries and segments (e.g., banking) or regions (e.g., China's ban of Facebook and Google). History has shown that such practices of horizontal and vertical segregation of market segments can leverage the desired effects (Crandall and Elzinga 2004; Phillips Sawyer 2019) as, e.g., the Interstate Commerce Act (1887, horizontal segregation of railway market), Glass-Steagall Act (1933, segregation of retail and investment banking), or the Air Mail Act (1934, segregation of airline production and operation). Third, disentanglement could go *beyond functions and markets*, e.g., innovation or user-base monopolies. In either case, regulators hypothetically could exert governmental influence on the companies' businesses through the purchase of company shares or nationalization (e.g., British Rail 1948).

Altogether, the regulator should take account of the power and gatekeeper positions of digital platforms. This particularly applies to resources (e.g., interfaces, data, patents) and the autonomy of complementors and other affected stakeholders (in terms of value creation, value proposition, and customer interaction) to ensure a level-playing field among all actors. Through digital platforms, governments are faced with a private counterpart in governing market rules, while the economy might suffer from user-base monopolization and citizens from surveillance capitalism and polarization.

5 Conclusion

The starting point of our considerations was the remarkable rise of debates and concerns about digital platforms in practice. While interdisciplinary research has increasingly engaged in DPR, the causal problems remained underexplored. Even IS research, which had theorized on the nature and mechanisms of digital platforms to vast extent, provided comparatively few knowledge about DPR. Against this background, we aimed to understand and conceptualize the regulatory problems of digital platforms from an interdisciplinary viewpoint, strengthening the contribution of IS.

Our results are twofold: (1) We propose an empirically-based classification of digital-platform problems that factors in the role of IT/IS in the interdisciplinary context. (2) We provide a taxonomy of digital platform regulation that builds upon the conceptualized problem classes and impact. At this, we draw on the interdisciplinary knowledge to analyze empirical data from various publicly available sources.

Our findings suggest that digital platforms have exploited regulatory inactivity while some have transformed into serious private market-governing entities, and thus to challengers of the governmental regulatory body. Basically, digital platforms capitalize on both platform- and monopoly-related problems, while IT/IS help emerge or amplify several of them. For purposeful DPR, the regulator has to recognize this distinction. Likewise, the regulator has to distinguish between regular digital platforms and digital platform ecosystems with a highly integrated product and service architecture where problems are intertwined and hard to tell apart. The control over valuable resources and the rule-making about the participation in platform markets are strategically relevant. Particularly, when it comes to the regulation of access to data and technological artefacts (interface, applications, algorithms), the IS research domain needs to bring in its knowledge into the interdisciplinary research discourse on DPR.

As a contribution to research, we provide a comprehensive and interdisciplinary systematization that helps understand and further explore the problems with digital platforms. At this, we fill not only a void in IS research, we also tie in with current theorizing processes on DPR in adjacent research disciplines, and shed more light on the importance of IT/IS. As a contribution to practice, we provide an analytical tool that regulators might employ to systematically and comprehensively approach DPR.

Our study has several limitations. First, the scope of our study is limited to digital platforms and regulatory approaches in Western societies. Our findings and inferences might not apply to digital platforms of the Asian economic area (e.g., Tencent, Alibaba). Second, our analysis focuses on the economic dimension of DPR. However, we acknowledge that other dimensions might be equally important (e.g., social polarization). Third and most importantly, our qualitative research design, including the inductive systematization, is reliant upon the subjective selection, coding, and interpretation of the authors. In awareness of this limitation, our findings build on practical evidence that is reflected with research.

We see three important avenues for future research. First, we need further empirical evidence on the implications of regulatory intervention into platform-dominated or -affected markets. This requires clear definitions of relevant markets within the overlap of the real-world and digital economy. Here, researchers could either examine the effects of factual or simulated regulatory interventions, which also entails questions of the design and time-scope of regulation, e.g., ex-ante or ex-post regulation (Cappai and Colangelo 2021). Second, we need to factor in the technological foundations of digital platforms in order to design accurate and feasible regulatory measures in terms of platform governance, interoperability, resource sharing, and transparency. For instance, this implies complex mechanisms like automated content moderation. Third, given its roots at the confluence of society–economy–technology, IS research has to participate more actively in the academic discourse as DPR implies an in-depth understanding of the interdependencies among these dimensions.

IV Conclusion

IV.1 Synthesis

The overarching aim of this thesis was to contribute to the knowledge in IS research of the impact of digital transformation (DT) on the economy and society through the analysis and theorization based on empirical cases. Particularly, the thesis sought to explore different selected aspects on the impact of *digital technologies* (papers II.1 – II.4) and *digital platforms* (III.1 – III.3). In addressing the research gaps within the DT research landscape (as per Chapter I), the papers of this thesis provide several results and findings that help to understand and assess the implications of DT from an IS perspective. Table IV.1-1 gives a summarizing overview of the results and findings of the papers included in this thesis.

Table IV.1-1: Overview of the Results and Findings of the Included Papers

Part	Article	Results and Findings
II – Digital Technologies	II.1: Technology Impact Types	- morphological categorization of digital technologies (technology framework) - classification of 10 detailed impact types of DT - coherent model of technologies, causes and impact of DT
	II.2: Organizational Ambidexterity	- morphological categorization of digital innovation barriers in healthcare - assessment of barrier-mitigating effects through a data management platform - classification and framework for digital innovation impact in hospitals
	II.3: Data-driven Business Models	- building blocks of data-driven business models - taxonomy of data-driven business models
	II.4: On-demand Healthcare	- conceptual framework of on-demand healthcare - definition of on-demand healthcare
III – Digital Platforms	III.1: Platforms in Insurance	- traditional and platform-impacted insurance value network - taxonomy of platforms in insurance - platform standard types in insurance
	III.2: GAFAM in Healthcare	- overview and analysis of GAFAM activities in healthcare - traditional and platform-impacted healthcare market value network - classification of platform business models in healthcare - healthcare GAFAM-impact framework (facilitators, GAFAM activities, market effects)
	III.3: Digital Platform Regulation	- analysis of GAFAM business architecture - classification of digital platform problems - taxonomy of digital platform regulation

Contribution on the Impact of Digital Technologies

In terms of the impact of digital technologies, *paper II.1* approached the issue of DT fundamentally by providing a generic model that helps understanding the potential implications for companies of employing digital technologies. We explored the impact on companies along the three dimensions of DT, using data from 75 cases studies from 40 industries. The outcome of the paper is threefold. First, we developed a categorizing technology framework with 22 characteristics to be considered in a DT project. Second, we derived a classification of 10 detailed technology impact types. Third, we systemized our results through a coherent conceptual model of technologies, causes and impact types along the three DT dimensions. For researchers, our results provide a more generic understanding of DT by means of a holistic model for DT. Thus, the model gives direction to potential cause-effect relationships of DT activities and projects that can be explored and analyzed in further detail. For practitioners, our results can be used as a reference or creativity tool to define or test a distinct technology mix, or to systematically develop future business models in due consideration of the three DT dimensions, digital technologies, and impact types. For instance, our model could be used to explore the potential solution space for an enhanced digital customer communication concept by selecting and exploiting appropriate technologies consciously. Moreover, our results can serve as a basis for assessing a company's status quo of DT and deliver a spectrum of potential implications of future DT initiatives.

Paper II.2 focused on the value creation model of DT and sought to explore how hospitals could more easily integrate digital healthcare innovations through an HDMP in order to approach organizational ambidexterity (OA). Our results are threefold: First, we provide a systematic categorization of literature-based and practically validated barriers for digital health innovations in hospitals. Second, we add an assessment of how an HDMP might help mitigate such barriers. Third, we conceptualized the potential impact of the integration of digital innovations in hospitals from a multi-level perspective. Our findings reveal that an HDMP might help hospitals to raise their innovative capacities through ambidextrous structures. Especially, it can help to mitigate technological, organizational, and behavioral barriers. However, such a platform alone cannot solve all problems of sourcing digital technologies, particularly in terms of externally-induced barriers, such as legal or structural ones. Thus, there might be complementary and less technology-oriented approaches to surmount barriers for innovation. As a contribution to research, we provide a systematic understanding of potential barriers and impact potentials of integrating digital innovations in hospitals. As a contribution to practice, we sensitize about barriers that digital innovations typically face, present a solution for mitigating such barriers, and provide an overview of potential benefits to capture. Thus, healthcare practitioners might employ this overview to systematically evaluate their IT landscapes and the potential benefits of new technologies.

Paper II.3 zeroed in on the value proposition model of DT and investigated the nature of data-driven business models (DDBM). The outcome of the paper is a consolidated taxonomy for DDBM with 14 building blocks within the three DT dimensions, based on a systematic taxonomy development approach including 26 existing taxonomies from literature and 30 DDBM cases for validation. For researchers, the consolidated taxonomy provides a systematic synthesis of available academic DDBM taxonomies and thus adds a puzzle piece towards a coherent understanding of DDBM from an IS perspective. Plus, it offers the possibility to further investigate the different building blocks that might be employed as a blueprint for the development of industry-specific taxonomies. For practitioners, the taxonomy primarily serves as a guidance tool with simple but precise building blocks to be considered when developing or transforming a DDBM.

Paper II.4 refers to the customer interaction model of DT and strived for a better understanding and systematization of the nature and concept of on-demand healthcare as there was virtually no theoretical foundation of this practically-known phenomenon so far. The outcome of our paper is twofold: First, we derived and developed prerequisites, drivers, standard types, and characteristics of on-demand healthcare services in order to develop a conceptual framework. Second, we propose a definition of on-demand healthcare on this theoretical and empirical basis. For researchers in the field of digital health, our results might serve as a starting and reference point when exploring phenomena in the context of on-demand healthcare and substantiating the concept. Hence, our contribution adds another puzzle piece in understanding the complex field of digital health. For practitioners, our results can be used to systematically comprehend and develop such digitally-enabled healthcare services.

Contribution on the Impact of Digital Platforms

In terms of digital platforms, *paper III.1* addressed the platform impact on traditional companies and explored how digital platforms impinge on incumbent insurers' value creation and customer interaction by offering new, digitally-enabled value propositions. The paper has three major outcomes: a role-based reference model of the insurance value network; its application for identification and analysis of insurance-related MSP configurations through an MSP-impacted insurance value network; and the derivation and classification of four platform standard types in the insurance industry. The findings suggest that digital platforms multilaterally affect the traditional insurer's business model by attaching themselves to several sides around its core business. This has three main implications for the insurance industry: specialization, modularization, and thus a higher complexity of the value network. Moreover, there are four platform standard types to describe the relationship constellations between platforms and traditional insurers: competition, coordination, cooperation, collaboration. The major research contribution is an improved understanding of how digital platforms affect value creation of companies in traditional service-oriented industries by occupying or creating roles in the value network. Practitioners might apply the reference models to explore different value network constellations to build or modify their value creation, value proposition, and customer interaction activities in insurance.

Paper III.2 approached the issue of digital platform dynamics more holistically and investigated how digital platforms affect value creation in the healthcare market, with a special focus on GAFAM platforms. We show how GAFAM services and products induce new value-creating roles and mechanisms in healthcare. Hereupon, we examined the GAFAM impact on healthcare by scrutinizing the facilitators, activities, and effects, which we condensed into a conceptual framework. Our findings suggest that GAFAM platforms affect value creation in healthcare in various ways through edging into existing structures by not only enabling transaction and interaction but also by providing products, services, and content themselves. As a contribution to research, we add new insights to the knowledge of the impact of digital platforms on conventional, service-oriented markets, and show how GAFAM platforms contribute to DT in healthcare by exploiting their cross-sectional and technological capacities. Moreover, our reference models might be employed for further analyses with other foci or with the objective of software-based quantification. As a contribution to practice, we might sensitize managers and policymakers in healthcare about the increasing and ubiquitous influence of platforms on their domain, and emphasize the importance of collaboration and shared standards.

Finally, *paper III.3* encircled the research gap of digital platform regulation (DPR) and sought answers to the question of how we could classify negative impact patterns of digital platforms and relate them to appropriate regulatory measures. First, we propose an empirically-based classification of digital-platform problems that factors in the role of IT/IS in the interdisciplinary context. Second, we provide a taxonomy of DPR that builds upon the conceptualized problem classes and impact. Our findings suggest that digital platforms exploited regulatory inactivity while some of these platforms have transformed into serious private market-governing entities, and thus to challengers of the governmental regulatory body. Basically, digital platforms capitalize on both platform- and monopoly-related problems, while IT/IS help emerge or amplify several of them. The control over valuable resources and the rule-making about the participation in platform markets are strategically relevant. As a contribution to research, we provide a comprehensive and interdisciplinary systematization that helps understand and further explore the problems with digital platforms. At this, we fill not only a void in IS research, we also tie in with current theorizing processes on DPR in adjacent research disciplines, shedding more light on the importance of IT/IS. As a contribution to practice, we provide an analytical tool that regulators might employ to systematically and comprehensively approach DPR.

Reflection on Research Gaps and Limitations

Overall, the papers included in this thesis addressed the selected research gaps within the DT research landscape in IS as presented in Chapter I. In view of the conducted case-study analyses in all papers, the thesis contributes to providing empirical data that helps understanding the implications of DT. Based on the conducted analyses, all papers are able to provide conceptual models, taxonomies, or frameworks that help describing, explaining, or even predicting the impact of digital technologies and digital platforms on companies and the economy or society at large (Gregor 2006). In consolidating and extending the knowledge about data-driven business models and on-demand healthcare, the thesis is also conducive to synthesize terminologies of emerging concepts. Through entwisting the research domains of digital health (papers II.2, II.4, III.2) as well as other social sciences such as economics and political science (paper III.3), the thesis offers interdisciplinary tie points to approach the phenomena of DT more comprehensively. Methodically, the papers in Chapter III add new insights through the employment of design science research and network analyses.

In view of the content, the papers help to understand the impact of digital technologies and digital platforms both on a micro and macro level. While some papers provide new knowledge of the impact of DT on companies and individuals (II.1, II.2, II.3, III.1), others consider the implications for industries (II.4, III.2) or the economy and society at large (III.3). Table IV.1-2 gives an overview of the addressed research gaps of each paper of this thesis.

Table IV.1-2: Overview of the Addressed Research Gaps per Paper

			Paper						
Focus	**Field of Action**	**Research Gap**	**II.1**	**II.2**	**II.3**	**II.4**	**III.1**	**III.2**	**III.3**
approach ("how")	empirical data & proper methods	empirical data on DT	x	x	x	x	x	x	x
		design science					x	x	x
		network analyses					x	x	
	new theories & concepts	theories & concepts	x	x	x	x	x	x	x
		terminologies			x	x			
		interdisciplinary approaches		x		x		x	x
content ("what")	impact of digital technologies on organizations	DT impact on companies	x	x	x		x		
		DT impact on sectors	x	x				x	
		shifting business models			x		x		
		DT impact on users				x			
	impact of digital platforms (DP)	emergence and dynamics of DP					x	x	x
		market transformation through DP					x	x	
		political realm of DP and regulation							x

The thesis entails limitations regarding methodology and content. First and in terms of methods, the results and findings are basically reliant upon the subjective selection, coding, and interpretation of the gathered data, which roots back to the qualitative nature of the case-study analyses. Hence, while the identified literature- or empirically-based constructs and artefacts might be comprehensive and inherently logical, other researchers might have coded and derived other constructs and artefacts. In order to increase reliability and objectivity, this drawback has been tackled through the involvement of at least two independent coders and extensive discussions within the entire research group in combination with the (hypothetical) application of the theoretical constructs to real-world cases, and/or the validation and assessment through independent experts and practitioners. In further awareness of this limitation, all our findings rely on comprehensible empirical evidence that is reflected with the current state of the art in research and practice.

Second and in terms of content, the scope of this thesis is limited to certain aspects of the impact of digital technologies and digital platforms. Hence, the thesis may only provide some puzzle pieces to complement the vast DT research landscape in IS. What is more, the studies primarily include phenomena and dynamics within certain industries (e.g., healthcare and insurance) of Western societies, so the findings and inferences might not be generalizable or transferable to other industries or to market participants of the Asian economic area (e.g., Tencent, Alibaba). Finally, the analyses mainly focus on the competitiveness of organizations in times of DT and the economic implications on competition in markets and industries. However, it is acknowledged that other aspects might be equally important, such as the impact on the workforce (e.g., ceasing or new jobs), the society at large (e.g., user behavior or social polarization), or the environment (e.g., power consumption).

IV.2 Outlook

Both research and practice have shown that DT is a long-lasting and profound process that will continue to impinge on the economy and society for the next years or even decades. Consequently, the IS research domain will have a great deal to further explore and understand the phenomena and interdependencies in the context of DT (e.g., Lynne Markus and Rowe 2020), including digital technologies and digital platforms in particular. In terms of digital technologies, the thesis has demonstrated how their conscious and unconscious application as well as their unforeseen emergence and ubiquity affects value creation, value proposition, and customer interaction of companies. In terms of digital platforms, the thesis has shown their potential to decompose traditional businesses, transform entire markets, and impinge on the economy and society.

On a micro level, these dynamic capabilities of DT not only give rise to new kinds of business models, but will change the way traditional companies will conduct their businesses or connect to their customers. Digital technologies hold promise to redesign the processes or organizational structures, while digital platforms can broaden or limit a company's scope of action. Consequently, future research needs to address the business dimension and further explore and conceptualize under which conditions what types of companies are affected to what extent, and how companies can react to or proactively approach DT. This also includes questions of the optimal degree of a company's digitalization.

Likewise, the ongoing pervasiveness of digital technologies and platforms, including their opportunities and threats, will influence the users in their attitudes and behaviors. The omnipresent accessibility of (digital) products and services will keep shifting consumer expectations, while the progressive accumulation and consumption of technical devices and services (e.g., smart health wearables, smart home products and security systems, autonomous cars) will keep changing the role and importance of digital technologies in our daily life and work. Consequently, future research needs to factor in the user dimension and further explore and conceptualize the interplay of the employment and omnipresence of digital technologies and platform services for users, consumers, and employees. This also includes questions of an individual's optimal degree of digitalization.

On a macro level, these implications will further advance yet initiated transformation processes and dynamics in the economy and society. First, DT will impact the *economy* as the dynamics will reconfigure traditional value creation networks and entire industries, leading to new types and constellations of competition. Incumbent companies might forfeit their place in the economy, while new players turn the orders up and down through the employment of digital technologies and innovative business models. Hence, future research needs to put more effort in understanding such market dynamics. This entails questions of which digital business models may sustain DT or even help forming it, which industries are affected by DT to what extent, or which markets dissolve or arise in the course of DT. Second, DT will have a *socio-economic* impact as, for instance, on the labor market. Traditional jobs might be rendered superfluous by digital technologies, while other tasks might emerge to control the new technologies (i.e., more sophisticated jobs such as data analysts) or to conduct (yet) hardly automatable task components of digital business models (e.g., unpleasant jobs such as dispatch riders). Third and in view of the *society*, the ongoing DT might further increase the emergent tendencies of individualization, distinction, and polarization. Hence, further research is required in highlighting and understanding both the positive and negative implications of DT. Altogether, future research needs to further explore and theorize the interdependencies and relationships among technology, economy, and society on both micro and macro level.

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Appendix

Content structure of the attached data medium:

00 Thesis

01 Figures

01-1 Figures of Chapter I

01-2 Figures of Chapter II

01-3 Figures of Chapter III

02 Data sets

02-1 Case Files (PDF+HTML)

02-2 Case Data Chapter II

02-3 Case Data Chapter III

02-4 Protocols

03 Published Articles

II.1 Technology Impact Types [PGBK19]

II.2 Organizational Ambidexterity [GlLe21]

II.3 Data-driven Business Models [DeGR21]

II.4 On-demand Healthcare [Glei20]

III.1 Digital Platforms in Insurance [PoGl19]

III.2 GAFAM in Healthcare [GlKP21]

Statutory Declaration

Eidesstattliche Erklärung und **Einverständniserklärung**

nach § 6 Abs. 2 Nr. 5, 6 und 7 der Promotionsordnung der Wirtschafts- und Sozialwissenschaftlichen Fakultät der Universität Potsdam vom 10.07.2013 von

Alexander Gleiß.

Hiermit versichere ich an Eides statt, dass

- meine hinsichtlich der früheren Teilnahme an Promotionsverfahren gemachten Angaben richtig sind;
- die eingereichte Arbeit oder wesentliche Teile derselben in keinem anderen Verfahren zur Erlangung eines akademischen Grades vorgelegt worden sind;
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Einer Überprüfung der eingereichten Dissertationsschrift bzw. der an deren Stelle eingereichten Schriften mittels einer Plagiatssoftware stimme ich zu.

Potsdam, 04.11.2021

Ort, Datum

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