Harnessing Digital Enterprise Transformation Capabilities for Fundamental Strategic Changes: Research on Digital Innovation and Project Portfolio Management

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Dedicated with great respect and deep affection to

my parents,

my wife,

and

those loved ones who are no longer with us.

Abstract

Digital enterprise transformations refer to the shifts in digital technologies, market structures, and customer demands that are fundamentally reshaping organizational structures, strategies, cultures, and business models. As a result of the rapid technological changes over the past years, the focus of decision makers has moved increasingly from cost reductions and business-IT alignment to the usage of digital technologies for developing new revenue-generating opportunities. Despite the high relevance of digital technologies in practice, many organizations lack an understanding about the capabilities and the building blocks required for successful digital enterprise transformations.

This thesis identifies digital innovation management and IT project portfolio management as the two key building blocks for effective digital enterprise transformation capabilities. The objective of this thesis is to develop a comprehensive understanding of the capabilities required to perform successful digital enterprise transformations. In the introduction paper, the goal of this thesis is decomposed into three individual yet interrelated research papers, each addressing specific sub-objectives and research questions. First, this thesis develops a more comprehensive understanding of digital enterprise transformations using an exhaustive literature review on the role of internal and external forces that effect business strategies today. Second, the thesis identifies archetypes of effective digital innovation management using a quantitative study. Third, based on a case study, this thesis identifies issues that impede effective project-based organizations in practice; specifically, the thesis develops design goals and principles for an IT project portfolio management configuration that is aligned and efficient yet agile. Finally, this thesis concludes by discussing the overarching main findings as well as its limitations and future research opportunities.

Overall, this thesis deepens our understanding on the microfoundations required for effective digital enterprise transformation capabilities. This thesis contributes to research, since it provides novel theoretical and empirical accounts on a prevailing problem. Decision makers and IT managers may profit from this thesis's results in that they can provide insights and recommendations into how firms can design innovation management and project portfolio management structures that are attuned to the context of digital enterprise transformations.

Keywords: *digital enterprise transformation, digital innovation, digital innovation management, project portfolio management*

Preface

"The universe is change; our life is what our thoughts make it."
— Marcus Aurelius (121–180 AD)

Change happens every day, and there is no way around it; our world will never stop changing, and neither will we. As we change, so do technologies. Our individual lives as well as the society at large will be what our beliefs and attitudes make of that change. This thesis is my humble attempt to express my thoughts on how organizations may seize the transformational opportunities brought by the staggering, digitally-enabled changes we are witnessing right now. However, before achieving this goal, it was necessary that I go through a strenuous yet exhilarating inner transformation myself—I needed to learn to move in uncharted scientific terrain and to deal with setbacks as I keep looking ahead with a positive mindset. Throughout this process, I was accompanied by many remarkable and well-disposed individuals—perhaps too many to enumerate one by one. Nevertheless, I would like to thank some of them explicitly.

First, I am deeply indebted to my supervisor Prof. Dr. Frederik Ahlemann for giving me the chance to pursue my doctoral studies at the University of Duisburg-Essen. My thesis would not have been possible without his boundless support, fruitful suggestions, helpful guidance, and constructive feedback. I am very grateful for the demanding yet enlightening time at his chair and am pleased to have worked with him. My sincere thanks also go to Prof. Dr. Nils Urbach for kindly accepting to be the second supervisor of my thesis.

Second, I also thank all my intelligent and humorous coworkers from the Chair of Information Systems and Strategic IT Management at the University of Duisburg-Essen for their support, feedback, and the delighting time. I am especially obliged to Andreas Drechsler for providing the initial impulse for starting my doctoral voyage, Florian Hesselmann for his advice during my first academic steps, and Kevin Rehring for making time in our shared office more enjoyable.

Third, I would also like to extend my gratitude to the Chair of Business Information Systems at the University of Hagen, the Chair of Information Systems and Strategic IT Management at the University of Bayreuth, and the colleagues from the IS department at the University of Duisburg-Essen for their valuable inputs during our research colloquia. In particular, I want to thank Sven Dittes for the helpful discussions about quantitative data analyses.

Finally, and most importantly, I am incredibly grateful for the warm-hearted support of my family and especially my wife Yvonne, who made this thesis possible through her constant encouragement all the way throughout the journey. Her love, patience, and trust always gave me peace of mind in tough times.

Krefeld, December 2019 *David Hoffmann*

Table of Contents

List of Publications

Preceding work or earlier versions of all research papers included in this thesis have either been published in conference proceedings or are currently under review for journal publication.

	Research Paper I	Research Paper II	Research Paper III
Title	Beyond Business-IT Alignment – Digital Business Strategies as a Paradigmatic Shift: A Review and Research Agenda	Enabling Digital Business Model Innovation: Organizational Design Configurations for Digital Innovation Management	Balancing Alignment, Agility, and Efficiency – Design Principles for Sustainable IT Project Portfolio Management
Related publications and VHB JQ3 ranking[1]	(Kahre, Hoffmann, and Ahlemann, 2017) [C]	(Böhl, Hoffmann, and Ahlemann, 2016) [B] (Hoffmann, 2018) [B]	(Hoffmann, Müller, and Ahlemann, 2017) [B]
Method[2]	Literature analysis	Quantitative survey	Qualitative case study
Co-authors	Cathrin Kahre, Frederik Ahlemann	—	Frederik Ahlemann
Assistance[3]	—	—	Data collection: Thomas Müller; data preparation: Stefan Reining
Own contribution	Framework development, literature review and analysis, development of research agenda, manuscript development	Model development, measurement and instrument development, pretest, data collection, data analysis, manuscript development	Model development, data collection, data analysis and coding, development of design goals and principles, evaluation, manuscript development

[1] Outlet ranking according to http://vhbonline.org/VHB4you/jourqual/vhb-jourqual-3/

[2] According to the classification provided by Palvia et al. (2004, p. 529)

[3] Refers to additional assistance that did not qualify for co-authorship in the dissertation's included version (Deutsche Forschungsgemeinschaft, 2013, p. 29)

Publications related to this thesis

Böhl, D., Hoffmann, D., & Ahlemann, F. (2016). The Structural Anchoring of IS/IT Innovation Management: Toward an Organizational Design Theory. In *Proceedings of the 24th European Conference on Information Systems (ECIS)*. Istanbul, Turkey.

Hoffmann, D. (2018). Shaping Wellsprings of Innovation: Towards Organizational Design Configurations for Digital Innovation Management. In *Proceedings of the 26th European Conference on Information Systems (ECIS)*. Portsmouth, UK.

Hoffmann, D., Müller, T., & Ahlemann, F. (2017). Balancing Alignment, Adaptivity, and Effectiveness: Design Principles for Sustainable IT Project Portfolio Management. In *Proceedings of the 25th European Conference on Information Systems (ECIS)*. Guimarães, Portugal.

Kahre, C., Hoffmann, D., & Ahlemann, F. (2017). Beyond Business-IT Alignment - Digital Business Strategies as a Paradigmatic Shift: A Review and Research Agenda. In *Proceedings of the 50th Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, HI.

Publications not related to this thesis

Hoffmann, D., Mikolon, J., & Ahlemann, F. (2018). Mehr in besserer Qualität - Blended Learning im Kontext der IT-Projektmanagementausbildung. In I. van Ackeren, M. Kerres, & S. Heinrich (Eds.), *Flexibles Lernen mit digitalen Medien ermöglichen: Strategische Verankerung und Erprobungsfelder guter Praxis an der Universität Duisburg-Essen* (pp. 181–195). Münster, Germany: Waxmann.

Mikolon, J., & Hoffmann, D. (2018). Stochastic Cellular Automation Modelling of Digital Platform Ecosystem Dynamics: Uncovering IT Innovations' Diffusion Patterns. In *Multikonferenz Wirtschaftsinformatik (MKWI): Research-in-Progress- und Poster-Beiträge*. Lüneburg, Germany.

Mikolon, J., Hoffmann, D., Greulich, M., & Werner, M. (2019). To Row Together Or Paddle One's Own Canoe? Simulating Strategies To Spur Digital Platform Growth. In *Proceedings of the 27th European Conference on Information Systems (ECIS)*. Stockholm, Sweden.

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A

INTRODUCTION TO "HARNESSING DIGITAL ENTERPRISE TRANSFORMATION CAPABILITIES FOR FUNDAMENTAL STRATEGIC CHANGES: RESEARCH ON DIGITAL INNOVATION AND PROJECT PORTFOLIO MANAGEMENT"

Abstract

This introduction provides an overview of this thesis's topic and structure, as well as the overall motivation and rationale. It explains the underlying motivation for the research and the research domain by introducing relevant concepts and by outlining prevalent problems in practice and research. Based on this discussion, the overarching research problem and research questions are derived. This paper further presents the taken philosophical stance and a synopsis of the overall research process. This paper concludes by providing an overview of the thesis' structure as well as a summary of the individual research papers and their key findings.

Keywords: *Motivation, research domain, philosophical stance, research design, research process*

Table of Contents

List of Figures

List of Tables

1 Introduction

Since the 1980s, the agenda of information technology (IT) executives was dominated by traditional management concerns such as business productivity, cost reductions, and business-IT alignment (Luftman & Derksen, 2012, p. 209). However, the rapid socio-technical developments of the past few years have challenged prevalent assumptions, in that these developments render traditional concepts such as business-IT alignment less meaningful. There are two main causes for this, namely the nature of digital technologies and the fundamental changes in how firms utilize digital technologies (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013, p. 472; Coltman, Tallon, Sharma, & Queiroz, 2015, p. 96). Here, technological developments such as smartphones, the Internet of things, cloud computing, artificial intelligence, 3D printing, and advanced data analytics are heralded to drive the next *technology inflection point*, thus setting the scene for a wave of digitally-enabled changes (Demirkan & Delen, 2013, p. 413; Zhou, 2013, p. 2). The ever-amplifying globalization increased international trade volume 19-fold over the past 60 years (bpb, 2018); as a result of this, diffusion rates of technologies are exponentially increasing and diminish the advantages for early adopters. While telephones took 75 years to reach 50 million people, the Internet achieved the same number of users in four years, and Twitter hit this number in nine months (Chui et al., 2012, p. 5; Frey & Osborne, 2015, p. 13). The ubiquity and the evolutionary pace of digital technologies have driven relentless changes in customer preferences and market structures, and these changes have in turn placed new demands on organizations (Berman, 2012, p. 16). The case of Kodak's unsuccessful response to the challenges brought by digital technologies illustrates how major firms fail to capitalize on emerging technological development and on rapidly changing customer needs (Lucas & Goh, 2009, p. 54). Today, an increasing number of companies enhance their customer experience through the use of digital technologies, and they augment their value creation processes through insights gathered from data about ongoing product use (Ansari & Krop, 2012, p. 1357). The tipping point of whether firms should locate digital technologies at their core business logic—and not as a mere supporter of business processes—may have passed. From 2008 to 2012, the topic of *revenue-generating IT innovation* has moved from the 17th position to the fourth position of IT executives' main concerns (Luftman & Derksen, 2012, p. 210). Well-established incumbents and new market entrants alike are increasingly seeking to leverage digital technologies for generating new revenue opportunities to differentiate in the market they compete in. Therefore, digital technologies must be linked indissociably to the firm's strategic core to avoid competitive disadvantages (Bharadwaj et al., 2013, p. 472).

The ongoing debate about digital technologies and their impact on organizations culminated in the research field of *digital enterprise transformation*—a term referring to the changes that digital technologies bring about in organizational structures, processes, business models, and culture (Hess, Matt, Benlian, & Wiesböck, 2016, p. 124). Digital enterprise transformations require that firms build appropriate capabilities to accommodate the changes brought on by digital technologies (Uhl & Gollenia, 2014, p. 29). Building on the seminal works by Barney (1992, p. 44) and Teece and Pisano (1994, p. 538), this thesis specifically focuses on the type of capabilities that represent the *complex routines that enable organizations to adapt to and capitalize on rapidly changing environments pervaded by digital technologies*. This understanding recalls Schumpeter's (1934) notion of "entrepreneurial function" (pp. 155) as continual reorganization, creative recombination, and change as a response to a pressing environment. While some firms today seem to have the required capabilities in place and excel at the development of novel digital products and services, many others suffer in the face of technological and competitive turbulence (Ansari & Krop, 2012, p. 1358). In a quantitative study by Kane et al. (2018, p. 9), the respondents listed the key challenges of developing structures that allow for corporate entrepreneurship and resolving the ambiguity and uncertainty of the fast-changing digital environment for firms that are striving to adapt to digital changes. While there is a mature body of research on topics such as *traditional* organizational transformations and new product development (e.g. Ansoff, 1957, p. 113), extant theory seems to provide little guidance for shaping successful digital enterprise transformations. Consequently, this thesis aims to organize and marshal the capabilities required for digitally-enabled changes. It contributes to the nascent body of knowledge on digital enterprise transformations in that it proposes several microfoundations for such capabilities based on empirical investigations, and the research here may guide organizations to cope with prevalent challenges.

To explore the ideas mentioned, this thesis is divided into three parts. Part 1 presents an introduction of the thesis (i.e., this paper), including the overarching research problem and design. Part 2 forms the core of the thesis and is the main body of the research. Following the cumulative tradition in information systems (IS) research (Hirschheim & Klein, 2012, p. 218), the second part features three research papers, each addressing specific research questions along the investigation process. Lastly, Part 3 summarizes the core findings, and it also discusses this thesis's implications, contributions, and limitations based on an overall assessment of all research papers.

In the following, Chapter 2 elaborates on the research domain of digital enterprise transformations as well as the required capabilities; it also derives the overarching research questions from the associated knowledge gaps prevalent in academia and practice. Chapter 3 lays out my research design by discussing my taken meta-theoretical assumptions and by outlining the overall research process and applied research methods. Chapter 4 demonstrates how the research design is reflected in the individual research papers and provides a summary of their key findings.

2 Background

2.1 Research Domain: Digital Enterprise Transformations

Over the past decades, IS scholars have investigated the impacts of *digital technologies* on organizational processes, structures, and strategies (Sambamurthy, Bharadwaj, & Grover, 2003, p. 258); they have also examined how firms may create business value and competitive advantage through IT (Kohli & Grover, 2008, p. 28). Hardware and software developments in the recent years turned researchers' attention to the unique properties of digital technologies. Increasing digitization (i.e., encoding analog information into discrete bitstrings) of various types on information resulted in the decoupling of information from physical carriers, such as the decoupling of book content from physical books (Faulkner & Runde, 2010, p. 7). This often enables a seamless recombination and reprogramming of information through standardized interfaces and file formats, which allows for artifacts to be incessantly re-purposed without changing a physical container (Kallinikos, Leonardi, & Nardi, 2012, p. 13). Digital technologies are reflexive by nature, meaning that they require the use of other digital technologies, such as the usage of a smartphone to utilize an app (Kallinikos, Aaltonen, & Marton, 2013, p. 366). Due to their nature, these technologies create positive network and diffusion effects, resulting in lower cost and lowered entry barriers (Fichman, Dos Santos, & Zheng, 2014, p. 333). Digitization moves along a continuum, ranging from the substitution of physical materiality (e.g., eBooks, music streaming platforms) to the digital augmentation of physical artifacts by embedding software, sensors, and other hardware into previously *pure* physical artifacts to improve product capabilities (Barrett, Davidson, Prabhu, & Vargo, 2015, p. 142; Vendrell-Herrero, Bustinza, Parry, & Georgantzis, 2017, p. 71). This includes networked artifacts such as autonomous cars, intelligent household devices, and smart meters; when placed in a network, these artifacts are able to react to human behavior and their environment (Rijsdijk & Hultink, 2009, p. 28; Wortmann & Flüchter, 2015, p. 221), ultimately forming the "Internet of Things" (Nylén & Holmström, 2015, p. 60). Digital technologies often build on layered modular architectures that make artifacts composable and malleable (Yoo, Henfridsson, & Lyytinen, 2010, p. 728) and enable increased release and update cycles (Rayna & Striukova, 2016, p. 217). These architectures allow changes to be applied in individual functionality without compromising the overall system, and they also allow features to be reconfigured or extended to address changing customer preferences, which are often based on insights gathered from usage behavior (Tiwana, Konsynski, & Bush, 2010, p. 683). For example, Tesla Inc. incrementally improves its shipped cars with advanced autonomous features via over-the-air software updates; the company also incorporates data about driving behavior to support engineering processes (Giaimo & Berger, 2017, p. 203). Furthermore, digital platforms functioning as one specific instance of digital technologies enable a large uncoordinated audience to contribute to the product's core by providing software development kits (SDKs) and application programming interface (APIs) (Yoo, 2013, p. 144). For example, the Google Play Store app market exceeded three million applications contributed by third-party developers by June 2017 (statista, 2018); this significantly enhances the stand-alone value (i.e., the core platform's value before developers add digital applications) of the Android operating system (Parker, Van Alstyne, & Jiang, 2017, p. 258).

Based on these characteristics of digital technologies that differ from traditional tightly coupled and integrated technologies (Draxinger, 2017, p. 7; Yoo, 2013, p. 141), their evolutionary logic was described as "fluid and editable, often embedded in complex, distributed, and shifting digital environments" (Kallinikos et al., 2013, p. 358). To investigate how digital technologies and the products and processes they enable are developed, researchers are putting increasing emphasis on the theme of *digital innovation* (Yoo, Henfridsson, et al., 2010, p. 725). According to Webster's Dictionary, innovation in general is "the introduction of something new" (Mish, 2009, p. 645), while Schumpeter (1934, p. 66) defines all types of innovations as the recombination of existing conceptual and physical resources to create something new. Innovations are new to the adopting organization and may occur in different forms, such as a firm's products and services, administrative processes, production equipment, work routines, and organizational structures (Damanpour, 1991, p. 561). Consequently, extant research on digital innovations is equally diverse. Some take a product-centric perspective by investigating the effects of the embedding of software and hardware into physical goods (Lee & Berente, 2012, p. 1430). Others take a process perspective and examine how organizational practices change through the use of digital technologies (Svahn, Henfridsson, & Yoo, 2009, p. 3). Yoo et al. (2010, pp. 13–14) carved out the distinctive traits of digital innovations as follows: (a) they unify features from previously separate products (i.e., convergence); (b) they allow for unprompted recombination of resources (i.e., generativity); (c) they evolve at a rapid pace resulting from exponential price-performance improvements; and (d) they unfold in distributed processes, which involve a wide variety of actors from previously separate industries.

Digital technologies and digital innovations reshape social and economic structures—this is a process broadly referred to as *digitalization* (Tilson, Lyytinen, & Sorensen, 2010, p. 3). While digitization refers to the technical process of converting analog information into digital bitstreams, digitalization refers to the socio-technical process of how digital technologies cause changes in various domains—from communication infrastructures to entire industries, markets, and social life (Brennen & Kreiss, 2016, p. 6; Yoo, Henfridsson, et al., 2010, p. 725). For example, smartphones, social media, and instant messaging services fundamentally changed social interactions (Kang & Jung, 2014, p. 385). Digital innovations also have the potential to disrupt prevailing market structures in major ways (Markides, 2006, p. 22). Here, on-demand ride sharing platforms (e.g., Uber) challenge traditional taxi services, while Amazon.com disrupts traditional brick-and-mortar retailers (Markides, 2006, p. 20; Remane, Hanelt, Hildebrandt, & Kolbe, 2016, p. 7). However, while the term digitalization is frequently applied on a macro-level when referring to digitally-enabled changes in industries or in the society at large, meso-level perspectives revolving around digital changes in organizations often apply the terms *digital transformation*, *business digital transformation*, or *digital enterprise transformation* (Berman, 2012, p. 16; Gianvito et al., 2018, p. 379; Uhl & Gollenia, 2014, p. 21). This transformation may be referred to as an *Industry 4.0* in the cases of manufacturing and engineering companies (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014, p. 240). Digital enterprise transformations are akin to *organizational transformations* (Chou, Liu, & Chen, 2011, p. 1730), which refer to substantial changes in organizational structures and practices as a response to pivotal changes in firm environments (Orlikowski, 1996, p. 63; Romanelli & Tushman, 1994, p. 1142). Contrary to traditional organizational transformations, changes in digital technologies and their usage represent the key triggers for departures from current trajectories in digital enterprise transformations (Chou et al., 2011, p. 1730). However, there are various understandings of the constituents, antecedents, and outcomes of digital enterprise transformations (Schallmo, 2016, p. 4). A recent systematic literature review on digital enterprise transformation that is scoped to publications in top-tier journals from the disciplines of management, information systems, organization, and marketing only yielded few results, and the review concluded that academia still lacks a consensus about this term (Gianvito et al., 2018, p. 378).

This thesis specifically focuses on the creation or use of digital technologies to reshape customer value propositions and on digitally-enabled changes in how the value is created, delivered, and appropriated in reconfigured cost and revenue structures to achieve competitiveness (Berman, 2012, p. 17; Matt, Hess, & Benlian, 2015, p. 340). From a practical perspective, this understanding is akin to Gartner's (2018) definition of the digitalization of enterprises. Together with associated changes in the corporate strategy, culture, and structures, this understanding provides an adequate organizational basis for the new operation model; it also reflects the core of what constitutes a digital enterprise transformation (Bharadwaj et al., 2013, p. 472; Hess et al., 2016, p. 124; Matt et al., 2015, p. 341). The concept transcends the traditional focus of IS research on process automation, business process redesign, and the integration of business functions by means of IT (Grover, Teng, & Fiedler, 1993, p. 435; Venkatraman, 1994, p. 82). Instead, this understanding advocates the idea that the traditional separation between business and IT strategies will dissolve as a result from the increasing entanglement of products and services with their underlying IT infrastructures (Bharadwaj et al., 2013, p. 472; Mithas & Lucas Jr, 2010, pp. 4–5).

2.2 Capabilities for Digital Enterprise Transformations

Since digital enterprise transformations require fundamental changes in strategy and firm scope (Gianvito et al., 2018, p. 381), the question arises as to how organizations can actually carry out digital transformations. Adaptation to change and transformation in general necessitates that organizations acquire the knowledge that is required for market survival and timely explore new opportunities for competitiveness (March, 1991, p. 72). The ability of a firm to effectively respond to changes in the environment is commonly referred to as *dynamic capabilities* (Teece, 2007; Teece, Pisano, & Shuen, 1997). Dynamic capabilities are defined as the capacities "by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die" (Eisenhardt & Martin, 2000, p. 1107). Dynamic capabilities are different from *substantive capabilities* (i.e., operating routines including products and processes), which are dedicated to the day-to-day functioning of the organization (Zahra, Sapienza, & Davidsson, 2006, p. 926; Zollo & Winter, 2002, p. 340). Here, the role of dynamic capabilities is to hone, reconfigure, and renew substantive capabilities (i.e., operational resources and competences) to address changing business environments (Teece, 2012, p. 1396). In the context of digital enterprise transformations, this thesis particularly focuses on the reconfiguration of substantive capabilities through the utilization of digital technologies to extend competitive advantage (Kesting, Cavalcante, & Ulhøi, 2011, p. 1337). Dynamic capabilities are considered appropriate for framing research on organizational transformations from a holistic perspective, since dynamic capabilities focus on the structures and processes that firms employ to enable change and growth in volatile environments (Dixon, Meyer, & Day, 2010, p. 418). As shown in Figure A-1, dynamic capabilities may be disaggregated into several capacities as follows: (a) to identify and assess opportunities (i.e., sensing), (b) to mobilize resources to address opportunities (i.e., seizing), and (c) to reconfigure and transform an organization's tangible and intangible assets (Teece, 2007, p. 1319, 2012, p. 1396).

The effectiveness of dynamic capabilities is context-specific, and it depends on institutional and external contingencies. These contingencies are seen to moderate between dynamic capabilities and competitive advantage (Barreto, 2010, p. 277). Firms need to align their sensing, seizing, and transformation capabilities with environmental conditions such as competitive intensity or technological turbulence (i.e., external fit) and with organizational strategy and structure (i.e., internal fit) to achieve superior performance (Wilden, Gudergan, Nielsen, & Lings, 2013, p. 88). Dynamic capabilities need to be combined with a good strategy to address the right opportunities (Teece, 2012, p. 1396). However, firms are also required to leverage their dynamic capabilities to modify their strategy and structures to accomplish necessary transformations in response to environmental changes (Teece & Pisano, 1994, p. 545).

Since the concept of dynamic capabilities is relatively generic, scholars recommend focusing on the *microfoundations* or the building blocks of dynamic capabilities (Teece, 2012, p. 1397) that facilitate strategic change in order to gain deeper insights and to allow for a more comprehensive analysis of the activities geared to strategic renewal (Kindström, Kowalkowski, & Sandberg, 2013, p. 1064). As shown in Figure A-1, each higher-order capability is formed by managerial microfoundations that encompass the required transformational processes, structures, and decision rules (Teece, 2007, p. 1321). In the context of digital enterprise transformations, *digital innovation management* may be considered as the key microfoundation to leverage new ideas and digital technologies for transformative business value (Berman, 2012, p. 21; Eisenhardt & Martin, 2000, p. 1109; Uhl & Gollenia, 2014, p. 37).

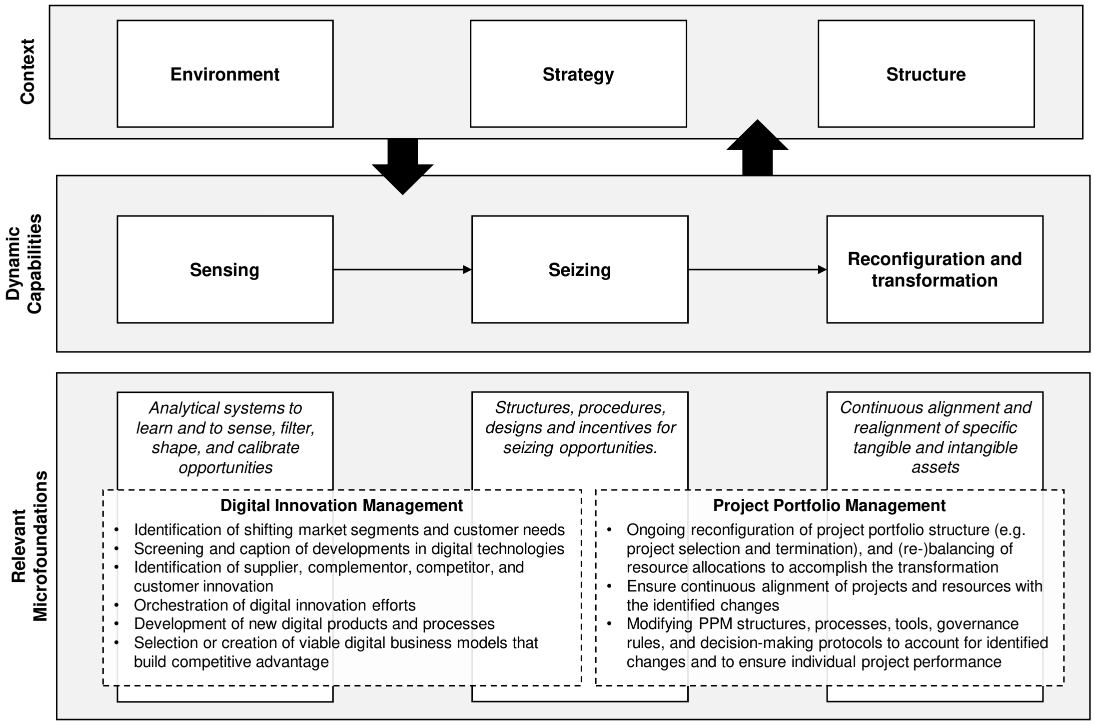

Figure A-1. Conceptual framework for digital enterprise transformations capabilities (based on Petit & Hobbs, 2010, p. 49; Teece, 2007, p. 1342).

In general, innovation management is defined as the "systematic planning and control of innovations in organizations or in networks of organizations" (Winter & Aier, 2016, p. 475). Given the impact of digital technologies on businesses, the concept of digital innovation management has received increasing attention over the past years (e.g. Nambisan, Lyytinen, Majchrzak, & Song, 2017; Nylén & Holmström, 2015; Svahn & Henfridsson, 2012). Digital innovation management may be understood as the collection of "practices, processes, and principles that underlie the effective orchestration of digital innovation" (Nambisan et al., 2017, p. 224). It acknowledges the nature of digital technologies in innovation management by putting a greater emphasis on their distributed evolution; this involves a variety of actors, fluid product boundaries, and their rapid pace of development (de Reuver, Sørensen, & Basole, 2018, p. 130; Nambisan et al., 2017, p. 227). Digital innovation management may be considered a dynamic capability, since the activities of digital innovation management may result in changes in a firm's substantive capabilities by digitally-augmenting products and processes, with associated changes in the firm's skill base that are required to create and deliver the new value propositions (Nylén & Holmström, 2015, p. 58). Here, the organizational learning, experimentation, and improvisation that are geared to the modification of operational routines and resources are seldomly routine activities (Lee & Kelley, 2008, p. 157; Zollo & Winter, 2002, p. 340). Digital innovation management involves gathering, interpreting, evaluating, and forecasting intelligence on new digital and market developments with respect to the current or future business (i.e., sensing), and from there it develops strategies for the subsequent appropriation of the developments in adjusted digital business models (i.e., seizing) (Fichman et al., 2014, p. 330; Frishammar & Åke Hörte, 2005, p. 254; Nylén & Holmström, 2015, p. 58).

Digital innovation initiatives are usually implemented and commercialized in the form of programs and projects (Uhl & Gollenia, 2014, p. 37); this idea highlights the point that digital innovation management and *IT project portfolio management* (IT PPM) need to be tightly coupled (Fernez-Walch, 2017, p. 122; Hanschke, 2009, p. 348). IT PPM encompasses all activities related to "(1) the initial screening, selection and prioritization of project proposals, (2) the concurrent reprioritization of projects in the portfolio, and (3) the allocation and reallocation of resources to projects according to priority" (Blichfeldt & Eskerod, 2008, p. 358). Changes delivered through projects that involve novel digital technologies would likely impact substantial capabilities (Kesting et al., 2011, p. 1337). Hence, IT PPM represents a key microfoundation in this study's context, since it becomes the primary means to deliver the new digitally-enabled operation models sensed and seized by the digital innovation management function (Berman, 2012, p. 21). IT PPM needs to select and prioritize projects that result from digital innovation management activities, and it also needs to mobilize adequate resources for their implementation (i.e., seizing) by employing appropriate processes, tools, and governance mechanisms (Petit & Hobbs, 2010, p. 50; Teece, 2012, p. 1396). Subsequently, it coordinates approved IT projects that use resources to generate new digital assets and capabilities that are required to achieve digital enterprise transformation objectives (Daniel, Ward, & Franken, 2014, p. 102; Petrović, Mihić, & Stošić, 2009, p. 161). IT PPM ideally balances project-related risks and rewards by reconfiguring the portfolio structure and resources in response to organizational changes; these changes are based on dynamic prioritization criteria that are scrutinized on a regular basis to ensure continuous alignment of projects with transformation objectives (Daniel et al., 2014, p. 102). By implementing digital initiatives that impact the business model and operations, IT PPM alters a firm's substantive capabilities to secure sustained competitive advantage (i.e., reconfiguration and transformation) (Dixon et al., 2010, p. 422). IT

PPM is clearly also part of a firm's substantive capabilities, since it does not exclusively engage in the exploration of new opportunities and the creation of new substantial capabilities as a response to change, but it also exploits existing competencies to perform operational activities (March, 1991, p. 72). Hence, an IT PPM that is ready for digital enterprise transformations needs to balance the opposing demands of strategic flexibility and agility, effectiveness (i.e., strategic fit), and efficiency (i.e., ensure individual project performance) (Kock, Heising, & Gemünden, 2014, p. 544; Meskendahl, 2010, p. 809).

2.3 Problem Statement and Research Questions

According to research by McKinsey, approximately 70% of all digital enterprise transformation initiatives do not reach their stated goals (Bucy, Finlayson, Kelly, & Moye, 2016, p. 2). Many companies fail at digital enterprise transformations in practice because they primarily focus on incremental changes, lack required capabilities, struggle from risk aversion, and lack speed, focus, and agility in their initiatives (Arora, Dahlstrom, Groover, & Wunderlich, 2017). To be up to par with their competitors, enterprises with low agility usually pursue a reactive technology investment behavior (Nissen, von Rennenkampff, & Termer, 2012, p. 931). Nevertheless, the cases of Kodak, Blackberry, and Blockbuster video rental services demonstrate how firms may get engulfed by technological and market developments; this occurs when they are unable to change and renew their strategic trajectories proactively and in an agile fashion (Gershon, 2013, p. 42). Proactive transformation is usually challenging, since the development of capabilities is path dependent, and firms are prone to organizational inertia (Sydow, Schreyögg, & Koch, 2009, p. 701). Many incumbents face challenges because they focus on exploiting existing competencies rather than promoting innovation and exploration (Ansari & Krop, 2012, p. 1358; Demirkan & Delen, 2013, p. 413; Zhou, 2013, p. 2). However, extant literature stresses that firms needs to address both the demands of exploitation and of exploration in order to achieve superior performance (Gibson & Birkinshaw, 2004, p. 212; March, 1991, p. 74). In other words, there are two objectives that firms need to achieve—to understand the significance and implications of digital enterprise transformations and also to build the necessary microfoundations for capabilities that enable them to proactively cope with these implications.

A question arises as to which existing theories may provide answers to the practical challenges that contemporary organizations face and which theoretical foundations may guide them in designing effective microfoundations for capabilities that are attuned to the context of digital enterprise transformations. A number of studies are considered to represent dominant theories in traditional organizational transformation research, namely the transaction cost theory, organizational learning, resource-based view, institutional theory, evolutionary economics, and also combinations thereof (Dixon et al., 2010, p. 418). The transaction cost theory from Williamson (1994) was applied to examine how firms optimize the efficiency of their organizational design under various circumstances (e.g., specificity of transactions), but it lacks explanations of how and when new organizational designs emerge (Roberts & Greenwood, 1997, p. 349). Furthermore, its strong emphasis on efficiency-based considerations may neglect other factors that are important for digital enterprise transformations, such as the role of technologies and their potential business value. Organizational learning and sensemaking perspectives (Weick, 1969) focus on how firms build new dynamic capabilities by searching for new routines and schemas (i.e., mental maps) that determine how firms undertake activities (Newman, 2000, p. 607). While such perspectives may advance our understanding of how organizations in general build new higher-order capabilities over time, they only provide limited insights into the specific microfoundations required to excel at digital enterprise transformations. Uhlenbruck et al. (2003, p. 261) employed the resource-based view of the firm (Barney, 1986; Wernerfelt, 1984) to explain how firms deploy their resources and capabilities to take advantage of market opportunities in transition economies. While the resource-based view may help us examine the effects of digital enterprise transformation capabilities that are *already* in place on firm performance (Nwankpa & Roumani, 2016, p. 11), it does not explain the genuine nature of the microfoundations and the shape of such capabilities. The institutional theory (Selznick, 1948) examines how organizations become more similar over time as a response to constraints and pressures in their environment (Newman, 2000, pp. 604–605; Peng & Zhou, 2005, p. 325). Similarly, the theory of evolutionary economics investigates the processes that transform entire economies, industries, employment, production, and growth (Dodgson, Gann, & Phillips, 2014, p. 11). Institutional theory and evolutionary economics alike aim to predict how firms adapt to resemble industry leaders through conscious imitation (Knott, 2003, p. 930). Hence, while both may guide us to understand how organizations strive to reactively imitate industry leaders in winner-take-all markets characterized by the domination of a few actors (Frank & Cook, 1996, pp. 107–108; Oestreicher-Singer & Sundararajan, 2012, p. 67), they seem unsuited to explain how firms utilize capabilities to proactively shape new digital market opportunities. Furthermore, since institutional theory focuses on uniformity in an organizational field (Roberts & Greenwood, 1997, p. 354) and evolutionary economics focuses on factor markets, they may be deemed more suitable for a macro-level perspective on the global phenomenon of digitalization. The aforementioned theories neither offer compelling or encompassing answers to the challenges in practice that were mentioned earlier, nor do they provide ready-made explanations for the microfoundations of digital enterprise transformation capabilities that allow firms to differentiate from their competitors by using digital technologies. The previous discussion is summarized as the overarching research problem (RP) of this thesis:

RP: *Due to a lack of theoretical and empirical underpinnings, many organizations struggle with the understanding and implementation of capabilities and the micro-foundations that are required for digital enterprise transformations; this situation manifests in low success rates of transformation initiatives.*

Renowned economist Edith Penrose (1989) claimed that there is only limited value in "universal comprehensive generalization purporting to explain all aspects of economic reality in one grand model" (p. 11). Similarly, innovation and dynamic capabilities literature alike suggests that our field needs fine-grained theories with reference to specific questions about the nature and activities of the microfoundations required to excel at digital enterprise transformations (Floricel, Bonneau, Aubry, & Sergi, 2014, p. 1092; Nambisan et al., 2017, p. 224; Teece, 2007, p. 1346; Tidd, 2001, p. 180). Dynamic capabilities are said to represent a *black box* that require further clarification by providing in-depth empirical investigations of their microfoundations and their contextual contingencies (Barreto, 2010, p. 276; Dixon et al., 2010, p. 431). Hence, the thesis addresses the overarching research problem by translating it into three key research questions (RQs).

First, the research problem stresses that the literature to date has given scant attention to how digital technologies reshape the core organizing logic of firms (Yoo, Henfridsson, et al., 2010, p. 725). Hence, it is necessary to gain a better understanding about the internal and external factors surrounding the process of digital enterprise transformations. While the overall conceptual framework in Figure A-1 (see section 2.2) highlights the interplay and confluence between the organizational and environmental factors and an effect on capabilities, there has not yet been an assessment on either the effects of firm and environmental factors on digital enterprise transformations or on the relation between the factors influencing the strategizing process and associated capabilities. To approach the research problem in a top-down manner, this thesis proposes to leverage the theme of digital business strategies. The concept of digital business strategies advocates a fusion of previously separate business and IT strategies to account for the transformations brought about by digital technologies and innovations (Bharadwaj et al., 2013, p. 472; Mithas & Lucas Jr, 2010, pp. 4–5). Hence, the theme of digital business strategy was chosen as a starting point, since it accounts for the digitally-enabled transformation of the entire organizational context (Mithas, Tafti, & Mitchell, 2013, pp. 512–513; Woodard, Ramasubbu, Tschang, & Sambamurthy, 2013, p. 538). This further includes lower-order concepts such as business models (Zott & Amit, 2008, p. 19; Zott, Amit, & Massa, 2011, p. 1031) and organizational structures and practices (Henfridsson, Yoo, & Svahn, 2009, p. 4; Nambisan et al., 2017, p. 224). Additionally, by applying extant theories on strategic change (Rajagopalan & Spreitzer, 1997, p. 69) that consider exogenous factors (e.g., market structures and technological developments) and the internal strengths and weaknesses influencing the need for a change to digital business strategy, it may be possible to provide contextualized insights that are relevant to the understanding of digital enterprise transformation capabilities. Hence, the first key research question addressed by this thesis is as follows:

> **RQ1:** *Which issues and phenomena at the intersection of strategy, technology, and organization need to be revisited in light of digital business strategies?*

Second, once we have gained a better understanding about the context and nature of digital enterprise transformations, the research problem suggests developing a more fine-grained understanding about designing the microfoundations that are required to actually carry out such transformations. The conceptual framework in Figure A-1 (see section 2.2) identified digital innovation management as one key microfoundation of digital enterprise transformation capabilities. While there is a mature body of research on innovation management in general—owing to the greater unpredictability level and nature of digital technologies (Yoo, Lyytinen, et al., 2010, p. 25)—findings from conventional innovation management or R&D research may not necessarily explain the effective management of digital innovation (Nambisan et al., 2017, p. 225). Extant literature suggests that the innovation management's effectiveness is decisively driven by its organizational design (Leih, Linden, & Teece, 2015, p. 2; Tidd, 2001, p. 179; Utterback, 1974, p. 81). This refers to the structures that determine the division of labor and the coordination and communication mechanisms that are used for managing innovation activities (Daft, 2009, p. 90; Miles, Snow, & Coleman, 1978, p. 551). Most often, historically grown structures act as *organizational filters* that screen out the information that is not relevant to the day-to-day business and thus increase efficiency, but they limit firms in appropriating new technological trajectories (Chandy & Tellis, 2000, p. 3). Thus, many organizations likely need to rethink their structures to allow for an effective digital innovation management (Svahn & Henfridsson, 2012, pp. 3348–3349). To assess the effectiveness of a particular organizational design, this thesis proposes applying digital business model innovativeness as a criterion variable. This refers to the degree of digitally-enabled newness embedded in a business model as a result of digital innovation activities (Garcia & Calantone, 2002, p. 125; Spieth & Schneider, 2016, p. 681). To date, extant literature that investigates effective organizational forms of digital innovation management is scarce (Hinings, Gegenhuber, & Greenwood, 2018, p. 3; Nambisan et al., 2017, p. 227). To close this knowledge gap relating to the first microfoundation of digital enterprise transformation capabilities, the second key research question of this thesis is as follows:

> **RQ2:** *How does digital innovation management's organizational design contribute to digital business model innovativeness?*

Finally, the conceptual framework in Figure A-1 (see section 2.2) posits that IT PPM constitutes the second key microfoundation of digital enterprise transformation capabilities. The previous discussions suggest that traditional approaches to IT PPM may not be sufficient to fulfill today's requirements in their entirety. Here, the uncertainty and the ambiguity associated with the evolutionary dynamics of the environment (Yoo, Lyytinen, et al., 2010, p. 25) require a flexible adjustment of IT project portfolios, and they force organizations to deliver an increasing number of projects in a shorter time than before (Kock & Gemünden, 2016, pp. 670–671). Nevertheless, while several professional bodies provide guidelines for a standardized and efficient exploitation of existing competencies by means of IT PPM (e.g. Project Management Institute, 2013), IT PPM approaches for the exploration and rapid responses to changes brought about by digital developments are not yet well understood. While a broad range of publications suggest approaches to optimize the efficiency of IT PMM (Kaiser, El Arbi, & Ahlemann, 2015, p. 127), they provide little advice on how organizations can achieve an IT PPM configuration that is able to proactively and efficiently seize emerging opportunities (Daniel et al., 2014, pp. 95–96; Frey & Buxmann, 2012, p. 1). Instead, many organizations today still suffer from projects that run late or do not meet intended objectives (Standish Group, 2015, pp. 6–7), and they fail to balance a consistent organizational alignment with the exploration of emerging digital opportunities in their portfolio (Kock & Gemünden, 2016, p. 678; O'Reilly & Tushman, 2008, p. 193). In sum, there is still too limited knowledge available on the factors that impede the coalescence of alignment, flexibility, and efficiency of an IT PPM that can serve as an appropriate microfoundation for digital enterprise transformation capabilities. Similarly, we are missing general recommendations on how the use of new digital technologies may be effectively implemented in an organization's operating model by utilizing the concept of IT PPM (Matt et al., 2015, p. 341). The final key research question that this thesis seeks to answer is therefore formulated as follows:

RQ3: *How can organizations achieve an aligned and agile yet efficient IT PPM?*

In answering the research questions, this thesis aims to contribute to the body of knowledge by elucidating the microfoundations of capabilities that are required for digital enterprise transformations on an empirical yet theoretically-informed basis. As explained in the next chapter, the decomposition of the research problem into three key research questions calls for a multi-staged, pluralistic approach to effectively dissect the research problem at hand (Palvia, Pinjani, & Sibley, 2007, p. 11).

3 Research Design

3.1 Meta-theoretical Assumptions

In the social sciences, findings are created through researchers, and thus the findings are usually guided and ingrained by the underlying philosophical stance (Guba & Lincoln, 1994, pp. 106–107). Here, the *inquiry paradigm* represents the set of basic beliefs and meta-theoretical assumptions held by a researcher that collectively represent a way of looking at the world, express how an individual perceives the nature of reality and knowledge (Mertens, 2009, p. 7), and define "what falls within and outside the limits of legitimate inquiry" (Guba & Lincoln, 1994, p. 108). Orlikowski und Baroudi (1991) argued that in the inquiry paradigm taken by researchers, they tend to "focus their attention on some things and not others, and bias their perception of the phenomena they study" (p. 25). In the domain of IS research, scholars typically discriminate between the two major paradigms *positivism* and *interpretivism* (Chen & Hirschheim, 2004, p. 200). Originated in the natural sciences, a positivist stance posits that a researcher and reality are separate, and that an objective reality and truth exists beyond the human mind. At the other end of the continuum, interpretivists assume that a researcher and reality are inseparable, and that knowledge is subjectively constructed through personal experience during the process of investigation (Weber, 2004, p. iv). Hence, as different philosophical assumptions provide different purposes of scientific inquiry and varying understandings of the examined phenomena (Chen & Hirschheim, 2004, p. 199), it is key to elaborate on the inquiry paradigm that underlies the mode of engagement; this allows for a reflection of the conducted research at the meta-theoretical level (Wahyuni, 2012, p. 69).

To perform a nuanced dissection of my taken stance, I base the following discussion of my philosophical assumptions on the four interconnected elements that constitute an inquiry paradigm: *axiology, ontology, epistemology,* and *methodology* (Guba & Lincoln, 2005, p. 192, 2005; Mertens, 2009, p. 10). Table A-1 provides a summary of the following discussion.

Table A-1. Anatomy of the inquiry paradigm.

Philosophical dimension and key question	**Taken stance**
Axiology (refers to the role of value systems and beliefs in conducting research) *"How do values, attitudes, and biases influence research?"*	*Value laden and etic-emic* • The thesis's objective is to maximize the benefits for organizations. • Research and facts are always value laden; the researcher is biased by world views and socio-cultural experiences. • Etic (outsider) and emic (insider) perspectives are found in different strands of the thesis.

Ontology
(refers to the nature of reality)
 	
"What is the nature of reality?"
	Critical and historical realism
	• Some entities exist independently of their identification (noumena), while others are dependent on human mind (phenomena).
	• Reality is multi-layered and stratified, and it consists of four overlapping modes:
	  • *Materially real* refers to entities that can be experienced and observed directly or indirectly (e.g., weather, humans);
	  • *Ideally real* refers to non-physical conceptual entities (e.g., discourse, language, signs, symbols, theories);
	  • *Artefactually real* refers to physical entities resulting from a human synthesis of the materially, ideally, and socially real; and
	  • *Socially real* refers to non-physical entities dependent upon human activity (e.g., market mechanisms, organizations, norms, conventions).
	• This reality is partially shaped by social, political, cultural, and economic forces.

Epistemology (refers to the nature of knowledge) *"What is the relationship between cognition and reality?"*	*Relativism* • Since there is a no proof way of knowing reality exists, research is a continuous journey to improve our understanding of reality. • Obtaining truth is difficult but not impossible. • All beliefs and artifacts are socially produced and hence potentially fallible.
Methodology (refers to the approach to systematic inquiry) *"How can we obtain the desired knowledge and understandings?"*	*Nomothetic-idiographic combination, methodological pluralism* • Development and testing of hypothetico-deductive generalizations for prediction are based on theoretical knowledge of causal mechanisms (i.e., nomothetic), and inductive generation of normative and prescriptive propositions are based on close dialogues with individual organizations (i.e., idiographic). • Mixed and multi-method design (quantitative and qualitative) is used. • Behavioral science and design science approaches are taken. • Range and scope focus on the development of middle-range theories.

Axiology refers to the overall role of researchers' bias and values associated with the process of scientific inquiry (Miller, 2000, p. 60). Axiology is akin to meta-ethics, which seeks to understand the nature of ethical properties and judgements (Goodwin & Darley, 2008, p. 1340). In general, this thesis subscribes to the statement that the objective of scientific research should be to maximize the outcomes for society, organizations, and individuals, while minimizing risk and harm and maintaining intellectual honesty (Mertens, 2009, p. 12). I reject the assumption of value-free inquiry as taken by pure positivists, and I also reject the assumption that social science researchers can always maintain an emotionally-detached stance in the process, as values are shaped through socio-cultural experiences that may bias the researcher–participant interaction and thus facts. However, opposed to a critical interpretivist's stance, I do not proactively inject my personal values into the research process to substantially influence the thesis's outcome. Instead, I aim to minimize the impact of my values by bracketing them (Ponterotto, 2005, p. 131). I adopted a combined etic-emic axiological approach (Wahyuni, 2012, p. 71), which is manifested in the different research papers of this thesis. The etic (outsider) view attempts to describe or predict behavior by employing constructs of a *universal status* without considering potential cultural differences. The emic (insider) perspective considers participants' self-understanding against the cultural and historical background of their individual organization, and it acknowledges their beliefs and worries in the research process (Davidson, Jaccard, Triandis, Morales, & Diaz-Guerrero, 1976, p. 10; Morris, Leung, Ames, & Lickel, 1999, p. 782). However, non-epistemic values such as emotions, ethics, and morals are generally not in the focus of this thesis (Baran & Davis, 2014, p. 15), although one research paper is slightly inclined towards social impacts and ethical standards of upper management behavior.

Ontology concerns the nature of reality and what can be known from this reality (Guba & Lincoln, 1994, p. 108). This thesis takes a moderate critical realist perspective. This perspective is different to the naive realism, which assumes a fully apprehendable and measurable reality, and different to a relativist view, which posits that reality depends on the mental constructions and perceptions of each individual (Ponterotto, 2005, p. 130). The critical realist stance views the physical and social world as existing independently from individual perceptions. However, it acknowledges that we certainly cannot fully apprehend that specific reality in its entirety (Miller, 2000, p. 68). Following Kant (1855, p. 178), this perspective posits that certain entities exist independently from our consciousness (i.e., noumena), while others depend on human cognition and are visible to an observer (i.e., phenomena) (Becker & Niehaves, 2007, p. 203). As noumena are "not an object of our sensuous intuition" (Kant, 1855, p. 185), only phenomena can be apprehended by an observer. The critical realist views differentiates between four stratified modes of reality, namely material, ideal, artefactual and social—materially real entities exist independently of human actions (e.g., the weather); ideally real entities originate from human discourse (e.g., models, theories); artefactually real entities are those physical artifacts which are produced by human actors (e.g., computers); and socially real entities are non-physical and depend on human activity (e.g., market mechanisms) (Fleetwood, 2005, p. 199). Socially real entities are different from ideally real ones in that they lack the discursive property, while the latter may offer theories or explanations *of* socially real entities (Fleetwood, 2005, p. 201). Additionally, the critical realist stance of this thesis is slightly inclined to historical realism, which acknowledges that the aforementioned modes of reality are evolved over time by cultural forces, social structures, and power relations (Guba & Lincoln, 1994, p. 110; Patomäki & Wight, 2000, p. 223).

Epistemology concerns the relationship between cognition and the object of cognition. This concerns whether we can obtain objective knowledge from reality (Becker & Niehaves, 2007, p. 203). Positivists assume that a *true* and replicable cognition of reality is possible by applying suitable measures and avoiding distortions in cognition (i.e., objectivism); they also assume that researchers are able to investigate the object of cognition without influencing it (i.e., dualism) (Guba & Lincoln, 1994, p. 110). At the other extreme, interpretivists argue that depending on the investigator's perspective, no objective reality exists, but there may be multiple truths (i.e., subjectivism); they also argue that meanings are created interactively as the researcher investigates the object of cognition (i.e., transactionalism) (Ponterotto, 2005, p. 131). In this thesis, I take a relativist stance, which may be regarded as a modified dualist/objectivist view (Mertens, 2009, p. 15). This perspective abandons the idea that true dualism is possible in social science research, yet it strives to maintain objectivity as an regulatory ideal (Guba & Lincoln, 1994, p. 110). The relativist stance acknowledges that culture, experience, and history shape research (Patomäki & Wight, 2000, p. 224) and that no proof way of knowing reality exists; instead, the stance understands research as a continuous journey to improve our understanding of reality (Weber, 2004, p. vi). Hence, this thesis assumes that obtaining truth is difficult but not impossible, and that research results are socially produced and hence potentially fallible (Pratten, 2000, p. 118). The taken perspective further emphasizes the compliance with general codes of academic conduct (e.g. Deutsche Forschungsgemeinschaft, 2013) and with community-specific best practices, such as the application of rigorous methods and the use of justificatory theoretical knowledge to underpin one's own research (e.g. Hevner, March, Park, & Ram, 2004, p. 92).

Finally, the *methodology* concerns how we can go about obtaining the desired knowledge and understandings (Mertens, 2009, p. 10). The methodology is different to the research method or research design (Morgan, 2007, p. 69). According to Wahyuni (2012), the methodology component in an inquiry paradigm encompasses the "underlying sets of beliefs that guide a researcher to choose one set of research methods over another" (p. 72), whereas the research method represents the actual procedures and techniques (e.g., interviews, surveys) to investigate a phenomenon of interest. The research design connects the ideological foundations of the methodology with the application of research methods that are considered appropriate for answering the research questions (Wahyuni, 2012, p. 72). This implies that the methodology must be congruent with its prevailing axiology, ontology, and epistemology (Guba & Lincoln, 1994, p. 108). While positivists rely heavily on experiments or quantitative methods to empirically test generalized hypotheses in a replicable manner and strive to eliminate any confounding biases (Guba & Lincoln, 1994, p. 110), interpretivists employ naturalistic designs and hermeneutical approaches such as ethnographies and in-depth face-to-face interviews, since the constructions pertaining to individuals can only be obtained via the interaction between and among the investigator and the object of cognition (Guba & Lincoln, 1994, p. 111; Ponterotto, 2005, p. 132). This thesis puts forward a combination of nomothetic and idiographic approaches, and it takes its place alongside the tradition of IS research's methodological pluralism and triangulation to temper biases (Mingers, 2001, p. 243). Researchers acknowledge that the true benefit of nomothetic knowledge depends on the extent to which it applies at an individual level (Dunn, 1994, p. 377). Taking the same line, the thesis's taken stance equally values nomothetic approaches, which aim to find broader generalizations about the phenomena of interest, as well as idiographic approaches that aim to provide highly detailed accounts of individual organizational practices (Wahyuni, 2012, p. 71). One assertion of this thesis is that there is not only one correct method of science (Hirschheim, 1985, p. 12), and therefore it applies a mixed and multi-method design by combining quantitative and qualitative methods. Across different stages, the thesis employs the development and testing of hypothetico-deductive generalizations and the generation of normative and prescriptive propositions; hypothetico-deductive generalizations are based on theoretical knowledge of causal mechanisms (i.e., nomoethic approach), while normative and prescriptive propositions are based on close dialogues with individual organizations (i.e., idiographic approach). Furthermore, this thesis subscribes both to *behavioral science research*, which strives "to develop and verify theories that explain or predict human or organizational behavior" (Hevner et al., 2004, p. 75), and to *design science research*, which aims to "extend the boundaries of human and organizational capabilities by creating new and innovative artifacts" (Hevner et al., 2004, p. 75). While the view of traditional design science focuses dominantly on the creation of novel IT artifacts such as software systems, this thesis employs a socio-technical design science approach that generates the prescriptions and interventions applied in the development and the use of IS to address governance and management issues (Carlsson, Henningsson, Hrastinski, & Keller, 2011, p. 110; Gregor, 2006, p. 628). The range and scope of insights generated by this thesis may be characterized as *theorizing of the middle range* (Pinder & Moore, 1980, p. 19). Contrary to the objective of generating all-encompassing grand theories that are unbounded in time and space but lack observational detail (Bacharach, 1989, p. 500; Gregor, 2006, p. 616), middle-range theorizing is bounded by a specific subject matter and has an in-depth focus on contextualized research to offer detailed insights into a specific phenomenon (Hassan & Lowry, 2015, p. 8). It accepts other theories and is open to cross-theoretical and cross-disciplinary fertilization (Pinder & Moore, 1980, p. 158). In this regard, theories of the middle range are less overbearing yet are abstract enough to provide generalizations that can inform research and practice; they are also highly accurate and testable (El Sawy, Malhotra, Park, & Pavlou, 2010, p. 844; Hassan & Lowry, 2015, p. 7).

When attempting to assign the overall configuration of this thesis's meta-theoretical assumptions to the traditional paradigm archetypes, I see that it is most closely positioned to a post-positivist stance that is slightly inclined to a critical theorist view in its ontological and methodological elements (Guba & Lincoln, 1994, p. 109). One might argue that commensurability is an issue, as some philosophical elements may be contradictory and mutually exclusive, particularly at the extremes of the paradigmatic continuum (Guba & Lincoln, 2005, p. 201; Morgan, 2007, p. 62). However, I regard this to be less of an issue, since a postpositivist and critical theorist stance are comparably close to each other in these dimensions. The individual research papers, based on the research questions, take slightly different meta-theoretical perspectives that are each closer to the traditional paradigm archetypes. This approach to inquiry is in line with Weber (2004, p. xi), who suggested that paradigmatic debates in IS research are often spurious and that the consummate differentiations are only of little help to improve our knowledge. Hence, I contend that this thesis overall takes a *pragmatist* stance (Mertens, 2009, p. 11; Morgan, 2007, p. 65; Tashakkori & Teddlie, 2010, p. 96; Wahyuni, 2012, p. 70), which argues that a philosophical stance is *true* if it *works* in providing answers to important research questions (Henderson, 2011, p. 342). Philosophical pragmatism embraces middle-range theorizing (Pawson, 2000, p. 283) and acknowledges that various techniques and views can and should be applied to obtain truth, depending on their fit with the problem to be solved (Morgan, 2007, p. 73; Tashakkori & Teddlie, 2010, p. 101). As Patomäki and Wight (2000) put it, "anything goes, as far as there are good reasons for it and it gives the promise of advancing our knowledge" (p. 227).

3.2 Research Process and Applied Methods

The overarching research questions and the meta-theoretical assumptions have guided the taken research path and the selection of applied methods of inquiry (Gregor, 2006, p. 634). Following calls for a pluralistic approach to research (Palvia et al., 2007, p. 11), this thesis applied varying research methods across the entire process and used the output of an antecedent phase as input for the subsequent phase (Mingers, 2001, p. 252). As depicted in Figure A-2, the research process was subdivided into three different phases, each of which constitutes a separate research paper with individual research objectives, an individual set of employed research methods, and individual outputs and contributions. Here, the middle-range theories generated throughout the process fall within different epistemic theory types, as elaborated in the following paragraphs. Nevertheless, all research papers are geared towards finding answers and solutions to the overarching problem and questions as articulated in section 2.3. Hence, each phase served as input to the following stages, with the aim to shed light on the phenomenon of digital innovation and PPM. Arrows in the figure indicate the dependencies among the individual research phases.

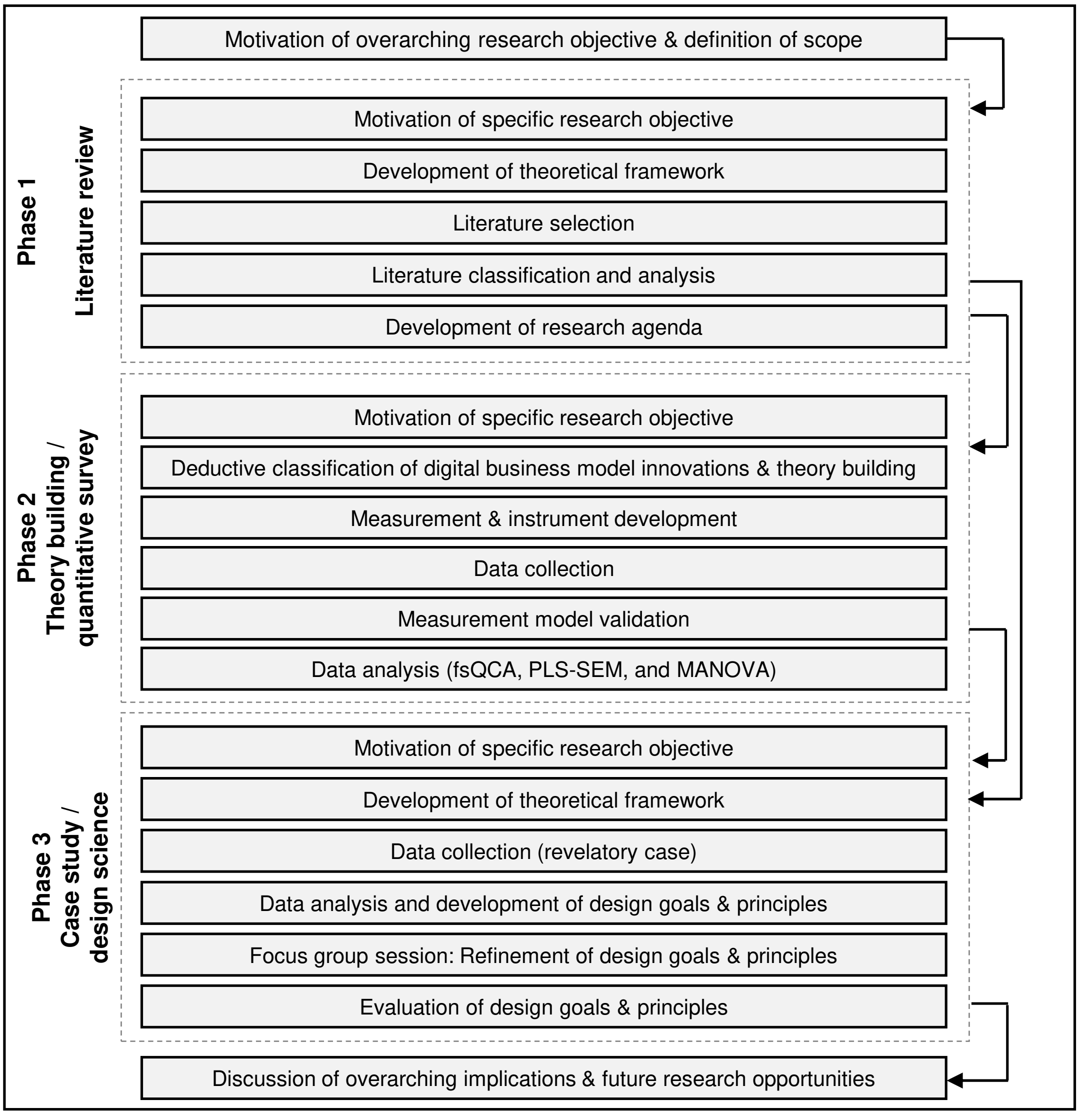

Figure A-2. Overview of the research process.

(1) Literature review: As a first step to unravel the state of the field on digital innovation management, a systematic literature review was conducted (Webster & Watson, 2002, p. xx). The objective was to develop an integrated synthesis on the topic of digital business strategies, carve out pivotal concepts, and point out avenues for future research (Cooper, 1998, p. 173). Putting the scope on digital business strategies allowed the study to achieve a broad coverage of publications that are potentially relevant to this thesis' overarching problem statement; this also allowed for a comprehensive discussion of prevalent knowledge gaps and research thrusts (Webster & Watson, 2002, p. xix). Referring to Cooper's (1998, pp. 3–4) framework, the review focused on contemporary research outcomes with the objective to synthesize past literature and to identify issues that are central to the field of digital business strategy. The review aimed to generate a representative overview of the state of the art and inform general scholars and practitioners. For the literature collection, major databases were screened by applying keywords related to the research question without limiting the search to individual disciplines or outlets (Webster & Watson, 2002, p. xvi), and a citation-based forward and backward search was carried out (vom Brocke et al., 2015, p. 216). Based on an inductive-deductive approach to content analysis by applying a systematic coding process (Mayring, 2000, pp. 3–7; Wolfswinkel, Furtmueller, & Wilderom, 2013, p. 6), an analytical framework was used to comprehensibly structure the corpus of papers in a concept-centric manner (Urbach, Smolnik, & Riempp, 2009, p. 319; Webster & Watson, 2002, p. xvi). The insights generated from the literature review served to scope the following research steps, and they conceptually informed all subsequent phases, as indicated by the arrows shown in Figure A-2.

(2) Hypothetico-deductive theory building and quantitative survey research: In the next step, a hypothetico-deductive approach for theory building and testing was employed. This etic approach builds on both the deductive formulation of hypotheses that are based on extant knowledge and on the subsequent empirical testing to falsify or corroborate the proposed theory (Dubin, 1969, p. 216). Based on a nomothetic approach that seeks to identify the "general causal laws" (Lee & Baskerville, 2003, p. 232), the objective of this phase was to clarify the concept of digital business model innovation and to identify common, effective structural arrangements of digital innovation management. For this purpose, I first developed a conceptual clarification of different digital business model innovation types based on extant literature (Cooper, 1988, p. 111). Next, a research model for effective digital innovation management design was built. To test the research model, a quantitative survey study was carried out for data collection (Pinsonneault & Kraemer, 1993, p. 78). Existing measurement models were adapted from the literature to the context of digital innovation management (Bourgeois, 1979, p. 446). Subsequently, the partial least squares structural equation modeling (PLS-SEM) was applied to validate the measurement models and to test direct effects (Ringle, Sarstedt, & Straub, 2012, p. x). For analyzing the collected data, fuzzy-set Qualitative Comparative Analysis (fsQCA; Ragin, 2000, 2008) was employed; fsQCA was deemed as particularly relevant, since this method allows different types of digital IM to be explored, and it provides insights into how these differences impact digital business model innovativeness (Fiss, 2011, p. 410). It further considers the combined effects of variables (instead of net effects, as in regression-based analyses); it also considers how multiple, equally effective *causal recipes* of those combinations may exist (Berg-Schlosser, De Meur, Rihoux, & Ragin, 2009, p. 8; Ragin & Fiss, 2008, p. 190). Finally, we employed multivariate analysis of variance (MANOVA) to relate these causal recipes to organizational performance. Following Gregor's (2006, p. 625) taxonomy of theory types in IS research, this phase yielded a *theory for predicting* (i.e., type III theory; *what will be*).

(3) Qualitative case study and inductive design science research: After having obtained an increasing understanding of the nomological interconnections gained from the preceding phases from a nomothetic perspective, the next step was to pursue a idiographic approach to provide a more detailed account of individual organizational practices that are related to digital innovation management (Dunn, 1994, p. 377; Wahyuni, 2012, p. 71). Hence, the objective of this phase was to understand the phenomenon by generalizing it from a specific context (Benbasat, Goldstein, & Mead, 1987, p. 369) to normative and prescriptive propositions through the application of a design science research approach (Hevner et al., 2004, p. 77). Since IT PPM is one of the primary functions that are affected by the uncertainty and ambiguity caused by the dynamic nature of today's business demands and digital technologies while being charged with the responsibility to implement digital innovation initiatives (Karimi & Walter, 2015, p. 45; Lee, DeLone, & Espinosa, 2007, p. 8), this context is deemed suitable for a more in-depth exploration of the overarching phenomenon. This phase focused on the identification of solutions to management issues in the field of IT PPM (Van Aken, 2004, p. 220) by generating prescriptive knowledge formalized through design goals and associated design principles. Here, design goals specify the scope and purpose of what should be achieved (Gregor & Jones, 2007, p. 320), while design principles may be viewed as general rules or recommendations that seek to guide organizations to achieve the stated design goals (Van Aken, 2004, p. 226). Investigating a revelatory case allowed the in-depth examination of issues impeding IT PPM agility, alignment, and efficiency (Eisenhardt & Graebner, 2007, p. 27; Yin, 2002, p. 42). Taking an emic perspective, ten interviews with a range of IT PPM-related stakeholders were conducted; two workshops were also held to unravel the underlying causes for ineffective IT PPM. Engeström's (1987, 2001) activity theory served as a framework for the deductive-inductive coding approach for analyzing the interview data (Miles & Huberman, 1994, p. 55), and it informed the subsequent creation of the design goals and principles as the kernel theory (Hevner et al., 2004, p. 80; Walls, Widmeyer, & El Sawy, 1992, p. 42). Our intermediate results were then presented to mid-level to senior-level management IT PPM experts who were not affiliated to our case company; this took place in a focus group session (Stewart & Shamdasani, 2014, p. 54), and subsequently the responses were refined based on the discussion results. To estimate and evaluate the relevance and utility of the final set of design goals and principles, they finally were subjected to a naturalistic ex ante evaluation (Venable, Pries-Heje,

& Baskerville, 2016, p. 79). The outcomes were evaluated in a series of 17 structured interviews with IT PPM experts according to the three dimensions of relevance as provided by Rosemann and Vessey (2008, p. 3)—namely importance, accessibility, and applicability. In terms of Gregor's (2006, p. 628) taxonomy of theory types, the resulting outcome represents a *theory for design and action* (i.e., type V theory; *how to do something*).

Finally, based on the insights gathered throughout the entire research process, the overarching implications for research and practice as well as future research opportunities were discussed.

4 Thesis Structure and Summary of Research Papers

The thesis at hand combines three stand-alone research papers that are consistently related to the research problem stated in section 2.3. This approach was chosen over a traditional five-chapter thesis format for four reasons: (a) it allows different inquiry paradigms to be better applied throughout the different research stages (see section 3.1), (b) it accordingly allows for a more nuanced dissection of individual sub-objectives as stated in section 3.2, (c) it allows findings and knowledge to be disseminated to the field more effectively, and (d) it better prepares for scholarship through training in writing and publication and the incorporation of reviewers' feedback (Gerber, 2000, p. 468; Willis, Inman, & Valenti, 2010, p. 45).

Overall, this thesis consists of three parts. Symbols contained in the black boxes represent the paper numbering. Part 1 includes this introduction paper and is followed by Part 2 that encompasses three research papers. Figure A-3 provides an overview of the individual research papers included in this thesis, their primary research questions, their theoretical foundations, and their objectives. Preceding versions of all three research papers have been published on highly ranked IS conferences.[4] Additionally, the third research paper is currently under review at a renowned journal. Part 3 includes a conclusion paper that briefly summarizes the thesis's major findings and discusses linkages between the separate research paper. To this end, it presents contributions to research and practice that become apparent from the overall assessment of all three research papers, the overall limitations and research gaps, as well as suggestions for future research. In the following, I provide a brief summary of the included research papers.

Research Paper I: Beyond Business-IT Alignment - Digital Business Strategies as a Paradigmatic Shift: A Review and Research Agenda

In the first research paper, the extant body of literature on digital business strategies is reviewed and synthesized. Since the 1990s, the idea of business-IT alignment (Henderson & Venkatraman, 1993, pp. 474–480) denotes that IT's primary function is to support organizations in achieving business objectives (Chen, Mocker, Preston, & Teubner, 2010, pp. 238–240). However, as digital technologies today are increasingly integrated into products and processes, they become transcendent over the traditional supportive role and also become the primary driver for performance and competitiveness in many businesses (Mithas & Lucas Jr, 2010, p. 4; Pagani, 2013, p. 619). Since the concept of digital business strategy is quite new to the field, a systematic literature review was conducted to chart the current publication landscape, with an objective to integrate the current state of the art and to identify research gaps and avenues for future research. Since digital technologies, environmental forces, and organi-

[4] See p. iv for an overview of published papers.

zational conditions mutually shape strategy and organizational outcomes, the theory of strategic change by Rajagopalan and Spreitzer (1997, pp. 69–70) is adapted as analytical framework to capture all facets of digital business strategies in a concept matrix (Webster & Watson, 2002, p. xvii). A key finding is that digital technologies fundamentally reshape how organizations operate from a strategic perspective, and that traditional concepts such as business-IT alignment needs to be rethought. Furthermore, while research bears certain starting points for understanding the tenets of digital business strategies, we know very little about how firms actually put digital technologies to practices, such as in cases of novel digital business models. Furthermore, the organizational structures and processes that are required to effectively support the management of digital innovations and related projects remain unclear to a large extent. Consequently, the paper develops a set of research propositions to address the identified gaps in future research.

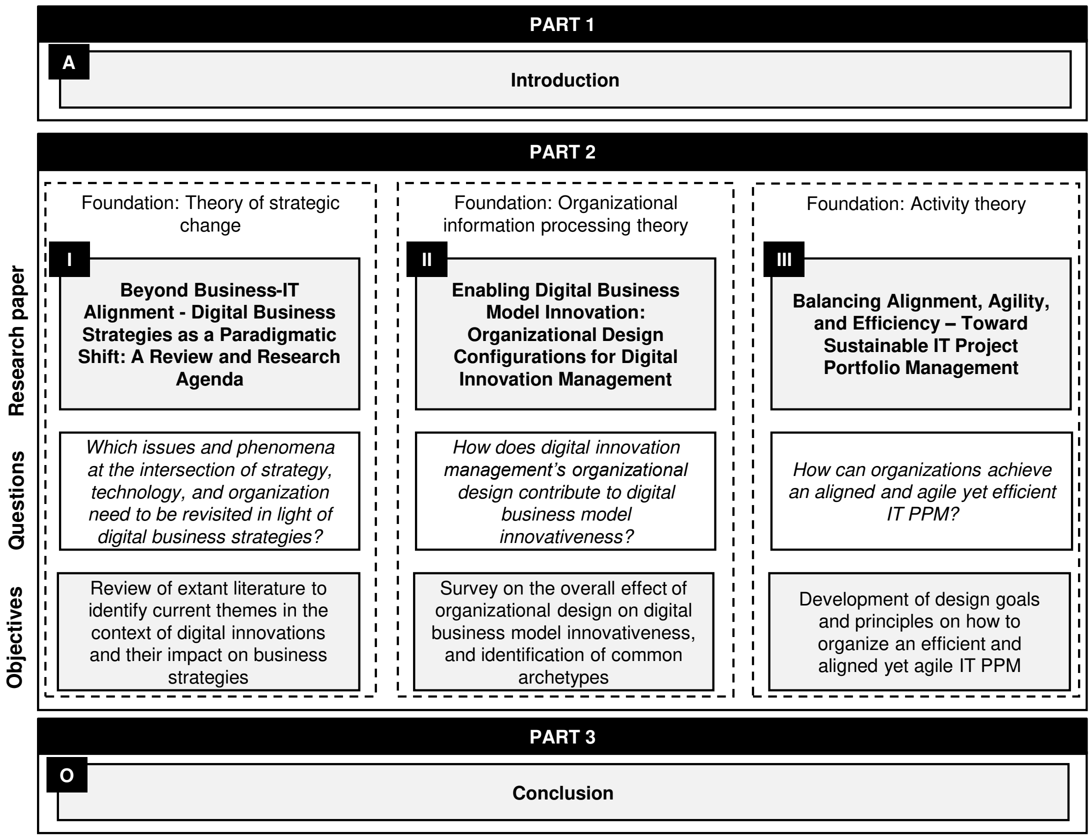

Figure A-3. Structure of the thesis.

Research Paper II: Enabling Digital Business Model Innovation: Organizational Design Configurations for Digital Innovation Management

The second research paper examines the role of organizational design for digital innovation management and its impact on digital business model innovativeness. The motivation for this study is the knowledge gaps found from the literature review, particularly gaps in the area of how firms deploy appropriate structures for accommodating digital innovation management, and how such an organizational design may impact digital business model innovativeness. Since the literature review also revealed that the concept of digital business model innovation is still nascent, the paper first sets out to clarify the notion of digital business model innovation (Fichman et al., 2014, p. 335; Rayna & Striukova, 2016, p. 217). Subsequently, a configurational framework building on Galbraith's (1973, 1974) organizational information processing theory and the fit-as-gestalts perspective (Mintzberg, 1979, p. 299; Venkatraman, 1989, p. 432) is developed. This theoretical lens is deemed useful here for two reasons: digital innovation management relies on substantial amounts of information processing (Tatikonda & Rosenthal, 2000, p. 75) and also organizational structures were found to represent the key factor for innovation success in previous research (Russell & Russell, 1992, p. 642; Tidd, 2001, p. 179; Utterback, 1974, pp. 81–82). The objective here is to develop a theoretical understanding for the effect of digital innovation managements' organizational design on digital business model innovativeness. The developed model posits that a configurational strategy-structure-environment fit is necessary for achieving a high degree of digital business model innovativeness (Priem, 1994, p. 430; Volberda, van der Weerdt, Verwaal, Stienstra, & Verdu, 2012, p. 1051). To this end, the model includes the contextual contingencies for digital enterprise transformations capabilities as presented in section 2.2. To empirically test the theoretical model and to identify "ideal-type" configurations of organization designs of digital innovation management, fsQCA was employed to analyze survey data (Miles & Snow, 1978, p. 29; Ragin, 2008, p. 190). The key findings suggest that multiple, equally effective configurations of digital IM directly contribute to organizational performance. The main contribution of this paper is in two main areas, namely the development of a comprehensive account of digital business model innovation and also the understanding of how firm strategy and structure of digital innovation management contribute to digital business model innovativeness. From a practical perspective, managers may apply techniques such as profile deviation analysis to assess the structural profile of their digital IM against the identified archetypes of top-performing organizations operating within a similar context (Kabadayi, Eyuboglu, & Thomas, 2007, p. 199).

Research Paper III: Balancing Alignment, Agility, and Efficiency – Toward Sustainable IT Project Portfolio Management

The third research paper proposes design goals and principles that represent suggestions for refining the traditional IT PPM toward a more agile, efficient, and aligned dimensioning. The previous stages highlighted that firms need to proactively respond to changing environmental and technological trajectories, and thus they are required to conduct a multiplicity of projects simultaneously and at an unprecedented rate to capitalize on emerging opportunities. Nevertheless, firms today often fail to align projects with short-term strategic changes, or struggle with completing projects in time and budget. The paper employs Engeström's (1987, 2001) activity theory as the analytical framework, which focuses on the *object-oriented activity system* as the intermediate unit of analysis. It provides a perspective on systems that can be characterized as a social structure with specific cultural and historical properties, where actors embedded in a community perform tool-mediated actions on a certain object to achieve a specific outcome (Kuutti & Arvonen, 1992, p. 234). In the study's context, the activity theory allows various analytical components to be included; these components account for the social, technical, and environmental forces that influence IT PPM (Engeström, 2001, p. 137). A case study was performed to identify the contemporary challenges of IT PPM that hamper flexibility. One key finding was that personal interests and top management interference spurred by long planning periods caused a lack of transparency about strategic priorities and requirements, resulting in an insufficient cooperation between the IT PPM and higher management levels. The negative effects rippled through the entire activity system, ultimately creating a vicious circle of high workloads and a high number of resource bottlenecks, as well as high rates of applied workarounds and outer-portfolio activities. Eventually, this resulted in ineffective IT PPM performance and subpar software quality, which triggered additional management interventions and thus reinitiated the vicious circle. The study subsequently derived, refined, and evaluated design goals and principles for a more sustainable IT PPM configuration that is aligned to changes yet also more flexible in adapting to them. The main contribution is the development of a new theoretical understanding on IT PPM and of the factors that impede the achievement of an aligned and agile yet efficient IT PPM. Here, the evaluated design goals and principles represent a potential solution for a significant problem in practice. The results further support practice to streamline their IT PPM to better achieve alignment and flexibility while maintaining overall efficiency of project execution, and it may augment existing portfolio management systems.

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I

BEYOND BUSINESS-IT ALIGNMENT - DIGITAL BUSINESS STRATEGIES AS A PARADIGMATIC SHIFT: A REVIEW AND RESEARCH AGENDA

Abstract

Since the 1990s, scholars and industry professionals have considered business-IT alignment to be the appropriate organizational frame regarding business and IT strategies. Subsequently, with the rising importance of innovative digital technologies for performance and competitiveness, the concept of digital business strategies (DBS) emerged. The fusion of business and IT strategies may account for the inevitable transformations triggered by digital technologies. This paradigmatic shift poses new challenges to practitioners and researchers, as current assumptions on strategizing processes have to be questioned again. This study sets out to clarify the current knowledge base on DBS in a structured way. It provides a threefold contribution by: 1) structuring the research efforts on DBS, 2) uncovering knowledge gaps, and 3) developing an agenda for future research.

Keywords: *business-IT alignment, digital business strategy, fusion view, literature review, research agenda*

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Table of Contents

List of Figures

List of Tables

1 Introduction

Information technologies (IT) have increasingly played a crucial role in determining nearly every aspect of our everyday life, especially in the business world (Collin, 2015, p. 29). Since organizations have become more dependent on their IT, many scholars no longer regard IT as sole service enablers but as sources of new opportunities (Chen, Mocker, Preston, & Teubner, 2010, p. 234; Krcmar, 2015, pp. 85–86; Peppard & Ward, 2004, p. 168). In this regard, researchers have agreed that IT provides sustainable competitive advantages, and in doing so IT can significantly influence corporate success (Peppard & Ward, 2004, p. 168; Porter & Millar, 1985, pp. 149–150).

While the importance of innovative technologies has steadily increased, practitioners and researchers have mostly treated IT strategies as subordinate to business strategies, and in particular they called for a business-IT alignment, which emphasizes the business value of IT but also its role as supporting the business strategy—not influencing and shaping it (Chan & Reich, 2007, pp. 297–298; Coltman, Tallon, Sharma, & Queiroz, 2015, p. 91; Sabherwal & Chan, 2001, pp. 11–12). While many chief information officers (CIOs) are concerned about their capabilities for fostering innovation and disruption within their IT organization, three out of four CIOs still regard business-IT alignment as one of the most essential capabilities (Kark, White, Briggs, & Shaikh, 2014, pp. 9–10). More recently, however, the concept of digital business strategies (DBS) has emerged to the fore, in turn postulating an inseparable merger of business and IT strategies as a prerequisite for organizations to drive innovations and remain competitive (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013a, p. 472; Mithas & Lucas Jr, 2010, p. 4). This phenomenon constitutes a global paradigmatic shift in the understanding of strategic management in the age of digital economics (Vukanovic, 2009), and it also accounts for the transformation of products, services, processes, organizational structures, and business models through innovative technologies (Mithas, Tafti, & Mitchell, 2013, pp. 512–513; Sandberg, 2014, p. 5; Woodard, Ramasubbu, Tschang, & Sambamurthy, 2013, p. 538). Since business and IT strategies should no longer solely *complement* each other (Chan & Reich, 2007, p. 300), it is imperative to assess how the fusion of business and IT affects organizations and their strategizing processes.

DBS play an important role, since strategy represents the linchpin for creating, extending, and modifying a firm's resource base (Wilden, Gudergan, Nielsen, & Lings, 2013, p. 76). Here, the specific emphasis of DBS may represent a crucial paradigm shift in that they position digital technologies as the primary driver for the transformation of resources and capabilities (Bharadwaj et al., 2013a, p. 472). However, while literature on IT strategy and business-IT alignment is manifold and mature (Jia, Wang, & Ge, 2018, p. 35), a preliminary selective review of literature indicated that the discussion on DBS is limited and fragmented, leading to a lack of transparency and focus. The unique notion of DBS differs fundamentally from the traditional understanding of business and IT strategies or the concept of business-IT alignment, so that current assumptions regarding the strategizing process must be questioned. Although scholars constantly add remarkable insights to the body of knowledge on constituents of DBS, they have not yet taken a holistic perspective in assessing the effects of organizational and environmental factors on DBS or the relation and causal agency between the factors that precede and influence the contents of DBS. Integrative knowledge remains sparse, specifically in the sense of a cumulative research tradition on DBS that could guide researchers in using this concept for further exploration and theoretical elaboration. A synthesized, comprehensive overview that integrates and structures prior research on dominant themes of DBS and their relationships has the potential to fertilize future research endeavors. Thus, the research question addressed in this paper is formulated as follows:

RQ: *Which issues and phenomena at the intersection of strategy, technology, and organization must be revisited in light of digital business strategies?*

To answer this question, we performed a systematic literature review. Reviews are particularly suited for a number of aims, namely to integrate and assess an emerging topic, to question traditional assumptions, to identify white spots, and to develop a research agenda for future inquiry (Rowe, 2014, p. 243; Schryen, Wagner, & Benlian, 2015, p. 3; Webster & Watson, 2002, p. xiv). Thus, the first objective of this literature review is to provide a structuring overview of the existing body of knowledge on DBS, particularly with regard to its contents, antecedents, and outcomes. The second objective is to identify research gaps and propose avenues for future research. We structured the review by adopting Rajagopalan and Spreitzer's (1997, pp. 69–70) theory of strategic change, since it accounts for both the environmental and organizational influences on strategy content and the subsequent effect on performance. The contribution of this paper is threefold: It provides a synthesized overview of contributions in the area of DBS, identifies gaps in research, and presents a research agenda for addressing these gaps.

The remainder of this paper is structured as follows. The next Chapter provides the necessary foundations related to DBS. Following this, the study explains the research design, after which the results Chapter presents a synthesis on the current state of knowledge. The study then presents the identified research gaps and an agenda for future research on DBS. Finally, the conclusion outlines a short summary including contribution and limitations.

2 Background and Analytical Framework

According to management science literature, a strategy represents a plan for achieving certain goals (Cöster, Petri, & Nilsson, 2011, p. 2; Davis, 1982, pp. 65–66). More specifically, business strategies focus on the positioning of the firm to achieve an advantage over competitors and on firms defending themselves against competitive forces (Prahalad & Hamel, 1990, p. 82; Thompson & Strickland, 1998, pp. 9–12). Over the past decades, strategy theorists have yielded an extensive body of knowledge on business strategies, recommendations on operationalizing strategies, the emergence of business strategies, and several typologies of strategy types (Miles, Snow, & Coleman, 1978, p. 558; Mintzberg, 2000; Porter, 1979, pp. 137–138). As the importance of information systems (IS) rises to a height in the 1970s, the demand for strategic planning and management of IT arose across all industries, thus setting the ground for dedicated IT/IS strategies (Chen et al., 2010, pp. 234–235; Henderson & Venkatraman, 1993, pp. 472–473; King, 1978, pp. 27–28).

Traditionally, researchers and practitioners viewed the primary goal of IT investments as supporting organizations in achieving business objectives and striving for a consensus among business and IT functions (Chen et al., 2010, pp. 238–240). Henderson and Venkatraman (1993) further specified this idea through the concept of business-IT alignment that describes the "degree to which the business strategy and plans, and the IT strategy and plans, complement each other" (Chan & Reich, 2007, p. 300). Research has shown that the successful alignment of business and IT strategy leads to better firm performance (Chan & Reich, 2007, p. 300). To provide a prominent example, the strategic alignment model (SAM) by Henderson and Venkatraman (1993) was widely recognized as the base for subsequent business-IT alignment research, and it has received several extensions and modifications over the past two decades (e.g. Bashiri, Engels, & Heinzelmann, 2010, p. 219; Maes, Rijsenbrij, Truijens, Goedvolk, & others, 2000, pp. 8–10). SAM provides an external perspective on IT (i.e., strategy) as well as an internal focus (i.e., infrastructure and processes); it also draws a distinction of strategic and operational integration between IT and the business. Based on SAM and its extensions, authors provided maturity assessment models and structured approaches to achieve business-IT alignment (Luftman, Dorociak, Kempaiah, & Rigoni, 2008, p. 2). However, in most of the past research on business-IT alignment, authors emphasized the subordinate role of IT strategies in supporting the business strategy but not in mutually shaping it (Chan & Reich, 2007, p. 298; Coltman et al., 2015, p. 91; Sabherwal & Chan, 2001, p. 13).

The recent trend of *digital enterprise transformation* (Berman, 2012, p. 16; Gianvito et al., 2018, p. 379; Uhl & Gollenia, 2014, p. 21) results in changes of this understanding of IT: It is seen as an increasing digitalization of products and services that significantly transforms existing business models, corporate structures, and whole industries (Bharadwaj et al., 2013a, p.

471; Collin, 2015, pp. 30–31). Consequently, this transformation affects internal operations and external transactions; it leads to a connected world with economic growth and an overall improved quality of life. ITs allow for a closer and more instant connection between enterprises and their stakeholders (Gephart, 2002, pp. 328–329), and as a result they also enable the realization of new opportunities (Lanzolla & Anderson, 2008, p. 75), which in turn dramatically reshapes the entire business (Elliot, 2011, p. 199). However, the sole existence of digital innovations usually does not result in the desired effects (Korhonen, 2015, p. 35; Sandberg, 2014, p. 5). Instead, this development calls for an active transformation of processes and systems through a redefinition of the organization's mission, organizational structure, and strategy in order to stay competitive (Muzyka, De Koning, & Churchill, 1995, p. 347). As IT becomes indistinguishably integrated into business services and products, they exceed beyond the common conception of merely complementing the business in a supportive way (Mithas & Lucas Jr, 2010, p. 4; Pagani, 2013, p. 619).

These aspects significantly influence the formulation of business strategies, and hence researches have recently undertaken more research on the topic of DBS (Bharadwaj et al., 2013a, p. 472). A DBS is a rather new concept, as introduced by Mithas and Lucas in 2010 (Mithas & Lucas Jr, 2010, pp. 4–5) and elaborated on by Bharadwaj et al. (2013a, p. 473) three years later. This concept represents an "organizational strategy formulated and executed by leveraging digital resources to create differential value" (Bharadwaj et al., 2013a, p. 472), and the emergence of innovative and disruptive technologies triggers this strategy (Mithas, Agarwal, & Courtney, 2012, p. 2). To clarify the novelty of the concept, Mithas et al. (2012, p. 3) outlined distinctive features of a DBS against traditional corporate strategies, namely that it (a) thrives for uncertainty, (b) focuses on a new game, (c) search for new sources of competitive advantage, and (d) pursues multiple goals simultaneously. In building on this, the authors believed that organizations should use uncertainty to their advantage when striving for competitiveness by developing dynamic capabilities and by relying on an improved level of real-time information (Mithas et al., 2012, p. 3). Bharadwaj et al. (2013a, pp. 474–478) concretized the term by defining four themes of interest, namely scope, scale, speed, and source. *Scope* defines the portfolio of the products and services; it emphasizes that a DBS not only unites corporate and IT/IS strategies but integrates the whole business ecosystem. In this sense, *scale* (i.e., leveraging network effects) becomes increasingly important due to the rising connectivity between partners and competitors. Besides the connectivity, digitalization also leads to an ascended *speed* of business activities. Lastly, the *sources* of value creation are expanded as digital technologies allow for new digital business models that extend beyond traditional chains of supply and delivery (Bharadwaj et al., 2013a, pp. 477–478). In sum, DBS thus reflect a "new logic of competitive strategy" (Woodard et al., 2013, p. 538), where the boundaries between business and IT/IS strategy become blurred (Peppard, Galliers, & Thorogood, 2014, p.

2). When business and IT are dynamically synchronized, they mutually become drivers of strategic change, business value, and ultimately competitive advantage (Bharadwaj et al., 2013a, p. 472; Mithas et al., 2013, p. 513; Sandberg, 2014, p. 7).

Consequently, business-IT alignment no longer represents the appropriate aim for organizational strategizing processes as it neglects the equivalent importance of business and IT. As DBS rise in importance for both researchers and practitioners, understanding their core becomes imperative. In this regard, it is of interest to examine the changes in the content of a strategy and in the dominant relationships, which exist among the important variables (Hitt, Tihanyi, Miller, & Connelly, 2006, p. 832). Business strategists differentiate between the characteristics of some common components for a specific strategy. One basic building block is the organizational conditions that foster the demand for a strategy or change in strategy (Døving & Gooderham, 2008, pp. 841–842; Hitt et al., 2006, p. 834; Homburg, Hoyer, & Fassnacht, 2002, pp. 86–87; Jansen, Van Den Bosch, & Volberda, 2006, p. 1662; Raisch & Birkinshaw, 2008, p. 2). Likewise, some have considered the exogenous factors that moderate the strategy formulation and adaptation process to be important for a thorough description (Hitt et al., 2006, pp. 846–849; Homburg et al., 2002, pp. 95–96; Jansen et al., 2006, p. 1666; Raisch & Birkinshaw, 2008, pp. 7–8). Next to assessing the conditions that shape a DBS, considering the outcomes of strategy implementation is equally essential, with performance outcomes being most prominent in management literature (Hitt et al., 2006, p. 852; Homburg et al., 2002, p. 96; Raisch & Birkinshaw, 2008, pp. 18–19). As organizations today face increasing turbulent conditions in light of digital innovation, they constantly try to co-align themselves with shifting competitive and technological environments through measures of strategic change in order to maintain continued survival and effectiveness (Kraatz & Zajac, 2001, p. 639). This alignment encompasses any activities of resource deployments and environmental interactions that represent how organizations aim to achieve their objectives (Schendel & Hofer, 1979). In particular, this includes organizational changes and changes in the content of a firm’s core strategy. Reciprocally, strategic change also includes how a firm aims to change its environment through an adjustment of its strategy.

For the present paper, we adopt the analytical framework visualized in Figure I-1 based on the theory of strategic change by Rajagopalan and Spreitzer (1997, pp. 69–70), which focuses on the outcomes of changes in strategies as well as on the environmental and organizational antecedents. *Environmental conditions and changes* describe the exogenous influencing factors characterized by uncertainty and dynamism. The *organizational conditions and changes* reflect both the internal weaknesses inhibiting changes and the strengths supporting the need for change. The *organizational outcomes* focus on noneconomic outcomes and financial performance effects alike. The reciprocal cause-effect relationship between the individual elements of strategic change is indicated through the arrows. Numbers on the arrows are used to classify extant publications in the concept matrix found in our results chapter. We deem this framework particularly useful for disseminating the topic of DBS, since researchers have commonly associated the topic with organizational transformation and strategic change (Bharadwaj et al., 2013a, p. 477; Mithas et al., 2012, p. 4). Applying this framework to chart the extant body of knowledge allows us to investigate the individual topics that influence DBSs and their relationships in a fine-grained manner.

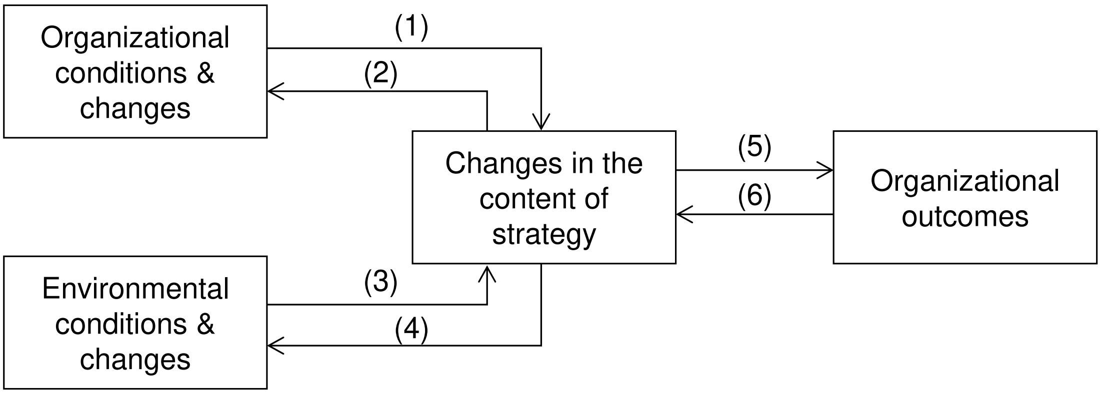

Figure I-1. Analytical framework adapted from Rajagopalan and Spreitzer (1997, p. 70).

3 Research Design

The paper utilizes a structured literature review approach to assess the current knowledge base and to derive possible research opportunities in the field of DBS. Researchers have acknowledged how literature reviews play a key role in the development of scientific knowledge and how they may serve as the basis for future research initiatives (Schryen et al., 2015, p. 2). To ensure high transparency and quality of our review, this Chapter clarifies on the *scope* (i.e., relevance) and the *review process* (i.e., rigor) of the research (Paré, Trudel, Jaana, & Kitsiou, 2015, p. 192). The scope of the review is classified in Table I-1 according to the typologies provided by Cooper (1988, p. 109) and Paré et al. (2015, p. 191). The review focuses on the research outcomes, methods, theories, and applications in the context of DBS; it also aims to combine previous research in interdependent ways in order to provide a holistic understanding of this concept and to identify related conceptual, theoretical, and methodological research gaps. In this way, this study takes a neutral stance and integrates the previous research results into the current discussion. The literature coverage is limited to a sample of representative articles; it does not include the entirety of the literature, since it is virtually "impossible to collect *all* [emphasis added] publications on a subject area in a comprehensive literature search" (vom Brocke et al., 2015, p. 214). The literature review follows a conceptual structure, since we analyze extant literature along with the concepts that are presented in our analytical framework in order to identify the relevant antecedents and outcomes of DBS. Overall, the results are dedicated to specialized scholars interested in the field of IT strategizing in general and DBS in particular. Since the review strives to identify patterns and trends by synthesizing the current research that may help to describe, understand, and explain the phenomenon of DBS, we may classify the review as a *descriptive* review (Paré et al., 2015, p. 190). We employ established recommendations (Cooper, 1998, pp. 182–185; vom Brocke et al., 2015, pp. 212–218; Webster & Watson, 2002, pp. xv–xx) to ensure rigor of the two-step *review process* that comprises both literature collection and analysis.

Table I-1. Classification of the Review Scope (based on Cooper, 1988, p. 109; Paré et al., 2015, p. 191).

Category	Criteria			
Focus	Research outcomes	Research methods	Theories	Applications
Goal	Integration	Criticism	Central Issues	
Perspective	Neutral representation	Espousal of position		
Coverage	Exhaustive	Selective	Representative	Pivotal
Organization	Historical	Conceptual	Methodological	
Audience	Specialized scholars	General scholars	Practitioners	General public
Type	Theoretical	Narrative	Descriptive	Scoping

3.1 Literature Selection

The literature selection follows the direction given by both the research gap and question as stated in Chapter 1 as well as the review scope as discussed in the previous chapter. More specifically, we used the terms "IT strategy," "IS strategy," "digital strategy," "digital business strategy," as well as combinations of "digitalization," "digitization," and "digital transformation" with "strategy" and "strategic management" in a full-text search in leading databases. These databases include the ACM Digital Library, AISeL, EBSCOhost, IEEE Xplore, ProQuest, and ScienceDirect. If the search across databases produced duplicates, we only considered one of the occurrences. To allow for a literature sample that is as representative as possible, we did not limit the search to certain publication outlets or specific timeframes,[5] as accordant restrictions would have unjustifiably reduced the sample size. Furthermore, both empirical work (i.e., *what is*) as well as editorials and conceptual publications (i.e., *what will be*) were deemed appropriate to inform our review. In deciding which publications to include in our review sample, we did not limit our usage only to those that used the term "digital business strategy" explicitly; rather, we regarded papers as suitable when they discussed digital strategy content in terms of "scope, resource deployments, competitive advantages, and synergy" (Rajagopalan & Spreitzer, 1997, p. 49), digital technologies, or digital enterprise transformations. We selected a preliminary review sample after reading the titles, key words, and abstracts of the search results. In addition, we complemented the literature selection process with a forward and backward search to yield additional publications that the initial search did not cover. Subsequently, we then studied the full texts and excluded publications that are not related to our objective. As a result of this refinement, the remaining 42 items include 35 peer-reviewed journal articles, three peer-reviewed conference papers, three book sections, and one doctoral dissertation.

[5] The literature collection was performed in June 2016.

3.2 Literature Classification and Analysis

To support the literature classification and analysis, this study developed a classification scheme that was adopted from Urbach et al. (2009, pp. 319–320). By differentiating between different factors across five categories, the scheme allowed for an initial classification that can provide an overview on the diversity of the identified literature. Table I-2 visualizes the classification scheme with the categories and criteria covered. After extracting the publication profile of each paper (e.g., year of publication, outlet), we documented the research approach (e.g., method and unit of analysis) and the underpinning theory. For analyzing the literature, we followed a deductive approach to content analysis and literature classification by applying the framework presented in Chapter 2 (Mayring, 2000, pp. 3–7). We analyzed the content and then classified the paper in a concept-centric manner to one or more of our analytical framework's dimension (i.e., the object of analysis); this framework's dimension is related to the components our framework (i.e., environmental conditions, organizational conditions, and organizational outcomes). We did not use *strategy content* as a criterion in the concept matrix, since it already served as the inclusion principle during the literature selection phase, and thus all papers in the sample fulfilled this criterion. We further analyzed whether the paper discusses any nomological relationships among the individual objects. Each paper's results were assessed and compared on a holistic level to identify common patterns and topics. For instance, several studies covered the influence of environmental turbulence and dynamism that result from rapid changes of digital technologies on the market position of organizations. From this, we identified the increasing role of technological considerations in a firm's strategy to maintain a competitive edge as one important theme. The summary of the review's core findings was structured according to the different objects of analysis to provide a comprehensive overview of the current state of the art. We compiled the results of the review process into a concise concept matrix, and ultimately this matrix served as a tool for the identification of research gaps and the development of a research agenda.

Table I-2. Literature classification scheme.

Category	Criteria
Publication profile	Title, author(s), year, outlet, discipline
Foundation	Underpinning theory
Research approach	Type of study (qualitative, quantitative, non-empirical), unit of analysis (organization, ecosystem), research method (e.g., case study, survey)
Object of analysis	Environmental conditions, organizational conditions, organizational outcomes
Nomological relationship	(1): Environment > Strategy, (2): Strategy > Environment (3), Organization > Strategy, (4): Strategy > Organization, (5): Strategy > Outcome, (6): Outcome > Strategy
Research results	Result type, result, limitations

4 Results

The literature review illustrates the rising importance of DBS for both theory and practice. Considering all publication profiles in our review sample, more than 80% of the papers that we identified were published between 2010 and 2016, thus emphasizing the novelty of the phenomenon and its gains in attention in the scientific community. The categorization of the analyzed publications reveals that the majority of papers we identified originates in the IS discipline while only a small proportion stems from the field of organizational behavior and management science. Some publications considered the whole ecosystem, i.e. a sphere of interacting organizations possibly crossing a variety of industries (Moore, 1993, p. 76)—but the greater share focused on the organization as their unit of analysis. Most of the papers that were identified are non-empirical; only seven conducted a quantitative research, and nine followed a qualitative research approach. More precisely, more than half of the papers are of a conceptual nature; four of them relied on a literature review, and eight constitute longitudinal studies, where researchers examine their object of analysis over a period of time. Next to longitudinal studies, there were five case studies, two field studies, and a survey that are represented.

The framework that was applied to identify the focus areas of the publications reveals a diverse discourse on DBS. A variety of papers have considered both the environmental conditions and changes as well as the organizational conditions and changes, while 16 papers also dealt with organizational outcomes. Since all publications have commented on the changes in the content of strategy, this element was excluded from the visualization. Likewise, all relationships among the elements are covered. The following subsections present a content-focused and in-depth description of the findings, which are structured according to our analytical framework. The respective subsections incorporate insights into the interrelationships between the elements.

4.1 Organizational Conditions & Changes

A prominent organizational precondition for the formulation of DBS is a change in the understanding of IT—that is, the role that technologies take in organizations. A variety of different publications have clarified the shift in the perception of IT over time: While IT was originally often regarded as either cost centers or expenses burdening companies, the understanding of their role changed towards that of an enabler or driver of business strategies (Cöster et al., 2011, p. 5; Luftman & Brier, 1999, p. 110). As already mentioned in Chapter 2, recent research has suggested that business-IT alignment no longer represents the suitable strategic posture. Companies should not regard IT/IS strategies as subordinate or supplemental to corporate strategy anymore but as coequal (Bharadwaj et al., 2013a, p. 480). This idea emphasizes an understanding of IT that is reflected in the term *fusion view,* where business and IT/IS strategies become inseparable (El Sawy, Malhotra, Park, & Pavlou, 2010, p. 837; Peppard et al., 2014, p. 3). If the merger of IT/IS and business strategies permeates the strategists' mindsets, the importance of DBS rise (Bharadwaj et al., 2013a, p. 478; Coltman et al., 2015, pp. 92–93). Consequently, the future strategizing process of companies should focus less on a successful alignment of business and IT but more on the development of a DBS, where IT precedes rather than aligns with corporate strategy (Coltman et al., 2015, p. 93; Mao, Kao, & Stomp, 2012, p. 125).

In addition to the understanding of IT, appropriate organizational structuring is another pre-condition for the formulation of a DBS. Literature has indicated that governance and power structures should account for the fusion of business and IT (Banker & Kauffman, 2004, p. 284; Fitzgerald, 1998, p. 318; Mithas, Ramasubbu, & Sambamurthy, 2011, p. 252). Here, research has considered leadership and accountability as one of the fundamental success factors for the realization of DBS (McKeown & Philip, 2003, p. 13). In this regard, organizations must decide on the senior manager who is in charge of the digitalization and development of a DBS and the associated report lines (Banker, Hu, Pavlou, & Luftman, 2011, pp. 488–489), as well as suitable incentive structures that are aligned with the digital strategy's objectives (Matt, Hess, & Benlian, 2015, pp. 339–340). For this position, CIOs, chief executive officers (CEOs), and new roles such as chief digital officers (CDOs) would be potential candidates (Matt et al., 2015, p. 341), as they are required to be visionary and operationally focused while being able to lead major changes (McKeown & Philip, 2003, p. 22). When it comes to the definition of new digital business models by means of innovative technologies, organizations have to ensure that the IT department is aware of senior management's tactical and strategic plans early on (Luftman & Brier, 1999, p. 111). The design and implementation of *digital governance* structures requires the joint work of IT and business representatives in equal measure; this is to ensure synchronized efforts (Hiekkanen, 2015, p. 46) and prioritizing initiatives (Hiekkanen, 2015, pp. 46–47; Luftman & Brier, 1999, p. 118).

As innovation is seen as the result of recombining existing resources (Lusch & Nambisan, 2015, p. 160; Mao et al., 2012, p. 127), researchers have underscored the importance of dynamic capabilities to quickly adapt to changing conditions and reconfigure their existing resource base accordingly (El Sawy et al., 2010, p. 837; Mithas et al., 2012, pp. 3–4). While the concept of *dynamic capabilities*—a term that describes a "firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environment" (Teece, Pisano, & Shuen, 1997, p. 516)—is not a new concept by itself (Eisenhardt & Martin, 2000, p. 1109), it has gained increasing attention in the context of digital innovations and their high frequency. The concept is now differentiated into *traditional* planned and improvisational dynamic capabilities; such capabilities enable spontaneous but not necessarily uncoordinated change in turbulent environments (El Sawy et al., 2010, p. 837). An accordantly achieved flexibility allows firms to prevent “maladaptive responses to turbulence” (Korhonen, 2015, p. 42), which responds to opportunities in the environment more easily and can consequently avoid potential threats from unexpected developments in the market (Drnevich & Croson, 2013, p. 486). Drnevich and Croson (2013, p. 498) specified that technologies enabling a spontaneous and instant reconfiguration of an organization allow unforeseen opportunities and threats to be captured and exploited. At the same time, this calls for a strong market orientation and corresponding intelligence mechanisms, since customers expect constant enhancements of products and services (Berman, 2012, p. 17). Customer-side operations changed again towards localized capabilities in order to satisfy the demand for high service-levels (Setia, Venkatesh, & Joglekar, 2013, p. 566). In equal measure, the architecture of products becomes more modularized to allow for a higher flexibility and reusability (Yoo, Henfridsson, & Lyytinen, 2010, p. 727). As a consequence, new digital business models are in demand, as these models exploit the declining costs of processing, storing, and analyzing information for the organizations’ own interests (Dhar & Sundararajan, 2007, pp. 126–127; Grover & Kohli, 2013, p. 656). However, structural inertia might pose a threat to the quick adoption to changes in the digital ecosystem, as this inertia highlights the stability of organizational arrangements, which is opposed to environmental change (Hannan, Pólos, & Carroll, 2004, pp. 217–219). In this sense, the current research also employs the path dependence theory, which provides explanations for the reduction of managerial scope of action through self-reinforcing strategic patterns on organizational and technical levels over time. Here, path-dependent organizations are seen as sociotechnical systems, and such organizations face challenges when it comes to the timely adoption of innovation due to coordination problems and high switching costs (Sydow, Schreyögg, & Koch, 2009, pp. 698–699).

Finally, changes towards a DBS lead to consequences for the entire company and are thus subject to potential resistance from different departments (Matt et al., 2015, p. 341). Therefore, the whole process requires top management support from business and IT, as this could prevent resistance and embed digital strategies in the employees’ mindset by actively involving the stakeholders (Banker et al., 2011, p. 490; Dhar & Sundararajan, 2007, p. 136; Ganguly, 2015, p. 7; Matt et al., 2015, p. 341; Mithas et al., 2011, p. 241). Since the ever-increasing digitalization makes it unlikely that most strategic directions get along without a digital component (Peppard et al., 2014, pp. 4–5), business and IT management have to define the future path for an organization mutually in order to either become or remain competitive (Berman, 2012, p. 18; Dehning & Stratopoulos, 2003, p. 10). Their attention and commitment to fuse business and IT in a structured way thus becomes a prerequisite for the success of the altered strategizing process (McKeown & Philip, 2003, p. 11). These developments highlight the demand for building adjusted organizational capabilities—which include IT, information management, and business competences, as well as organizational learning structures (Mithas et al., 2011, p. 250).

4.2 Environmental Conditions & Changes

According to the literature review, several exogenous factors influence the formation and implementation of DBS. One of the most prominent aspects is the reinforcement of competition through IT. The increasingly ubiquitous nature of IT diminishes the significance of technologies themselves, but it does enforce their effective and advantageous utilization (El Sawy et al., 2010, p. 841; Sandberg, 2014, pp. 6–7). Hence, technologies progressively turn into *hygiene factors* (Korhonen, 2015, pp. 37–41; Sandberg, 2014, p. 25): As their impact declines, an effective application to innovative digital business models becomes the distinctive feature (Korhonen, 2015, pp. 38–39; Pavlou & El Sawy, 2006, pp. 198–199). In this sense, all organizations, market structures, as well as whole industries are influenced by the digitalization and would require new transformational strategies to remain competitive (Berman, 2012, p. 18; Collin, 2015, pp. 30–31; Dehning, Richardson, & Zmud, 2003, p. 641; Korhonen, 2015, p. 35; Woodard et al., 2013, p. 542). Due to the digitalization, firms should explore digital trends to enhance, extend, or redefine their value proposition (Berman, 2012, p. 18), while market channels experience drastic power shifts (Bharadwaj et al., 2013a, p. 480). As a consequence, whole industries are confronted with changes in profitability, value chains, and market spaces (Dehning et al., 2003, p. 641). Viewed as a service ecosystem with a set of mostly loosely coupled actors that are engaged in the creation and delivery of value, the environment requires organizations to prepare themselves to be flexible and to maintain a shared worldview among participating actors (Lusch & Nambisan, 2015, p. 165; Markus & Loebbecke, 2013, pp. 649–651). While some organizations can achieve leading positions and power in these ecosystems, Markus and Loebbecke (2013, p. 651) challenged common beliefs in the competitive advantage of single, powerful actors. They suggested the consideration of business communities, which consist of multiple partially overlapping ecosystems with several dominant actors aiming for supremacy. The degree of competitiveness is further intensified by the rising price transparency that is expedited through internet markets. As potential customers are able to find the lowest price at near-zero search costs due to digitalization, rivalry increases tremendously (Drnevich & Croson, 2013, p. 490).

This development goes hand in hand with the increasing technological dynamism. Since innovative technologies elevate the organizational dependency on information systems (Dhar & Sundararajan, 2007, pp. 132–133; El Sawy et al., 2010, p. 842; Swanson, 1994, pp. 1069–1070), IT-enabled business becomes even more important than before (Collin, 2015, p. 31). While IT was traditionally utilized for supporting and enabling the business, IT now offers opportunities with regard to new products, services, or whole business models (Korhonen, 2015, pp. 39–41). Therefore, organizations constantly need to recognize and explore the potential offered by new technologies (Dhar & Sundararajan, 2007, p. 137; Peppard et al., 2014, p. 2). According to El Sawy et al. (El Sawy et al., 2010, p. 842), information systems reinforce environmental turbulences and therefore oblige their strategic usage (Pavlou & El Sawy, 2006, p. 199). Organizations must be able to quickly respond to dynamism and turbulence, which are characterized by demand uncertainty, technological discontinuity, and unpredictable changes in an industry (El Sawy et al., 2010, p. 841; Mithas et al., 2013, p. 516). In particular, organizations need the ability to constantly adjust strategies and structures to account for changing external conditions, especially against the background of increasing environmental turbulence (Pagani, 2013, p. 620). Therefore, an effective usage of IT is imperative for organizations "to be alert, predict the future, and effectively compete" (Granados & Gupta, 2013, p. 638). As market boundaries become blurred, the complexity rises, which therefore requires a more dynamic adaptation and positioning of organizations (Mao et al., 2012, pp. 126–127; Pagani, 2013, p. 626).

At the same time, digital strategic changes also influence the environment: Markets are confronted with altered strategic directions and ecosystems, and therefore they necessitate new ways of digital partnerships (Bharadwaj et al., 2013a, p. 479), which links to the aforementioned firm capacities such as market adoption and dynamic capabilities, as well as capabilities to design and manage networks of interacting organizations (Bharadwaj et al., 2013a, p. 480).

Research has pointed out that path-dependent organizations are either unwilling or unable to exploit opportunities arising from emerging information systems (Rothmann & Koch, 2014, pp. 79–81). In this sense, Wenzel et al. (Wenzel, Schmidt, & Fuerstenau, 2015, p. 7; Wenzel, Wagner, Wagner, & Koch, 2015, pp. 8–10) highlighted that innovative technologies have the potential to severely disrupt strategic paths of organizations. Disruption represents an environmental destabilizer for the self-reinforcing mechanism of strategic paths and therefore requires action taken in the form of repositioning or adapting the business strategy (Wenzel, Wagner, et al., 2015, p. 12). Without accordant adjustments, the disruption would induce the demise of the organizational path. Authors in the area of path dependency have supported the demand for DBS, and in doing so they shed further light on the disruptive nature of information systems on organizations.

Mithas et al. (2012) summarized the different drivers of DBS in five "elements of duality" (p. 2): In this regard, IT may represent either sustaining or disruptive innovation. Moreover, IT allows for both fundamental changes in markets as well as faster adaptation to changing environments. IT also provides new competitive advantages, but at the same time IT increases the transparency among competitors. The fourth duality lies in the reduced transaction costs that are confronted with the augmented application of IT within companies. Lastly, unpredictable novelties in IT yield uncertainty while improved analysis tools decrease this level of insecurity. To face these opposing developments, DBS are required to leverage the strengths of existent IT in order to restrict potential threats (Mithas et al., 2012, p. 4).

4.3 Changes in the Content of Strategy

According to Bharadwaj et al. (2013a, p. 480), questions of *how*, *when*, and *why* innovative technologies impact the scope of a business should be of particular interest to researchers when it comes to DBS. The authors specified that the business scope of a strategy defines the portfolio of products and services as well as the definition of necessary activities to create and deliver the portfolio (Bharadwaj et al., 2013a, p. 473). DBS firstly provide new options for value creation, and companies must be aware of these options (Bharadwaj et al., 2013a, p. 478). More specifically, digital products and services themselves become “fundamental driver[s] of business value creation” (Bharadwaj et al., 2013a, p. 480). Organizations should no longer manage IT as a standardized resource but should instead imagine digital strategy frameworks that introduce new sources of value creation (Yoo et al., 2010, pp. 730–731). Hence, digital innovations might disrupt traditional value chains, and such disruptions often lead to new product and service portfolios while addressing different markets and customer segments (Matt et al., 2015, p. 341). Consequently, digitalization induces networks of competitors, partners, and customers that need to be incorporated into the DBS (Bharadwaj et al., 2013a, pp. 479–480; Markus & Loebbecke, 2013, p. 652, 2013). This is further specified through the idea of value co-creation, an idea “which views value or experience as cocreated by the service offer(er) and the service beneficiary” (Lusch & Nambisan, 2015, p. 157). According to Lusch and Nambisan (2015, p. 171), the rising digitalization and the diverse opportunities that are offered by IT have induced ecosystems of co-creating and subsequently of interacting and interdependent entities. To comply for a value co-creation in the digital age, organizations must ensure appropriate internal processes and the distribution of roles, such as customer-facing employees who enhance the value experienced by the customer (Lusch & Nambisan, 2015, pp. 168–169). Hence, the digitalization can significantly expand the scope of business strategies; specifically, it can synchronize IT and resources with digital value propositions, and subsequently it becomes a part of the key resources and key processes of a firm (Mao et al., 2012, p. 127).

In this regard, researchers have agreed that digital technologies provide an opportunity that allows firms to expand or reconfigure their overall product and service portfolio. However, extensive strategic planning is necessary for redefining the business scope. Hence, based on an analysis of internal and external conditions, firms need to develop a roadmap for achieving specified goals and then put them into action (Mithas et al., 2011, p. 243). Here, it is significant to incorporate both top-down planning and bottom-up knowledge into the formulation process to achieve high acceptance for the resulting DBS (Mao et al., 2012, p. 128). Likewise, the development of *relational intelligence* must be considered; this refers to an open communication with stakeholders to legitimate operations and succeed in the ecosystem (Pagani, 2013, p. 627). At the same time, it becomes increasingly important to specifically prevent disclosure of information to the competition in order to perceive advantages over a longer time frame (Granados & Gupta, 2013, p. 637).

Another activity for the realization of DBS is the selection and implementation of appropriate information systems (Dehning & Stratopoulos, 2003, p. 9). This includes the careful choice and adaptation of disruptive technologies (Lucas, Agarwal, Clemons, El Sawy, & Weber, 2013, pp. 380–381) as well as the effective leveraging of IT capabilities (Pavlou & El Sawy, 2006, pp. 220–221). As business processes and underlying IT infrastructure are intermingled, digital assets must satisfy the requirements of the DBS (Mithas & Lucas Jr, 2010, p. 4; Pagani, 2013, p. 629). As DBS account for the transformation of processes, offerings, and structural aspects owing to new technologies, the changes toward a digital business can affect the organizational setting in tremendous ways. While minor changes to the corporate structure can be incorporated fairly easily, the placement of more radical new digital activities might require the creation of subsidiaries or other structural forms (Matt et al., 2015, p. 341).

In terms of the impact of DBS on organizations and their structuring, scholars point out that digitalization leads to transformations in “organizations, markets, industries, societies, and the lives of individuals” (Lucas et al., 2013, p. 371). As a consequence, new challenges confront businesses, as these challenges often require adjustments in strategies, internal processes, capabilities, as well as external services and intra-organizational relationships (Bharadwaj et al., 2013a, p. 480). In this context, the importance of organizational learning next to strategic design actions cannot be overemphasized (Merali, Papadopoulos, & Nadkarni, 2012, p. 5). Organizational learning includes both internal and external sources such as customers and competitors (Merali et al., 2012, p. 12). Establishing a corporate knowledgebase would enable the development of further dynamic capabilities and the opportunity for higher flexibility and adaptability (Mao et al., 2012, pp. 127–128; McKeown & Philip, 2003, p. 11). Furthermore, the role of senior managers can change dramatically because they carry huge responsibilities in making decisions about the institutionalization of innovative technologies (Bennis, 2013, pp. 635–636). According to Bharadwaj et al. (2013b, p. 634), this point represents one of the major challenges with regard to DBS, as managers are in need of new capabilities to manage the process, especially adaptive capacities (Bennis, 2013, p. 636). Furthermore, organizations should carefully integrate digital assets and IT infrastructures into the strategy while establishing profound IT capabilities at the same time (Korhonen, 2015, pp. 39–41; Mithas & Lucas Jr, 2010, p. 4). However, an adjustment of IS is not sufficient, since processes, systems, functions, and management all equally need to be digitalized (Ganguly, 2015, p. 10). This demonstrates the comprehensiveness of DBS, namely in how they require a holistic consideration of the organizational design.

4.4 Organizational Outcomes

An expanded or reconfigured digital business scope can facilitate organizations to cultivate opportunities, which in turn allow them to expand into new markets, diversify themselves, and gain competitive advantage (Bharadwaj et al., 2013a, p. 480; Drnevich & Croson, 2013, pp. 491–492). However, this requires organizations to identify ways to mitigate new, arising challenges by adjusting existing structures and processes accordingly. At present, research remains scarce regarding the performance outcomes of DBS, which deal with pay-offs in terms of non-financial and financial company performance.

In terms of non-financial improvements, a faster and better adoption to changing environmental conditions and customer needs can be achieved (Berman, 2012, p. 22; Fitzgerald, Kruschwitz, Bonnet, & Welch, 2013, pp. 6–10; Peppard et al., 2014, p. 5), which in turn would enable a higher differentiation from competitors and subsequently an extended sustainability (Bharadwaj et al., 2013a, p. 472; Ganguly, 2015, p. 5; Mithas et al., 2013, p. 519). While constantly changing environmental conditions erode strategic advantages, organizations that leverage DBS are able to enhance their flexibility and react to new opportunities and threats easily through changes in the infrastructure and innovations in their value propositions (Drnevich & Croson, 2013, p. 496; El Sawy et al., 2010, p. 842).

With regard to financial outcomes, studies have traced significant business growth and enhanced profitability back to a successful IT-enabled transformation process (McKeown & Philip, 2003, p. 14). Researchers have found that ITs and systems which are effectively leveraged with the help of DBS can offer an enhanced competitive positioning (Dehning & Stratopoulos, 2003, p. 13). Accordant competitive advantages might manifest themselves in improved customer service and subsequently satisfaction, higher performance, productivity, and profitability, as well as the creation of new value propositions (Ganguly, 2015, p. 6; Keen & Williams, 2013, pp. 644–646; Mao et al., 2012, pp. 126–127; Mithas & Lucas Jr, 2010, pp. 4–5). Better competitive positioning can even be achieved by adjusting market entry and exit barriers through appropriate IT (Dehning & Stratopoulos, 2003, p. 10; Drnevich & Croson, 2013, p. 498). DBS allow for higher organizational efficiency and effectiveness (Hiekkanen, 2015, p. 47) through streamlined operations and enhanced resources, as well as fully new capabilities or lines of business (Drnevich & Croson, 2013, p. 494; Fitzgerald et al., 2013, pp. 5–6). At the same time, successfully leveraged IS provide benefits with regard to governance costs by supporting the monitoring or coordination of the search, specification, and contract negotiation (Drnevich & Croson, 2013, pp. 497–498). Information on partners, buyers, suppliers, or competitors can be obtained and processed more easily, and this in turn facilitates the choice among alternatives (Drnevich & Croson, 2013, pp. 492–493). These aspects are also related to better financial performances that are reflected in profitability measures (Drnevich & Croson, 2013, p. 496; Mithas & Lucas Jr, 2010, p. 5) such as return on asset or return on investment (Ganguly, 2015, pp. 11–12; Matt et al., 2015, p. 341).

Only a few authors have analyzed how learning occurs as changes in the content of strategy are realized by assessing outcomes through defined procedures. Matt et al. (2015, p. 341) highlighted the need for a continuous reassessment of the underlying assumptions and the overall transformational progress based on organizational outcomes, but they did not provide explicit recommendations on the implementation. Conceptually related to the aforementioned path dependence of organizations, Woodard et al. (2013, p. 545) provided an empirical approach to assess *design moves*, which enlarge, reduce, or modify the number of digital artifacts by evaluating the range of available options and technical debt resulting from prior business outcomes.

According to the analytical categories discussed in the background Chapter, we synthesized our findings into the concept matrix presented in Table I-3. This analysis serves as the foundation for the following analysis of research gaps and also the outline of future research opportunities.

Table I-3. Review results as concept matrix.

		Object			Nomological relationship						Discipline			Unit		Type			Method					
	Theory	Environmental Conditions	Organizational Conditions	Organizational Outcomes	(1): Environment > Strategy	(2): Strategy > Environment	(3): Organization > Strategy	(4): Strategy > Organization	(5): Strategy > Outcome	(6): Outcome > Strategy	Information Systems	Organizational Behavior	Management	Organizational	Ecosystem	Qualitative	Quantitative	Non-Empirical	Conceptual Paper	Literature Review	Case Study	Longitudinal Study	Field Study	Survey
(Banker et al., 2011)	1		•	•			•	•			•			•			•					•		
(Bennis, 2013)		•			•			•			•			•				•	•					
(Berman, 2012)		•										•		•				•	•					
(Bharadwaj et al., 2013a)		•	•	•	•			•	•		•			•				•	•					
(Bharadwaj et al., 2013b)	2							•			•			•				•	•					
(Chan & Reich, 2007)	2		•								•			•				•		•				
(Collin, 2015)								•			•			•				•	•					
(Coltman et al., 2015)	2	•	•		•						•			•				•	•					
(Cöster et al., 2011)					•						•			•		•						•		
(Dehning et al., 2003)	2	•		•		•		•			•			•			•					•		
(Dehning & Stratopoulos, 2003)	3	•	•	•	•	•					•			•			•					•		
(Dhar & Sundararajan, 2007)		•	•					•			•				•			•	•					
(Drnevich & Croson, 2013)	3	•	•	•	•		•				•			•				•	•					
(El Sawy et al., 2010)	3	•	•	•	•			•			•				•			•	•					
(Ganguly, 2015)			•	•				•				•		•		•					•			
(Granados & Gupta, 2013)		•	•		•						•			•				•	•					
(Grover & Kohli, 2013)		•									•			•				•	•					
(Hiekkanen, 2015)		•	•	•							•			•				•	•					
(Keen & Williams, 2013)		•		•				•			•			•				•	•					
(Korhonen, 2015)		•									•			•				•	•					
(Lucas et al., 2013)		•			•						•			•				•	•					
(Luftman & Brier, 1999)	2		•				•	•					•	•		•						•		
(Lusch & Nambisan, 2015)	4	•	•		•	•	•	•			•				•			•	•					
(Mao et al., 2012)			•				•	•			•			•				•		•				
(Markus & Loebbecke, 2013)		•			•	•					•				•			•	•					
(Matt et al., 2015)			•	•				•		•	•			•				•	•					
(McKeown & Philip, 2003)	1		•	•			•	•	•		•			•		•					•			
(Merali et al., 2012)	3	•	•		•	•	•				•			•				•		•				
(Mithas et al., 2012)		•	•		•	•		•			•			•				•	•					
(Mithas & Lucas Jr, 2010)		•	•	•		•	•	•	•		•			•				•	•					
(Mithas et al., 2011)	3			•					•		•			•			•					•		
(Mithas et al., 2013)		•			•						•			•			•					•		
(Pagani, 2013)		•	•		•	•		•			•				•	•							•	
(Pavlou & El Sawy, 2006)		•		•	•		•		•		•			•			•						•	
(Peppard et al., 2014)	3		•				•				•			•				•	•					
(Sandberg, 2014)	3	•	•	•	•		•	•	•		•			•		•					•			
(Setia et al., 2013)	3		•	•			•	•	•		•			•			•							•
(Swanson, 1994)			•				•	•				•		•				•		•				
(Wenzel, Schmidt, et al., 2015)	5		•				•				•			•		•						•		
(Wenzel, Wagner, et al., 2015)		•	•		•		•				•			•		•					•			
(Woodard et al., 2013)		•	•		•	•		•		•	•			•		•					•			
(Yoo et al., 2010)		•	•		•	•		•			•			•				•	•					
N=42		**27**	**28**	**16**	**20**	**10**	**15**	**23**	**7**	**2**	**38**	**3**	**1**	**37**	**5**	**9**	**7**	**26**	**22**	**4**	**5**	**8**	**2**	**1**

1 = Strategy-structure theory; 2 = Alignment theories (e.g., MIT90s, SAM); 3 = Resource-based view & capability perspective; 4 = Service-dominant logic; 5 = Path dependence theory

5 Discussion and Agenda for Future Research

This paper aimed to assess the current state of knowledge on DBS and also to identify research gaps and paths. Table I-4 summarizes the key components of the proposed research agenda on DBSs. As pointed out, the results indicate a significant growth and rising attention on the environmental, organizational conditions, and changes in the strategy of organizations. The term *digital business strategy* gained much popularity in research and in practice after being coined by Mithas and Lucas (2010, p. 5). Yet, the underlying phenomenon of a fusion view of both domains emerged only roughly a decade ago when publications on business-IT alignment started to put emphasis on the use of IT for achieving overall competitive advantage (Chan & Reich, 2007, p. 289; Pavlou & El Sawy, 2006, pp. 199–200). The recent publications aim at going beyond the traditional understanding of business-IT alignment: As organizations increasingly digitize their business models and subsequently start to recognize the differential value of IT, researchers have been postulating the necessity for a “two-way alignment” (Coltman et al., 2015, p. 96) between business and IT (Bharadwaj et al., 2013a, p. 472). In this sense, organizations that possess digital options but are unable to leverage these assets through their business processes will likely fail to capitalize on digital opportunities (Coltman et al., 2015, p. 96; El Sawy et al., 2010, pp. 843–844; Woodard et al., 2013, p. 559). When these insights are taken together, they infer that business processes and capabilities become a means through which IT creates value, and in this way they epitomize a fundamental new notion of alignment between business and IT. Despite the growing body of literature, our review shows that many facets of DBS yet remain to be explored. We identified three primary gaps in extant research, namely (a) a lack of knowledge about the processes to explicate and implement DBSs, (b) a dominance of traditional business-IT alignment perspectives, and (c) a deficiency in understanding about the required capabilities needed to be successful at DBS.

First, from a holistic change perspective on DBS that encompasses content, context, and processes (Pettigrew, 1987, p. 657; Rajagopalan & Spreitzer, 1997, pp. 71–72), publications have primarily focused on the inner and outer contexts as well as on the content of DBS. Thus, current research primarily addresses the *why* of change and *what* of change questions when it comes to DBS. However, research remains scarce regarding the *how* of change—which can only be understood from a detailed analysis of the processes focusing on transformational changes, digital strategy formation, and implementation. In this context, comparative and longitudinal case study research on the activities, responsibilities, and success factors for the formulation of DBS may yield reliable and fruitful empirical insights. Based on this, we define one of the research directions to be as follows:

> **Research Thrust 1:** *How do organizations formulate and implement digital business strategies successfully*?

Table I-4. Agenda for DBS research.

Research gaps	Research thrusts	Research avenues
Extant research focuses on the ***why*** *and* ***what*** *of DBS but not on the* ***how*** *to implement digital business strategies*	How do organizations formulate and implement digital business strategies successfully?	• Identify phases, activities, and responsibilities for the formulation and implementation of DBS in longitudinal case studies • Analyze success factors for the formulation and implementation of DBS
Dominance of traditional business-IT alignment perspectives (e.g., SAM)	Which new forms and models of alignment are necessary in times of DBS? How do DBS contribute to organizational performance?	• Investigate decision variables that contribute to alignment • Empirically investigate the new organizational structures, processes, and governance mechanisms that are required in the age of digitally-driven businesses • Uncover the ultimate economic meaning of DBS, their competitive value, and the relationship to firm performance, and also develop methods to measure their value and benefits
Missing understanding about the dynamic capabilities and microfoundations that are required to excel at digital business strategies	How and when do organizations reconfigure their resource and capability base when they are confronted with DBS? How do digital technologies enable new forms of capabilities? How do organizations effectively leverage scarce digital resources and competencies from their ecosystem?	• Investigate the structures and processes of dynamic capabilities that are suited to digitally-enable a firm's resource base (e.g., digital innovation and portfolio management) • Form a thorough conceptual development of how digital capabilities differ from other capabilities • Identify different classes of digital capabilities • Investigate how the increased customer and supplier power impacts DBS

Second, a considerable number of researchers (Bharadwaj et al., 2013a, p. 472; Chan & Reich, 2007, pp. 303–304; Coltman et al., 2015, p. 96; Luftman & Brier, 1999, pp. 118–119) have employed theories on business-IT alignment—such as SAM and its successors—to reflect upon the current developments. As stated earlier, researchers have increasingly challenged the prevalent view on alignment, which has been advocated for almost three decades, and in some cases, this view has even been reversed (Coltman et al., 2015, p. 92). As the role of IT transcends beyond enabling the business (Lusch & Nambisan, 2015, p. 166), the role of the relationship between business and IT needs to be thoroughly re-investigated with renewed intensity. Today, a firm's competitors can easily replicate *commodity IT*, and thus firms need to find new ways to utilize digital technologies to differentiate themselves in their market. Researchers have now given increasing attention to the idea that strategic alignment is not the mere degree of how IT provides support for business strategy; however, this idea does require researchers to investigate which new decision variables contribute to alignment, and more generally, how new digital technologies change the meaning of alignment (Coltman et al., 2015, pp. 95–96). Researchers may further explore which organizational processes, structures, and governance mechanisms are suited to achieve alignment in times of DBS. To uncover new modes of organizing that support an effective positioning of the IT function as both an enabler and a trigger of digital strategies, Legner et al. (2017, p. 307) proposed focusing research efforts on new structural forms such as co-location, cross-functional digital teams, and innovation management. Hence, we formulate the second research thrust:

> **Research Thrust 2:** *Which new forms and models of alignment are necessary in times of digital business strategies?*

Further, seminal IS literature has stressed that business performance improves when IT resources and capabilities are aligned with business strategy (Sabherwal & Chan, 2001, p. 25). Researchers have suggested that the development and utilization of novel digital technologies may relate positively to firm performance (Fichman, Dos Santos, & Zheng, 2014, p. 335; Sambamurthy, Bharadwaj, & Grover, 2003, p. 239; Zott & Amit, 2008, p. 19). Nevertheless, it became apparent that the impact of DBS on organizational outcomes and reciprocal feedback mechanisms have been little examined up until now (Bharadwaj et al., 2013b, p. 634; Lucas et al., 2013, pp. 380–381; Setia et al., 2013, p. 570). We believe it is important to extend our knowledge of the impact of strategic changes on performance because this relationship may be fundamentally different in a digital ecosystem compared to traditional environments. This becomes evident through the concept of value co-creation, with performance outcomes shared among networks and communities of individual actors (Lusch & Nambisan, 2015, pp. 166–167; Pagani, 2013, p. 629). Hence, researchers may investigate the nomological network of DBSs and organizational performance, and they may also develop methods and metrics to measure and evaluate the overall value of DBSs. Thus, we propose the following research thrust:

> **Research Thrust 3:** *How do digital business strategies contribute to organizational performance?*

Third, we see a lack of research on the required capabilities and their building blocks to successfully carry out DBS. This is particularly striking, since the authors who are included in our review have predominantly adopted the resource-based view or a capability perspective as the most common theoretical underpinning (Dehning & Stratopoulos, 2003, pp. 8–12; Drnevich

& Croson, 2013, p. 497; Merali et al., 2012, p. 4; Mithas et al., 2011, p. 238; Peppard et al., 2014, p. 3). In the context of DBS, dynamic capabilities as “learning-to learn capabilities” (Ambrosini & Bowman, 2009, p. 34) play a key role, since they denote the ability of a firm to adapt to changes in volatile environments (Teece et al., 1997, p. 516). Dynamic capabilities for reconfiguring the resource base are seen as imperative for sustaining competitive advantage in the digital era (Coltman et al., 2015, p. 97; El Sawy et al., 2010, p. 842). Along these lines, Bharadwaj et al. (2013a, p. 476) argued that the “ability to recognize and respond to the fast-paced nature of innovation and implementation . . . is fundamental to a firm’s competitive success and survival under digital business conditions” (p. 476). While scholars from the organizational sciences have already yielded many publications on capability building and the emergence of dynamic capabilities at the beginning of the millennium (i.e. (Zollo & Winter, 2002, p. 340)), there is virtually no knowledge with respect to capability building in the digital era. We particularly lack insights into the microfoundations or *building blocks* that both constitute dynamic capabilities (Teece, 2012, p. 1397) and enable organizations to change how they operate, innovate, and reconfigure themselves through digital technologies. To leverage new ideas and digital technologies for transforming business resources and capabilities, the topic of *digital innovation management* promises fruitful research avenues. This kind of management denotes the “practices, processes, and principles that underlie the effective orchestration of digital innovation” (Nambisan, Lyytinen, Majchrzak, & Song, 2017, p. 224). It also serves as the primary function to alter a firm’s products and processes by utilizing digital technologies and by appropriating them in digital business models (Fichman et al., 2014, p. 330; Nylén & Holmström, 2015, p. 58). Nevertheless, we know very little about the organizational requirements for carrying out digital innovation management in different environmental and strategic contexts (Barrett, Davidson, Prabhu, & Vargo, 2015, p. 149; Kudaravalli, Faraj, & Johnson, 2017, p. 58). Hence, future research may investigate effective organizational configurations of such an innovation function that account for the unique properties of DBS. Furthermore, it may be valuable to investigate which new requirements the project and portfolio management systems need to fulfill in order to efficiently support the implementation of DBS, which are usually delivered through projects (Uhl & Gollenia, 2014, p. 37). Here, research has indicated that traditional project and portfolio management systems are increasingly challenged since they have to balance the previously unknown, rapid deployment of digital initiatives with operational efficiency (Kock, Heising, & Gemünden, 2014, p. 544; Meskendahl, 2010, p. 809). Thus, we propose the following research thrust:

Research Thrust 4: *How and when do organizations reconfigure their resource and capability base when confronted with digital business strategies?*

Furthermore, while first attempts have been made to define “digital capabilities” (Sandberg, 2014, p. 1) as a collection of routines for leveraging digital assets to create differential value, research currently lacks broader insights into what exactly these digital capabilities are, how they differ from other sorts of capabilities, and which different types of digital capabilities exist. We thus propose the following research thrust:

Research Thrust 5: *How do digital technologies enable new forms of capabilities?*

Table I-3 and Section 4.2 highlighted that most of the reviewed publications focus on the influence between environment and DBS. Nevertheless, we lack a theoretically-informed understanding about how organizations may proactively acknowledge environmental turbulence as driving forces in digital ecosystems as part of their strategizing process (El Sawy et al., 2010, p. 842; Pagani, 2013, p. 620). Many researchers have viewed the factors of increased volatility as well as uncertain and ambiguous nature of technologies as the most challenging exogenous forces, and these forces put pressure on organizations to constantly review and adjust their business strategy accordingly (Bennis, 2013, pp. 635–636; El Sawy et al., 2010, p. 845; Mithas et al., 2011, p. 243). Organizations have become increasingly connected to other actors in digital ecosystems in their value creation activities, and they do this with far-reaching strategic implications. Authors have put emphasis on the point that the networked co-creation of value infers a change of organizational structures among focal firms, suppliers, and customers towards digital ecosystems (El Sawy et al., 2010, pp. 845–847; Pagani, 2013, p. 620; Woodard et al., 2013, pp. 545–548). As organizations are increasingly dependent on the environment and its resources, the resource dependence theory (RDT) (Pfeffer & Salancik, 2003) might provide a suitable conceptual lens. The RDT argues that the extent of uncertainty varies depending on the distribution of critical resources in the environment (Nienhüser, 2008, pp. 11–12). The central notion of the theory is that all organizations depend on other organizations for the provision of critical resources, and that this interorganizational dependence is often reciprocal. The RDT was frequently applied to investigate the mechanics of different interorganizational arrangements, such as alliances, joint ventures, and mergers and acquisitions (Drees & Heugens, 2013, p. 1667; Nienhüser, 2008, p. 28). In the context of DBS, researchers have postulated that organizations should manage uncertainty to their advantage through appropriate digital investments in order to achieve a leading position in the ecosystem (Mithas et al., 2012, p. 2). While researchers such as Pagani (2013, pp. 626–627) have already provided insights into how digital ecosystems evolve and what their dynamics of value creation are, the RDT might serve as a theoretical lens to explain what actions organizations take to use environmental uncertainty to their advantage. In this sense, the digital ecosystem may be envisioned as a “hostility-munificence continuum” (Castrogiovanni, 1991, p. 551) that is characterized by the scarcity or abundance of resources and the ability to support the sustained growth of an organization. Moreover, several researchers proposed a meta-theoretical view by combining RDT with the resource-based view due to their complementary focus on resources (Hillman, Withers, & Collins, 2009, p. 14; Nienhüser, 2008, p. 17). As a single firm alone is often not able to seize the value inherent to digital technologies (Piccinini, Hanelt, Gregory, & Kolbe, 2015, p. 10; Selander, Henfridsson, & Svahn, 2010, p. 9), customers and suppliers gain an increasing power in the ecosystem (Barratt, 2004, p. 32). Future research may provide novel explanations on how organizations effectively acknowledge these external forces in their DBS. We therefore propose our final research thrust:

Research Thrust 6: *How do organizations effectively leverage scarce digital resources and competencies from their ecosystem?*

Besides these topic-related research avenues, we also identified methodological patterns and gaps in the extant literature. While the largest share of our review sample consists of non-empirical publications such as conceptual papers, editorials, or research commentaries, only a relatively limited number of studies employed empirical quantitative or qualitative approaches. Field study and survey research designs are seldom applied to the context of DBS, and for this reason we encourage researchers to explore the utility of quantitative methods to generalize and test emerging theories in the field. Nevertheless, we are confident that more qualitative research will extend our knowledge on the variables and their relationships that lead to the formation of DBS and subsequently apply quantitative research approaches. Hence, as soon as we accumulate more knowledge of what the variables of DBS are and how they will be measured, the survey and field study research as well as a combination of different research methods may yield reliable insights on DBSs and their impact on the alignment perspective (Benbasat, Goldstein, & Mead, 1987, pp. 369–371; Mangan, Lalwani, & Gardner, 2004, pp. 573–576).

In sum, the digital transformation and its influence on strategizing still offer plenty of room for investigation. This refers to both quantitative and qualitative approaches, as well as the diversity of theoretical underpinnings.

6 Conclusion

This paper examined the current knowledge base on DBS to identify changes in the strategy formulation process. The results are based on a structured literature review that considered 42 papers published between 1994 and 2015. To assess the current state of knowledge and discover further research opportunities, we adapted a framework disclosing relevant elements of strategic change.

The assessment of publications resulted in a detailed overview on the environmental and organizational conditions as well as the changes that foster and influence the changes in the content of strategy towards DBS. The study also analyzed and presented the organizational outcomes thoroughly. Based on these findings, we revealed knowledge gaps and subsequently developed an agenda for further research on DBS to account for our research question. Due to the novelty of the phenomenon, the scientific discourse currently lacks detailed insights on DBS, particularly their facilitators and outcomes as well as the reciprocal influences among these elements. Hence, future research should assess the moderating role of internal and exogenous factors such as dynamic capabilities, the role of top management, organizational structuring, and ecosystem dynamics. Both the consequences for the content of organizational strategies and their formulation and implementation offer equal research possibilities. In particular, questions of *how*, *why*, and *when* of organizational and processual transformations to realize DBS are significant and should be assessed using different conceptual lenses.

These findings highlight the contributions of the paper: For practice, the present research gives an overview on the relevance of DBS that will replace the demand for business-IT alignment, and therefore DBS will likely become imperative for managers in the future. In view of the scientific community, the paper highlights the need to question current assumptions on the strategizing process due to the progressive digitalization and the related emergence of DBS. Furthermore, the study introduced a structured description of the current knowledge base on DBS and the related content elements as well as an agenda for future research.

Nevertheless, the paper faces some limitations with regard to the research approach. First, some publications may potentially remain undiscovered due to the search terminology that focus on digitalization in combination with strategies. The novelty of the topic might impact the publication state such that more might be of interest.

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II

ENABLING DIGITAL BUSINESS MODEL INNOVATION: ORGANIZATIONAL DESIGN CONFIGURATIONS FOR DIGITAL INNOVATION MANAGEMENT

Abstract

The management of digital innovations represents a major challenge for organizations, since such innovations evolve rapidly in a converging, generative, and distributed fashion. Therefore, they differ greatly from other innovation types. Furthermore, creating novel digital products and services is not an end in itself, but it requires the understanding and adjustment of the activities across the entire business model to improve profit margins or achieve revenue growth. Given that digital innovation's logic is so diverse and that digitally enabling business models is so complex, the demands regarding institutionalized anchoring of the corporate innovation management function may be substantially different. However, research has given little attention to the individual features of digital innovation management's organizational design and the ways they relate to digital business model innovativeness. We address this gap by proposing a configurational model that is informed by the organizational information processing theory, as we aim to understand the mutual effects of organizational design and contextual factors on digital business model innovativeness. To do this, we employ fuzzy-set qualitative comparative analysis in analyzing survey data to test our model and to identify organizational configurations of digital innovation management. Our findings suggest that organizational strategies combine differently to form multiple effective and ineffective configurations, and follow-up statistical analyses confirm that firms with an effective digital innovation management also achieve higher organizational performance. Our research contributes to the field, since it enables us to achieve a theoretically framed understanding of a contemporary phenomenon and allows practitioners to scrutinize their innovation management function.

Keywords: *Digital innovation management, digital business model innovation, organizational information processing theory, organizational design*

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Table of Contents

List of Figures

List of Tables

1 Introduction

Today, the vast confluence of rapid technological developments, competitive conditions spurred by new market entrants, and changing customer needs is transforming products, services, and organizations (Lucas, Agarwal, Clemons, El Sawy, & Weber, 2013, p. 372; Yoo, Boland Jr., Lyytinen, & Majchrzak, 2012, p. 1399). Central to this phenomenon is *digital innovation* (Nambisan, Lyytinen, Majchrzak, & Song, 2017, p. 223). This denotes the use of digital technologies such as self-learning algorithms, sensors, 3D-printing, and digital platforms in a broad range of new processes, goods (e.g., *smart* products), services, or the use of such technologies during the innovation process itself (Hinings, Gegenhuber, & Greenwood, 2018, p. 54; Porter & Heppelmann, 2014, p. 69; Svahn, Mathiassen, & Lindgren, 2017, p. 243). For example, NASA's Open Innovate crowdsourcing platform is used to foster the discussion around future innovations by exposing NASA technologies to citizen scientists (Hardash, Graham, Decker, & Thompson, 2014, p. 3). Whereas traditional innovation models assume quite a linear progression of developments (Moore, 1995, p. 17; Rogers, 1962, p. 243), digital technologies evolve in a non-linear, reflexive, and distributed manner (Yoo, Lyytinen, Boland, & Berente, 2010, p. 13), and they consequently "challenge traditional ways of organizing" (Boland, Lyytinen, & Yoo, 2007, p. 644).

Although studies estimate that the global economic impact of digital technologies will likely reach up to US$13.5 trillion per year by 2025 (Negreiro & Madiega, 2019, p. 2), a digital innovation building on such technologies by itself has no economic value (Chesbrough, 2010, p. 354; Teece, 2010, p. 173). The economic value of a new digital product, service, or process remains latent until it is put to use in some way through an adjusted business logic, thereby allowing ongoing economic rents to be extracted (Woodard, Ramasubbu, Tschang, & Sambamurthy, 2013, p. 540). This perspective suggests that organizations place *digital business model innovations* in the focus of digital innovation research rather than artificially narrowing the scope on novel digital products, services, or processes. Business model innovation in general represents new ways of proposing, creating, delivering, and capturing value to achieve competitive advantage (Teece, 2010, p. 186). *Digital* business model innovation was broadly described as changes in business models that are embodied in or enabled by digital technology (Fichman, Dos Santos, & Zheng, 2014, p. 330). However, the extant body of knowledge lacks clarity and comprehensiveness about the concept and how individual business model components are innovated through digital technologies. For example, Fichman et al. (2014, p. 335) argued that both digital product and business model innovation focus on the supply side, and subsequently the authors treat them synonymously. Considering that digital technologies are found to pervade all demand- and supply-side stages of the value chain beyond individual products (Chesbrough, 2010, p. 355; Nambisan et al., 2017, p. 223), we contend that this perspective falls too short to explain how organizations may seize the inherent benefits of digital innovation (Leih, Linden, & Teece, 2015, p. 2). For example, Amazon effectively orchestrates digitally-enabled innovations across their entire business model. They extend their value proposition by offering video streaming services or by commercializing unused infrastructure capacities as cloud services; they also enhance their value delivery by using automated warehouses and drones, and they broaden the value creation by offering self-publishing opportunities (Marques da Silva & Lindič, 2011, p. 1703). Overall, our current understanding of digital business model innovation remains rather vague. This is particularly puzzling, since we see that digital business model innovations are at the heart of the socio-technical process referred to as digital transformation (Hess, Matt, Benlian, & Wiesböck, 2016, p. 124; Lusch & Nambisan, 2015, p. 158; Teece, 2010, p. 186). Hence, as a first step, this paper aims to provide a clear conceptualization of digital business model innovation by answering the following research question (RQ):

RQ1: *What is the nature of digital business model innovation?*

Business model innovation requires that firms proactively track technological trajectories, identify unmet customer needs, and subsequently develop a commercialization strategy that defines how to capture value from these insights in an updated business logic (Amit & Zott, 2012, p. 43; Teece, 2010, p. 173). However, due to technology's rapid and complex evolution, firms may find it increasingly difficult to identify promising digital technologies in a timely way, assess their potential for addressing new or unmet customer demands, and relate them to their business model (Nylén & Holmström, 2015, p. 58). To excel at digital business model innovation, firms need to orchestrate large amounts of information across various internal and external sources, and subsequently they have to channel these into the innovation processes (Nambisan et al., 2017, p. 229; Yoo, Lyytinen, Boland, et al., 2010, pp. 21–22).

Literature has suggested that *organizational design* (OD) plays a key role in effectively managing innovation-related information (Daft, 2009, p. 92; Tidd, 2001, p. 179; Utterback, 1971, p. 81). OD in the innovation context refers to structural parameters such as the division of labor, control hierarchies, and communication mechanisms that are employed to carry out innovation activities (Mintzberg, 1979, p. 67). To evaluate, assimilate, and utilize outside information for innovation activities, firms often create dedicated structural arrangements such as corporate innovation management (IM), research and development (R&D) units, or new product development departments (Bowonder & Miyake, 1992, p. 320; Utterback, 1971, p. 78). However, while conventional IM structures prove to be quite efficient for the management of incremental innovation projects, they seem less likely to generate disruptive or breakthrough digital innovations (Fay, Shipton, West, & Patterson, 2015, p. 274; KPMG, 2016, p. 9). The greater unpredictability level and pace resulting from the non-linear and distributed nature of digital technologies increases uncertainty and ambiguity in the IM regarding the approaches for generating new ways for proposing, creating, and delivering value based on these technologies (Yoo, Lyytinen, Boland, et al., 2010, p. 25). Here, many firms face tremendous challenges when coordinating the complex, fuzzy, and distributed information flows that are related to digital innovation using established structures; consequently, firms fail to harness the potential of digital technologies for new or adjusted business models (Svahn et al., 2017, p. 239; Yoo, Henfridsson, & Lyytinen, 2010, p. 730). This suggests that organizations are most likely forced to rethink their IM structures in order to allow for a more effective organization of digital innovations and the digitalization of business models (Svahn & Henfridsson, 2012, pp. 3348–3349). For example, Svahn et al. (2017, pp. 240–241) demonstrated how Volvo first struggled with developing a *smart car* using their established innovation routines, but the company then gained momentum by establishing a separate innovation hub that was disconnected from traditional automotive cycle plans and also involved external partners.

The need to infuse institutional logics into the messy socio-technical regime of digital innovation processes has spurred the theme of *digital innovation management* (digital IM) (Nambisan et al., 2017, p. 224). However, literature bears only little knowledge on the role of OD regarding digital IM (Barrett, Davidson, Prabhu, & Vargo, 2015, p. 149; Kudaravalli, Faraj, & Johnson, 2017, p. 58). The previous discussion highlights the point that findings from extant IM or R&D research may not necessarily apply to the management of digital innovation or may prove insufficient (Nambisan et al., 2017, p. 225; Yoo, 2013b, p. 232). Accordingly, the question arises as to which digital IM structures today allow a firm to effectively capture the potentials of digital innovations in the firm's business models (Kohli & Melville, 2019, p. 216). The discourse culminated in recent calls to unravel different effective *organizational configurations* of digital IM (Hinings et al., 2018, p. 58; Nambisan et al., 2017, p. 227), which represent archetypical patterns of structural features (Greenwood & Hinings, 1996, p. 1025).

Scholars in OD have contended that *structural, strategic, and environmental variables only in conjunction* "define a meaningful and coherent slice of organizational reality" (Miller, 1981, p. 8). Against this background, we posit that the *fit* between environmental contingencies (i.e. the logic of digital innovation) with a firm's strategic intent and the digital IM's OD can determine digital business model innovativeness to occur (Chesbrough & Teece, 2002, pp. 70–71; Volberda, van der Weerdt, Verwaal, Stienstra, & Verdu, 2012, p. 1044). Furthermore, OD constructs often exhibit non-linear relationships, thus resulting in "typological configurations [that] are marked by causal asymmetry" (Fiss, 2011, p. 399). Theory and evidence suggests that completely different organizational configurations may be responsible for determining high and low performance (Miller, 1982, p. 135). Hence, we deem it important to uncover both effective and ineffective ODs of digital IM that may or may not result in digital business model innovativeness (i.e., the degree of digitally-enabled newness embedded into a business model) to guide research and practice. Thus, the paper strives to answer this second research question, which is as follows:

RQ2: *Which configurations of digital innovation management's design, firm strategy, and environment lead to high and low digital business model innovativeness?*

Achieving innovativeness is not a means to an end, since empirical research has demonstrated its direct contribution to the corporate bottom line (Ali, Seny Kan, & Sarstedt, 2016, p. 5321; Camisón & Villar-López, 2014, p. 2897; Hernández-Perlines, Moreno-García, & Yañez-Araque, 2016, p. 5385). Since digital business model innovativeness' effect may be different due to the unique logic of digital technologies, we argue for examining the linkage between digital business model innovativeness and organizational performance. Furthermore, relating effective and ineffective digital IM configurations to overall performance may add evidence to ongoing discussions about the contributions of digital technology and its management to firm growth (Brynjolfsson, 1993, p. 76; Stanley, Doucouliagos, & Steel, 2018, p. 722). Hence, we address a third research question:

RQ3: *How do digital business model innovativeness and the digital IM configuration relate to organizational performance?*

To answer our research questions, we followed a multi-staged approach. To address our first research question, we conceptualized digital business model innovativeness and carved out the most pivotal concepts that drive the digital enablement of business models by synthesizing the dispersed literature on this topic (Cooper, 1988, p. 111). To answer our second research question, we first theorize about the relationship of digital IM's OD, strategy, environment, and digital business model innovativeness. While Nambisan et al. (2017) stated that "there is a critical need for novel theorizing on digital innovation management" (p. 223), this paper argues that Galbraith's (1973, 1974) well-developed *organizational information processing theory* (OIPT) proves to be highly relevant as a starting point for the study of digital IM designs. OIPT provides explanations of how firms employ certain strategies to their OD in order to mitigate uncertainties and ambiguities by reconciling task-related information (Dibrell & Miller, 2002, p. 621). We regard OIPT as highly suited for the study of digital IM, since the original theory and its updates have accounted for contextual factors, interorganizational interactions (Bensaou & Venkatraman, 1996, p. 86), and technology's role in enhancing information flows (Fairbank, Labianca, Steensma, & Metters, 2006, p. 297). Moreover, we believe that importing this theory holds great potential to populate new ways of thinking about managing innovation in the digital age.

We subsequently conducted a survey study to collect data. To identify different configurations of digital IM from the collected data, we applied fuzzy-set qualitative comparative analysis (fsQCA; Ragin, 2000, 2008). Here, fsQCA is a method that relies on Boolean algebra to identify a collection of configurations that consist of attribute bundles that in conjunction generate the phenomenon of interest (i.e., digital business model innovativeness) (Schneider & Wagemann, 2012, p. 8). The method allows us to explore what the different kinds of digital IM are, and how these differences impact digital business model innovativeness. Contrary to regression-based approaches, the method assumes causal asymmetry (i.e., the configurations of variables explaining the presence and absence of a phenomenon are different), as well as conjunctural causation and equifinality. The latter implies a focus on the combined effects of variables (instead of net effects), and that multiple equally effective "causal recipes" (Ragin, 2013, p. 172) of combinations may exist (Berg-Schlosser, De Meur, Rihoux, & Ragin, 2009, p. 8; Ragin & Fiss, 2008, p. 190). In contrast to clustering techniques, the features of fsQCA enable us to gain more nuanced insights into the complex internal causal structures of digital IM's OD. To answer our third research question, we use partial least squares structural equation modeling (PLS-SEM) to estimate the direct effect of digital business model innovativeness on organizational performance at a higher level; we also employ multivariate analysis of variance (MANOVA) to relate the identified digital IM configurations to organizational performance. By combining set-theoretic analysis, structural equation modeling, and multivariate analysis, we aim to strengthen our results' validity (Mingers, 2003, p. 246).

We set out to make three primary contributions. First, we identify the most pivotal constituents that drive the digitally-enabled transformations of business models and thus provide a structured framework for further investigations. Second, our study contributes to our understanding of which context-specific design strategies create the right conditions for digital business model innovations to succeed. Third, from a managerial perspective, this study enables organizations to scrutinize the structures in which they carry out digital IM.

This paper proceeds as follows. We provide an overview of the foundations of digital technologies and innovations in Chapter 2. In Chapter 3, we synthesize the nature and the different dimensions of digital business model innovations from extant literature (→*RQ1*). We theorize the management of digital business model innovation from an OIPT perspective in Chapter 4. In Chapter 5, we present our research design, including descriptions of the measurement, data collection, and analyses approaches. Chapter 6 covers multiple configurations of digital IM that exhibit high and low degrees of digital business model innovativeness (→*RQ2*) and demonstrates the direct effects on organizational performance (→*RQ3*). We derive configurational propositions for effective digital IM to theoretically integrate our findings in Chapter 7, and subsequently we discuss our contributions to research and practice, as well as the limitations and associated opportunities for further research. Finally, the paper concludes with a summary of the research in Chapter 8.

2 Foundations

2.1 Digital Technologies and Architectures

To understand the nature of digital innovations, we first need to discern the unique material characteristics of digital technologies. We then describe the features of digital architectures—which are spurred by the features of digital technologies—to highlight how they jeopardize traditional design hierarchies.

2.1.1 Features of Digital Technologies

The terms *digital technology* and *information technology* (IT) are frequently used interchangeably and in an overlapping way (e.g. Grover, Gokhale, Lim, Coffey, & Ayyagari, 2006, p. 275; Nambisan, 2013, p. 216). For example, Brynjolfsson and Hitt (2000) defined IT "as computers as well as related digital communication technology" (p. 24), while Davis (2000) defined IT as the general collection of hardware, software, networks, and associated practices used to "deliver information and communication services needed by the organization" (p. 67). Others use the term digital technology when referring to contemporary technologies such as big data or cloud computing (e.g., Dziergwa & Rederer, 2018, p. 28). While research on information technology often revolves around topics such as business-IT alignment, adoption, and decision-making support (Gable, 2010, p. 9), research under the term of digital technology is more focused on the material properties of technology and the ways in which they affect socio-technical processes such as innovation (Yoo, Henfridsson, et al., 2010, p. 725). In this study, we argue that laying out the properties of digital technology may help us in understanding their differences with relation to other sorts of technologies, as well as how these features spur new forms of innovation. Extant discourses on digital technologies point out five fundamental features that, when taken together, define their functional identity.

First, the notion of digital technology is connoted with the practice of digitization. This refers to the technical process of encoding analog information (e.g., audio, video, or text) into discrete bitstrings, as well as their storing, transmitting, and processing (Goblick & Holsinger, 1967, p. 323). While analog information is usually tightly bound to a specific physical storage (e.g., a book or a vinyl record), digital representations of any kind can be stored and accessed using a variety of devices and networks (Faulkner & Runde, 2010, p. 6). Hence, the advantage of digitization is the decoupling of information from a physical transmission medium (Tilson, Lyytinen, & Sørensen, 2010, p. 749). Fueled by the emergence of standardized interface and file formats (e.g., JPEG, JSON, XML, or PDF), this *homogenization of data* allows for seamless combinations with other forms of digital information, and this makes information accessible to a broad range of digital devices (Yoo, Henfridsson, et al., 2010, p. 726).

Second, objects and information that are subjected to digitization achieve an *immaterial mode of being*. A bitstring that inscribes a former material object (e.g., image, sound, text) becomes a non-material bearer of that object (Faulkner & Runde, 2010, p. 7). The non-physical state of digitized objects exhibits the trait of non-rivalry in use, which means that their consumption by one person does not reduce its use or availability for others (Faulkner & Runde, 2010, p. 8). While analog information (e.g., that which is written on a letter) can only be used by a single person per time, digital technologies are as flexible in their parallel use as the programmer allows. For example, the use of Microsoft Word by a specific user at a specific place and point in time does not limit the number of other people who can do so at the same time in different places (Hylving & Schultze, 2013, p. 4).

Third, due to their capacity to accept and implement different sets of instructions (Faulkner & Runde, 2010, p. 6), digital technologies are flexibly *(re)programmable* (Kallinikos, Leonardi, & Nardi, 2012, p. 13). Unlike analog technology, in which physical materiality and the artifact's features are tightly coupled and fixed, digital technology separates the logic from physical materiality and allows the artifact to flexibly repurposed for an infinite number of purposes without modifying the physical embodiment in which the logic is stored (Arthur, 2009, p. 88; Yoo, Henfridsson, et al., 2010, p. 726).

Fourth, digital technologies are *self-referential* (or reflexive) by nature, meaning that their consumption necessitates the use of other digital technologies (e.g., computers) (Kallinikos, Aaltonen, & Marton, 2013, p. 366; Yoo, Lyytinen, Thummadi, & Weiss, 2010, p. 10). For instance, a digital image can only be modified by using image editing software (Kallinikos et al., 2013, p. 359). The necessity of digital technologies to access other digital technologies creates positive network effects and accelerated diffusion rates; this in turn leads to decreasing costs and the creation of further digital artifacts (Fichman et al., 2014, p. 333). The ubiquitous access of digital technologies together with lowered entry barriers has spurred the diffusion of new digital technologies (Yoo, 2013a, pp. 139–140). For example, search engines adding new information to solve the problem of information affluence about webpage availabilities may in turn stimulate website producers to produce additional content and to optimize their content to the search engine's ranking algorithm (Kallinikos et al., 2013, p. 366).

Finally, the digitization of artifacts grants them new *material properties*. Both converting analog information into digital representations and the embedding of programmable computer chips and connectivity into objects make them traceable across time and space, thus making them addressable within the global information infrastructure (Yoo, Lyytinen, Boland, et al., 2010, p. 10). By adding sensors and memory capacities, objects gain the ability respond to changes in their environment, and they can record and store the information that was generated about the environment. Programmable artifacts gain the ability to be identified and associated with other entities, and they enable some future states and conditions to be inferred (Herterich & Mikusz, 2016, p. 9). All these factors allow an unprecedented number of users to experiment with digital technologies and subsequently to spawn new technologies (Yoo, Lyytinen, Thummadi, et al., 2010, p. 10). Table II-1 summarizes the features and properties of digital technologies.

Table II-1. Features of digital technologies (based on Faulkner & Runde, 2010, p. 8; Yoo, Henfridsson, et al., 2010, p. 726; Yoo, Lyytinen, Boland, et al., 2010, p. 10).

Features	Description
Homogenization of data	Interfaces and standards allow for combination and consumption of digital information across heterogeneous devices; homogenization of data decouples content from medium
Immateriality	Increasing amount of information is digitized (i.e., converted into bitstrings); non-physical state makes digital technologies non-rival in use
(Re)programmability	Detaching functional logic from the physical container; artifacts may be incessantly repurposed without changing the physical container
Self-reference	Digital technologies require other digital technologies (e.g., computers) to be acted upon, which creates a virtuous cycle of diffusion
Properties of digital materiality	Communicability, traceability, addressability, memorability, sensibility, associability

2.1.2 Digital Architectures and Design Hierarchies

Conventional system architectures (e.g., of physical products) are typically represented by an *integral design hierarchy*. As shown in Figure II-1, a design hierarchy is described in two terms—a *hierarchy of nested parts* and a *hierarchy of control* (Murmann & Frenken, 2006, p. 938). The *hierarchy of nested parts* decomposes a system in a top-down manner into subsystems and components, with fixed one-to-many relationships among elements that make up the system as a whole (Clark, 1985, p. 241). A component at a certain level in the hierarchy of nested parts usually performs one specific function; it is part of exactly one subsystem or component on the level above and may contain further components on the levels below (Henfridsson, Mathiassen, & Svahn, 2014, p. 29). For instance, the hierarchy of nested parts of a single-lens reflex camera (SLR) consists of an optical and mechanical subsystem, an electronic subsystem, a digital image sensor, housing, and lens elements. In turn, the optical and mechanical subsystem may be decomposed into other components, such as the shutter unit, the mirror box, the autofocus module, and prisms (Toyoda, 2005, pp. 14, 16).

The location and order of subsystems and components within a hierarchy of nested parts is governed by a *hierarchy of control*, denoting their relative importance to system functioning

(MacCormack, Baldwin, & Rusnak, 2010, p. 2). The hierarchy of control distinguishes between the components which are central or *core* to the major functions performed by the system and those which are more *peripheral* (Tushman & Murmann, 2003, p. 323). Core components are those which are tightly coupled to other components, whereas peripheral components only exhibit loose connections to other parts (MacCormack et al., 2010, p. 4). For instance, in an SLR's hierarchy of control, the optical and mechanical components represent core subsystems, and the sensor and electronic systems may be regarded as peripheral parts. While the optical and mechanical components represent only two subsystems of the many required for a SLR to function, they are core subsystems in that the changes to the optical and mechanical design have a large impact on the designs of other subsystems (Huenteler, Ossenbrink, Schmidt, & Hoffmann, 2016, p. 1204; Toyoda, 2005, p. 16).

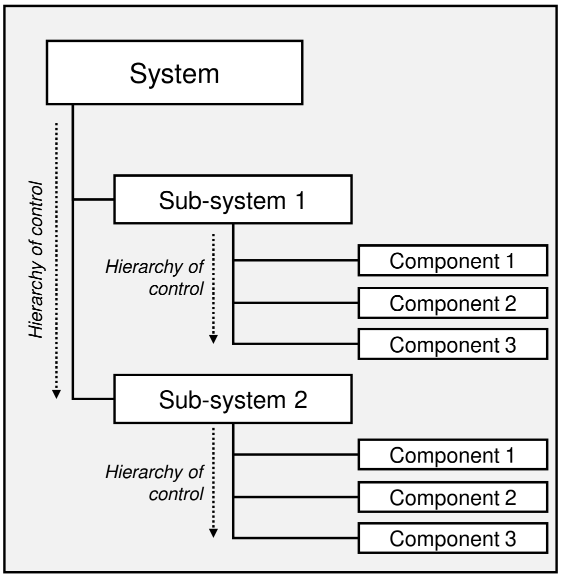

Figure II-1. Traditional, integral modular design hierarchy (adapted from Huenteler et al., 2016, p. 1197).

Traditionally, innovation activities in integral system architectures first tend to focus on core parts that are most relevant to the characteristics of a product, and then they shift toward more peripheral subsystems and components to accommodate emerging market demands (*market-pull*) and technological trends (*technology-push*) (Huenteler et al., 2016, p. 1197; Tushman & Murmann, 2003, p. 330). Through a process of diffusion and adoption as well as standardization and cost-minimizing, a particular set of core components may become a dominant design in an industry, thus setting the agenda for subsequent technical changes (MacCormack et al., 2010, p. 4; Utterback & Abernathy, 1975, p. 641). Combustion engines, typewriters, or the architecture of hard drives and microprocessors can be identified as such dominant designs (Murmann & Frenken, 2006, pp. 933–934). In the case of SLRs, the industry first focused on optical and mechanical parts to improve performance and image quality; the industry later replaced silver halide photographic film with digital imaging sensors and eventually added video and connectivity capabilities (Miranda & Lima, 2013, p. 1181; Shu, 2016; Toyoda, 2005, p. 3). Due to their tight coupling with many other components they control, core components are more costly to evolve since they typically result in cascading technological changes (MacCormack et al., 2010, p. 8).

Flexibility in integral design hierarchies is gained using *modular* yet *product-specific* components. For instance, the flexibility of SLRs originates from their standardized mounts, which allow for the use of multiple lenses from different suppliers—but only in the SLR's specific product context (Yoo, Henfridsson, et al., 2010, p. 728). Therefore, traditional modular architectures are *tightly coupled* to a single hierarchy in that they are fixed to a specific product boundary and determined by functional design requirements that are conceived from the product's context before individual subsystems and components are designed (Draxinger, 2017, p. 7; Resca, Za, & Spagnoletti, 2013, p. 73; Yoo, 2013a, p. 141). The modular design hierarchy fosters flexibility during design phases and scale economies during production cycles. During the design phase, firms may substitute single components to address new customer demands or technological deficiencies, while external manufacturing resources may be involved for different components during the production phase. However, to seize those benefits, firms need to separate their design and production cycles, and the architectural design needs to be stalled when the product is released for production; consequently, these situations leave only limited windows of opportunities for redesigning activities (Henfridsson et al., 2014, pp. 29–30).

We should note that it is unlikely for the peripheral display unit of a SLR to become a core component within the SLR's design hierarchy, or for it to perform fundamentally different tasks in other products' contexts or the same product context (e.g., taking over the role of the mirror box). By contrast, the materiality of digital technologies spurred the dissemination of *layered modular architectures* that jeopardize the constraints of traditional hierarchies of control (Yoo, 2013a, p. 140). A *layered* architecture defines groupings (i.e., layers) of code that offer a coherent set of related functionalities and abstracts from the implementation specifics (Gamma, Helm, Johnson, & Vlissides, 1994, p. 25). The layered design follows the separation-of-concerns principle by distributing the technical responsibilities across layers, for example, by logically separating the business logic from data access routines (Bass, Clements, & Kazman, 2012, p. 205). Each layer comprises *modules*—groups "of programs and data structures that collaborate to provide one or more expected services to the rest of the software" (Abdeen, Ducasse, & Sahraoui, 2011, p. 394). Modules and layers are usually *loosely coupled*. Loose coupling describes the objective of minimizing interdependencies and side effects between modules; this is done by connecting them through interfaces and abstract classes and by avoiding shared data and procedures (Gamma et al., 1994, p. 106). The advantages of layered modular architectures are that they support portability, adaptability, reconfigurability, and reuse in that they can be extended to add functionality in new or different contexts, with little impact on other parts (Alvares, Rutten, & Seinturier, 2015, p. 3).

According to Yoo et al. (2010, pp. 726–727), layered modular architectures feature four loosely coupled layers of contents, services, networks, and devices. The contents layer includes information that end users interact with, such as texts, videos, images, or metadata (Ojala & Lyytinen, 2018, p. 1027). The service layer provides interactive functionalities that directly serve users as they create or consume contents (Turber, Vom Brocke, Gassmann, & Fleisch, 2014, p. 21). The network layer is divided into two layers, namely a logical transmission layer that involves network standards and protocols, and also a physical transport layer that encompasses cables and transmitters (Draxinger, 2017, p. 6). Finally, the device layer features a physical machinery sub-layer—which refers to physical devices (e.g., a television, computer, or mobile phone) that are used for connecting and interacting with the system—and a logical capability sub-layer (e.g., firmware and operating systems) that connects the physical machine to the other layers and provides their control and maintenance (Resca et al., 2013, p. 73). A digital layered modular architecture can manifest as a product (e.g., the iPad) and as a platform (e.g., Apple's iOS operating system) (Resca et al., 2013, p. 73).

We may understand individual layers as separate design hierarchies, since they provide the general operational principles (e.g., interfaces) for the different components they contain (Murmann & Frenken, 2006, p. 931). Yet, the component design in one layer is independent from other layers, and it allows components to be combined using standardized interfaces and homogenized data (Draxinger, 2017, p. 6; Turber et al., 2014, p. 21). Contrary to the tight coupling of integral architectures, the loose coupling of digital layered modular architectures allows components across different design hierarchies to be integrated or replaced (Lee & Berente, 2012, p. 1430). As shown in Figure II-2, a component may be used for different purposes across different layers since it does not have to adhere to a single fixed hierarchy of control (Hylving & Schultze, 2013, p. 5; Lee & Berente, 2012, p. 1431). Instead of defining necessary and product-specific linkages between components as implied by the hierarchy of control in integral architectures (Clark, 1985, p. 241), components in a digital layered modular architecture are *product-agnostic*, since they are not bound to a specific product (Henfridsson, Nandhakumar, Scarbrough, & Panourgias, 2018, p. 90; Yoo, 2013a, p. 141).

Hence, digital systems may be derived from multiple distinct design hierarchies, and consequently they do not have an a-priori fixed boundary (Yoo, Henfridsson, et al., 2010, p. 728). Digital systems are therefore inductively enacted by orchestrating components across the different layers (Draxinger, 2017, p. 6). This implies changing interactional patterns and meanings every time a component is used in a different layer (i.e., design hierarchy), and this makes digital architectures *composable* and *malleable*. The former refers to the ability of an architecture to apply changes in modules without compromising the overall system, while the latter refers to an architecture's ability to reconfigure or extend the behavior of modules to cater for changing user behavior or new technologies (Tiwana, Konsynski, & Bush, 2010, p. 683).

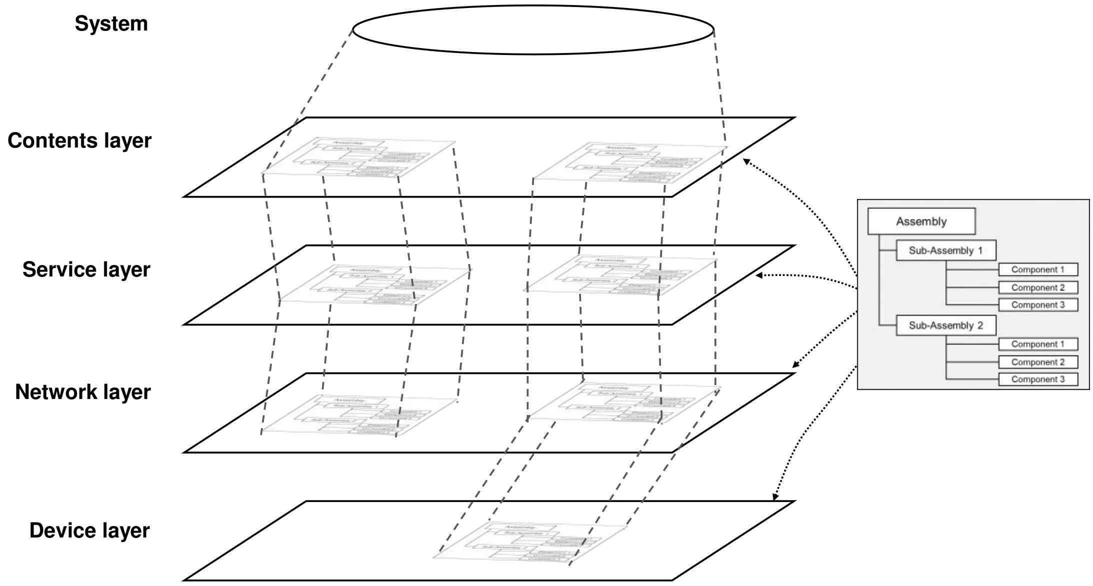

Figure II-2. The architectural design of digital technologies (based on Huenteler et al., 2016, pp. 1197–1198; Yoo, Henfridsson, et al., 2010, p. 727).

Since components may be part of different design hierarchies, their ultimate usage is often not conceived from a specific product context in an upfront manner (Resca et al., 2013, p. 73). Many application programming interfaces (APIs) and web services are developed without any specific product in mind, or they may be repurposed due to their reprogrammability and the homogenization of data (Yoo, 2013a, p. 141). For instance, Google Maps can be used as standalone product (i.e., content layer), or it may be recombined in a multitude of different applications (i.e., service layer) (Nambisan, 2017, p. 1039). Hence, the use and meaning of Google Maps is contingent upon whether it is used as a standalone product or as module in a ridesharing app or a real estate listings website (Henfridsson et al., 2018, p. 94). In stark contrast to integral modular architectures and design hierarchies, this idea implies that depending on a component's use, a component's role as a core or peripheral part in a system increasingly blurs and is appropriated in a situated way (Yoo, 2013a, p. 151).

Opposed to integral architectures, the design and production cycles of digital layered modular architectures do not need to be separated (Henfridsson et al., 2014, pp. 29–30), and thus these architecutres allow firms to speed up release and update cycles (e.g., over-the-air updates) (Rayna & Striukova, 2016, p. 217). Kallinikos et al. (2013) summarized the nature of digital artifacts building on layered modular architectures as "fluid and editable, often embedded in complex, distributed, and shifting digital environments" (p. 358). Hence, the capacities of digital technologies and layered modular architectures provide new entrepreneurial opportunities for product development and innovation, but they may also embody new challenges to organizations (Nambisan, 2017, p. 1039).

2.2 Digital Innovation

To justify the study of how organizational structures facilitate digital business model innovativeness, we need to discriminate digital innovations from traditional forms of innovations. We first introduce our general understanding of innovation before we carve out the unique nature and logic of digital innovations that are ingrained by digital technologies' features and architectures. After this, we discuss the broader socio-technical context surrounding digital innovation.

2.2.1 Innovation Defined

Drawing on a Schumpeterian (1934, p. 66) notion, we may broadly understand any form of *innovation* as a recombination of existing conceptual and physical resources. More precisely, we may perceive innovation as the combination of knowledge, tools, methods, and technologies to develop new or adjusted conceptual (e.g., services, processes) or material artifacts such as products and technologies (Andersson, Lindgren, & Henfridsson, 2008, p. 21; Chatterjee, Moody, Lowry, Chakraborty, & Hardin, 2015, p. 159; Fichman & Melville, 2014, p. 206). Innovation is distinct from *invention*. An invention is the result of converting a theoretical conception or idea into a tangible new artifact or process; this is done based on a synthesis of technical information but without any immediate economic significance or organizational impact. Innovations are inventions that have reached the state of market introduction or first use, and they may be compared to preceding artifacts in terms of their degree of newness (Utterback, 1971, p. 77). Regarding inventions, Schumpeter (1934) argued that "as long as they are not carried into practice, inventions are economically irrelevant" (p. 88). Nevertheless, more recent literature dispenses with the focus on the adoption component. For example, Arthur (2009) stated that "innovation is not so much a parade of inventions with subsequent adoptions . . . it is a constant re-expressing or redomaining of old tasks . . . within new worlds of the possible" (p. 85). Building on Schumpeter's understanding, Arthur (2009) defined *redomaining* as the "expressing of a given purpose in a different set of components" (p. 73).

To understand the impact of digital innovations and the context of how they differ from other sorts of innovations, it is decisive to understand common approaches for distinguishing different types of innovation. Over the past decades, researchers have attempted to categorize innovation types according to their specific characteristics (Chandy & Prabhu, 2011, p. 96), which also have been acknowledged and standardized by international committees and professional bodies over time (e.g., OECD, 2005, p. 53). The two most widely accepted dichotomies encompass the following distinctions, namely *product* vs. *process* and *radical* vs. *incremental* innovations (Amit & Zott, 2012, p. 41; Damanpour, 1991, p. 560). Depending on the context and the specific instance, a single innovation might be classified according to both dichotomies, such as a radical product innovation (Gerpott, 2005, p. 38).

The first distinction is made between product and process innovations. *Product innovation* refer to new products or services that are introduced to address new or unmet market needs (Utterback & Abernathy, 1975, p. 642), whereas process innovations are defined as new elements introduced into production and service operations, such as workflows and technologies that are used to generate and deliver products and services (Damanpour, 1991, p. 561). It is important to highlight that the product innovation category may contain innovations of both tangible physical goods as well as intangible services (Damanpour, Szabat, & Evan, 1989, p. 588). While material product innovations aim at achieving a product leadership through creating better physical goods that in turn create new value for customers, immaterial service innovations are geared to achieving higher consumer intimacy and delivering superior experience (Bitner, Ostrom, & Morgan, 2008, p. 69). Due to their activity-like nature, service innovations in particular are often related to process innovations in that they significantly rely on insightful information that are gathered from organizational processes, such as the customer data accrued during marketing and sales activities (Bitner et al., 2008, p. 68; Chew & Gottschalk, 2012, p. 414). *Process innovations* are subdivided into three types: organizational (or administrative) innovations, marketization innovation, and technological innovations. *Organizational* innovations relate to changes in administrative processes, organizational structures, practices, strategy, and social system. *Marketization* innovations are concerned with the introduction of new procedures to the organization's operating systems to increase the efficiency and effectiveness of delivering its products to customers. *Technological* innovations are associated with the introduction of novel physical equipment, techniques, and both software and hardware communication systems within organizations (Walker, Avellaneda, & Berry, 2011, p. 100).

Second, innovations may also be differentiated along a *degree of newness* continuum. While *incremental* (or continuous) innovations are minor improvements or adjustments in a firm's products and services, radical (or discontinuous) innovations represent revolutionary changes and embody high degrees of new knowledge (Dewar & Dutton, 1986, pp. 1422–1423; Ettlie, Bridges, & O'Keefe, 1984, p. 683). Incremental innovations are related to improvements in a given technology, while radical innovation involves the development of significantly new technologies into nonexistent markets and may require fundamental behavior changes. The most radical innovations have the potential to disrupt prevailing market structures and consumer habits in major ways (Markides, 2006, p. 22). One word of caution is put forward regarding the evaluation of the newness dimension: Depending on the perspective, the newness of an innovation may be assessed differently by the developing or adopting firm, business unit, the industry, competitors, and customers (Garcia & Calantone, 2002, p. 112).

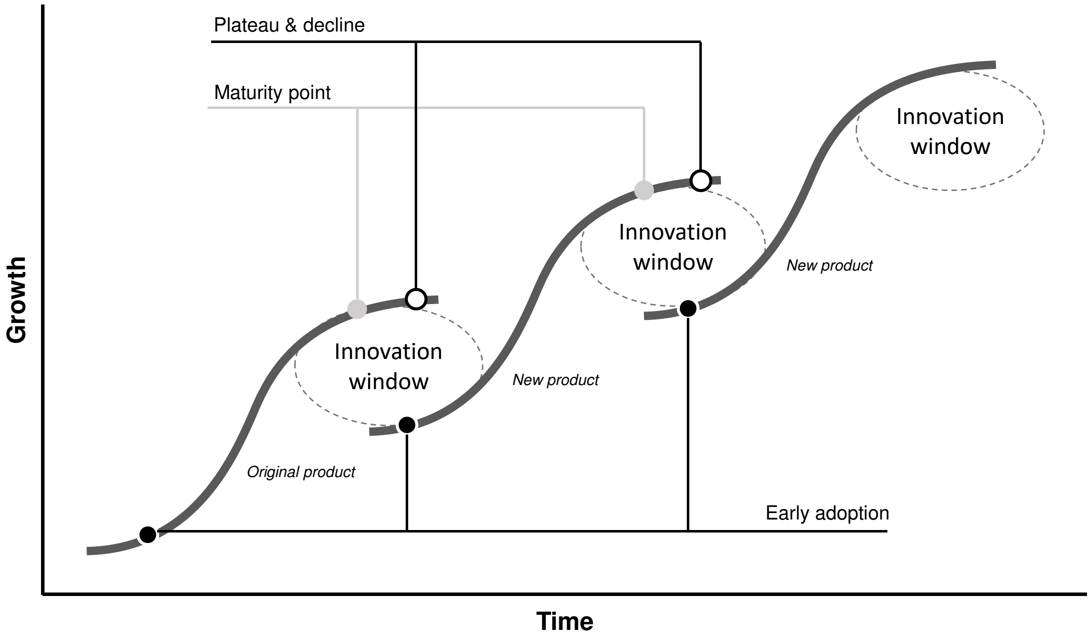

Figure II-3. S-Curve of innovation (based on Rogers, 1962, p. 243).

It is also important to understand how innovations traditionally used to evolve. The traditional innovation lifecycle suggests that a technology progresses through a set of stages, starting with the emergence of a new technology (Moore, 1995, pp. 17–18). As shown in Figure II-3, the innovation lifecycle is often represented as an S-curve (Rogers, 1962, p. 243). Here, an early innovation is used by more technical-savvy niche adopters, and it achieves mass-market adoption after a period of immaturity and experimentation (Mazhelis, Luoma, & Ojala, 2014, pp. 198–199). Once the innovation's maturity is acceptable from a market perspective, the innovation progresses through a phase of market growth and price-performance improvements; it may ultimately become a dominant design if competing alternatives are ruled out and if agreement among various technical, political, and social forces is achieved (Anderson & Tushman, 1990, p. 618; Yoo, 2013b, p. 228). During this later stage, firms focus on the product exploitation, incremental improvements, cost optimizations, and process innovations rather than creating radically new innovations (Anderson & Tushman, 1990, p. 618; Hylving, Henfridsson, & Selander, 2012, p. 15). However, each technology is expected to reach a maturity plateau when facing its natural limitations for improvement, thereby making it vulnerable to be overtaken by new competing technologies. Traditionally, the timeframe for a technology to be supplanted by a new one is usually between five to 15 years on average (Schramm, 2017, p. 50). Hence, to stay competitive, firms have to *move* in a timely way from one S-curve to the next one by deliberately displacing currently successful products and by venturing into new domains through the identification of changing customers' needs and relating it to new technological developments (Schramm, 2017, p. 51).

2.2.2 Logic of Digital Innovations

To investigate the effects of new products, services, and processes that derive from digital technologies, the research theme of *digital innovation* has recently come to the fore. The question arises as to how digital innovation differs from the more widespread topic of IT innovation. Without a clear conceptualization, the topic of digital innovation may turn out as a short-lived research fad, or it may join what Baskerville and Myers (2009) called *research fashions*, which "appear to be new and innovative, but . . . are in fact just old wine in new bottles and a repackaging of old concepts" (p. 647). The need for a thorough discussion becomes more evident when we consider that both the term digital technology (e.g., Mayo, 1985, p. 111) and the practice of digitization (Goblick & Holsinger, 1967, p. 323) are not new (Swanson, 2017, p. 4203). We also observe that digital technologies have not always had major impacts throughout history. For example, the movement from analogous to digital telecommunication in the late 1960s improved the quality of voice services, but it did not cause radical changes in the dominant service models of providers or in the broader socio-technical context of telecommunication. Yet, we see that recent digital technologies such as cross-platform messaging and voice over Internet Protocol (VoIP) are in fact changing dominant service models and the socio-technical context of communication (Tilson, Lyytinen, & Sørensen, 2010, p. 749; Yoo, Lyytinen, Thummadi, et al., 2010, p. 8). Furthermore, the pace of technological progress and deteriorating costs of computing power and storage has made digital technologies ubiquitous and more widely accessible (Yoo, Lyytinen, Thummadi, et al., 2010, p. 10). Going beyond the mere translation of physical information into digital bitstreams, the developments over the past two decades have made it possible to pervasively embed digital capabilities into almost any physical container to solve new business problems and reengineer business processes (Swanson, 2017, p. 4203; Yoo, Lyytinen, Thummadi, et al., 2010, p. 9). Resulting from these developments, the focus has turned to the overarching phenomenon of *digitalization*, which focuses on revisiting socio-technical structures and business logics through digitized artifacts (Yoo, Henfridsson, et al., 2010, p. 725). Hence, we deem it important to differentiate between the concepts of IT innovation and the more recent topic of digital innovation.

According to Lind and Zmud (1991), *IT innovations* represent "administrative or operational ideas, practices, or objects perceived as new by an organizational unit and whose underlying basis lies with information technology" (p. 196), and Swanson (1994) defined them as "innovation in the organizational application of digital computer and communications technologies" (p. 1072). As these definitions demonstrate, earlier research predominantly revolved around the adoption of already-existing IT artifacts that are new to organizations, as well as the ways in which these artifacts can primarily be used for process innovations in firms (Fichman et al., 2014, p. 334; Kohli & Melville, 2019, p. 222; Yoo, Henfridsson, et al., 2010, p. 725). More recent IT innovation research also considers their creation (Lyytinen & Rose, 2003, p. 557) and ways to realize competitive advantages by acknowledging IT's potential for changing strategic variables; such research underscores the enabling role of novel IT artifacts for business innovations (Kiessling, Wilke, & Kolbe, 2011, p. 2). When these are taken together, we see that IT innovation is germane to the notion of information technology in that research is looking for novel ways to deliver information and to deploy new communication services (Davis, 2000, p. 67) or for ways to gain improved abilities "to align IT resources and business resources . . . to achieve organizational advantage" (Schwarz, Kalika, Kefi, & Schwarz, 2010, p. 63).

Building on earlier definitions of IT innovations and the features of digital technologies and architectures (see section 2.1), research on *digital innovation* has emerged. Extant digital innovation literature often takes a product-centric perspective, where it describes the usage of layered modularity and the embedding of digital materiality (e.g., programmability) into physical goods (e.g. Lee & Berente, 2012, p. 1430; Yoo, Henfridsson, et al., 2010, p. 725). Svahn et al. (2009) took a more process-oriented view and described digital innovations as "organizational, technical, and cognitive innovation practices that follow the digitization of physical artifacts" (p. 3). Similarly, others include the creation of digitally-enabled process innovations to account for "new ways of doing things in an organizational setting" (Fichman et al., 2014, p. 330) by using novel technologies that may further allow the creation of new capabilities, strategies, and structures (Nambisan et al., 2017, p. 224). While authors often refer to a certain innovation being either *digitally enabled* or *digitalized* as a prerequisite for it to qualify as *digital* in its own right, they do not provide an extensive discussion about this enablement dimension. In the traditional business-centric view, technology has an enabling role in innovation if one of three conditions are met, namely (a) if it serves as tool that supports managers in developing new products and services, (b) if it allows for efficiency or effectiveness gains in business services and processes, or (c) if it enhances the functioning of a firm as a whole (Nischak, Hanelt, & Kolbe, 2017, p. 7; Teo, Ranganathan, Srivastava, & Loo, 2007, p. 211).

IS researchers today herald that digital technology should be regarded "no more an outsider, as an external force generative of change and possibility for innovation, but as an organizational factor" (Pozzi, Pigni, & Vitari, 2014, p. 10). In this context, scholars advocate an understanding that does no longer restricts the role of digital technology to that of an enabler but as a *trigger*, initiator, or bearer of innovation (Lusch & Nambisan, 2015, p. 157). In underscoring its value as a source of strategic benefit, the view of digital technology as a potential trigger of innovation suggests that it is now becoming an inherent part of different sorts of innovations (Breidbach & Maglio, 2015, pp. 2–3). Although enabling and triggering effects may overlap, digital technologies can give rise to the initiation and emergence of genuinely digital ecosystems, in which technical and organizing principles mutually determine strategic trajectories (Nischak et al., 2017, p. 7; Tiwana et al., 2010, p. 676). For example, digital platforms based on layered modular architectures—such as Apple's iPhone operating system (iOS)—go far beyond a supportive role in that they spurred the dissemination of entire new business ecosystems, in which platform actors co-develop new digital capabilities (Tiwana et al., 2010, p. 675). When these ideas are taken together, we understand an *innovation as digital, digitalized, or digitally enabled* when digital technologies are used as facilitators or core components for the creation of new products, services, and processes that would not otherwise have been possible, and grants the innovation outcome certain digital features (e.g., programmability) as described in section 2.1.1 (Lusch & Nambisan, 2015, p. 157; Nambisan et al., 2017, p. 226; Teo et al., 2007, p. 211; Venkatraman, 1994, p. 84). While this understanding is akin to IT(-enabled) innovation, it shifts the focus to a perspective that revolves around the material features of digital technologies, and it emancipates itself from the traditional subordinate role compared to business (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013, p. 472).

More than traditional IT innovations, digital innovations allow a technological problem to be redomained through a combinatorial evolution of existing digital components for different purposes more easily; this opens up endless possibilities for further redomaining and the creation of entirely new domains (Arthur, 2009, p. 73). It is worth noting that digital innovations often do not follow traditional S-curve patterns as shown in Figure II-3 in the previous section. Instead, the unique features and material properties of digital technologies infuse an innovation logic that is characterized by four traits: *convergence*, *generativity*, *distributedness,* and an *accelerated pace* (Yoo, Lyytinen, Boland, et al., 2010, p. 3).

First, digital innovations afford *convergence*, which denotes the unification and combination of diverse functions by synergizing previously distinct products and services that served different markets and purposes in the past. Spurred by modularity, digitization, and homogenization of data, digital innovations unify the previously separate user experiences (Yoo, Lyytinen, Boland, et al., 2010, p. 14). Computers now incorporate features of communication devices, and smartphones are becoming capable to take on the functionalities of computers (Pon, Seppälä, & Kenney, 2015). Convergence allows all forms of data (e.g., text, audio) the possibility of being consumed across different carriers (e.g., optical fiber, radio wave transmission) with multiple devices (e.g., computer, smartphone) (Lyytinen & Yoo, 2002, p. 379). Convergence also encompasses the integration and embedding of digital technologies into non-digital artifacts; this makes all sorts of products and services more flexible or *smart*, thereby changing the scope and meaning of traditional products (Yoo et al., 2012, p. 1399; Yoo, Boland, Lyytinen, & Majchrzak, 2009, p. 278).

Second, digital innovations afford *generativity*, which describes “a technology’s overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences” (Zittrain, 2006, p. 1980). Both interoperability and reprogrammability make digital technologies accessible and modifiable by others (Kallinikos, Aaltonen, & Marton, 2010). Contrary to tangible products, digital products do not need to be fully specified before production, and they can be reproduced at virtually zero marginal cost due to their immateriality (Hylving et al., 2012, p. 8). While traditional products are equipped with a fixed set of functionalities during the time of production, digital products building on a layered modular architecture may be reconfigured, reproduced, and re-equipped with additional features throughout their entire lifecycle (Henfridsson et al., 2014, p. 30). As the production does not need to be suspended when changing a digital product’s design, they “facilitate scale innovation rather than scale economics” (Henfridsson et al., 2014, p. 28). Owing to the combinatory and malleable capacity of digital architectures (Nambisan et al., 2017, p. 1039; Yoo, Henfridsson, et al., 2010, p. 725), digital artifacts allow third-party developers to constantly recombine and repurpose technologies and services to spontaneously spawn derivative and redomained innovations in a non-linear fashion that is not anticipated by the original creators (Henfridsson & Bygstad, 2013, p. 911; Yoo et al., 2012, p. 1399). The separation of physical from digital materiality and the modularity and reprogrammability of digital infrastructures allow actors to contribute independently across all architectural layers in an unforeseen way (Kazan, Tan, & Lim, 2014, p. 2; Ojala & Lyytinen, 2018, p. 1027; Turber et al., 2014, p. 21). Through recombination, digital innovation “bootstraps itself upward from the few to the many and from the simple to the complex” (Arthur, 2009, p. 21). For instance, while Google Maps APIs allow for the seamless and dynamic creation of various mashups (He & Zha, 2014), Uber’s business model has given rise to other innovative apps that allow customers to compare different ridesharing services’ rates (Remane, Hanelt, Hildebrandt, & Kolbe, 2016, p. 7). Through the self-referential combination of digital resources, novel digital “technology creates itself out of itself” (Arthur, 2009, p. 21). Generativity has increasingly jeopardized the idea of dominant designs, which would require “a moment of stability in the evolution of a product’s architecture” (Lee & Berente, 2012, p. 1432) that allows for growth and incremental improvements over a certain period of time. However, the generative nature neither grants long periods of stability, nor does it foster a stable consensus about what should constitute a particular dominant design. The incessant recombination of mutually interacting and intruding digital components may create non-linear wakes of innovations that form a complex innovation landscape and may promote innovation windows throughout their lifecycle as a rippling effect (Boland et al., 2007, pp. 631, 641). This contrasts with traditional products having fixed modular design hierarchies (see section 2.1.2) that typically follow S-curve patterns, which offer only limited innovation opportunities (see Figure II-3 in section 2.2.1).

Third, digital innovations unfold as *distributed* socio-technical processes spanning ecosystems, where firms from previously unrelated industries now cooperate but also fiercely compete with one another (Pon et al., 2015, p. 30; Tilson, Lyytinen, & Sorensen, 2010, p. 3). For example, Amazon extended its electronic commerce business model by becoming a cloud infrastructure provider; it also entered the film content-production industry to disrupt traditional cable networks, and it entered the grocery store market to compete with traditional brick-and-mortar retailers (Stark, 2017). Furthermore, the building blocks that are required for the creation of digital innovations are seldom entirely contained within the confinements of a single institution, thus requiring firms to draw on a multitude of external resources (Kallinikos et al., 2010). For example, a digitized running shoe may build on a map API to visualize running tracks and may use social media API to share running information with friends (Yoo et al., 2012, p. 1402). Clearly, this shows that "the success of an individual innovation . . . is often dependent on the success of other innovations in the firm's external environment" (Adner & Kapoor, 2010, p. 310). As the locus of innovation is now often located beyond a focal firm's boundaries (Tilson, Sørensen, & Lyytinen, 2013, p. 2; Yoo et al., 2012, p. 1401), organizations must increasingly engage in interorganizational innovation settings to capitalize on emerging opportunities (Chesbrough, 2003, p. 43). Today, innovation processes are carried out in cooperative and coopetitive arrangements, such as innovation partnerships, alliances, or crowdsourcing. The involved actors can range from external suppliers, competitors, to customers, who mutually recombine resources to develop new capabilities, products, and services (Nambisan & Baron, 2013, p. 1074). For example, several accounting firms have partnered with technology providers in deploying machine-learning-based systems to analyze large volumes of financial data; they aim to detect anomalies and thus to provide insights to their clients that were not available previously (Kepes, 2016). The number of interconnected actors that may contribute to digital innovation processes significantly has increased over the past two decades. While fewer than 1% of the world's population was online in 1995, in 2015 there was more than half of the global population who had access to the internet (UNdata, 2015). However, distributed digital innovations also bring new social, legal, and economic challenges, such as those with regard to organizing principles, license agreements, and intellectual property (IP) (Yoo et al., 2012, p. 1402).

Finally, the *rapid pace* of digital innovation is spurred by Moore's Law. In 1965 and 1975, Gordon Moore observed a doubling in computer processing power at a cadence of 18 to 24 months at reduced cost (Jorgenson, 2001, p. 3). However, this exponential behavior does not solely apply to price-performance improvements at the chip level, but it was similarly observed for computational performance (i.e., flops), internet bandwidth, hard drive efficiency, and others (Nielsen, 1998; Walter, 2005, p. 32). Since the invention of the integrated circuit in 1958 (Jorgenson, 2001, p. 2), digital technologies have demonstrated a gradual yet sustained progress over the first 50 years. Phenomena such as the *AI winters* in the mid-1970s and late 80s showed that, besides being impeded by over-inflated expectations and funding issues, many innovative applications still required significant computing capacity that was not yet available (Hendler, 2008, p. 3). As the exponents in Moore's quotation became increasingly larger in the beginning of the 2000s, we started to witness stellar developments and improvements in shorter cycles, such as the presence of AI in many thousands of applications in every industry (e.g., credit approval, search engines), the rise of smartphones, and the advent of quantum computers that harness superconductivity (Biamonte et al., 2017, p. 196; Kurzweil, 2005, p. 180; Waldrop, 2016, p. 146). As the impact of exponential progress over time is difficult to grasp, examples may illustrate the magnitude in practice. In 1997, the supercomputer Accelerated Strategic Computing Initiative (ASCI) Red, which was created from off-the-shelf CPUs to maintain and test the U.S. nuclear arsenal, had a performance of 1.8 teraflops at a peak power consumption of more than one megawatt; it also costed US$46 million and occupied 150 square meters (Anthony, 2012). Just nine years later in 2006, the Sony PlayStation 3 offered the same processing power to private consumers at fractions of the cost, power consumption, and physical size of the ASCI Red (Kogge, 2011, p. 52). The progress in self-driving vehicles further illustrates the pace of digital technologies. In 2004, the U.S. Defense Advanced Research Projects Agency (DARPA) invited research institutes and businesses to demonstrate the viability of autonomous ground vehicles. In this first run, the best vehicle went only 4% of the 150-mile course before breaking down. However, just one year later, three contestants already managed to complete the course successfully. By 2018, Google's self-driving vehicles have achieved more than 5,000,000 miles autonomously on public roads since 2009, and Tesla Inc. is rolling out autonomous features in its commercially available cars (Endsley, 2017, p. 227; Urmson, 2015, pp. 6, 8; Waymo, 2018). As both examples highlight, exponential price-performance improvements made a multiplicity of products economically feasible, and accelerated the emergence of new digital innovations (Fichman et al., 2014, p. 333). Generativity, composability, and the malleability of digital architectures have accelerated the evolutionary pace of digital innovations, since they allow for easy and rapid recombination into novel products (Nylén & Holmström, 2015, p. 59; Tiwana et al., 2010, p. 683). Additionally, evolutionary speed is typically faster by often not having to freeze a system architecture (see section 2.1.2) when applying design changes to a digital design hierarchy (Henfridsson et al., 2014, p. 29). Their self-referential nature further spurs the creation, availability, and diffusion of digital technologies (Yoo, Henfridsson, et al., 2010, p. 726).

When taken together, the traits of convergence, generativity, distributedness, and pace draw a picture of digital innovations that is characterized by an increased clock speed, dynamism, and non-linearity. Table II-2 summarizes the main traits that we ascribe to digital innovation's logic.

Table II-2. The logic of digital innovation (based on Yoo, Lyytinen, Boland, et al., 2010, pp. 13–14).

Characteristic	Description
Convergence	Continuous unification and combination of diverse functions from previously distinct products and devices are spurred by digitization, modularity, and homogenization of data.
Generativity	Modularity, interoperability, and reprogrammability allow for the unprompted recombination and modification of digital resources into novel configurations.
Distributedness	Digital innovation unfolds as distributed socio-technical processes and brings together actors from previously separate industries. Single elements constituting a digital innovation are typically dispersed across various institutions.
Pace	Exponential price-performance improvements resulting from Moore's Law are making an increasing number of digital innovations economically feasible. Composability, malleability, and self-referentiality further enable rapid recombination and dissemination of digital innovations.

3 Unraveling Digital Business Model Innovation

3.1 The Nature of Digital Business Model Innovation

Firms may not be able to seize sustainable profits and advantages from digital product or process innovations alone, but they need to update their business logic accordingly to harvest ongoing rents from their investments (Amit & Zott, 2012, p. 41). Galunic and Rodan (1998) argued that innovations need to be used "in novel and potentially rent-generating ways" (p. 1194) to prove themselves as valuable. Hence, developing novel processes and products is not a means to an end, since companies usually aim to achieve efficiency improvements or competitive advantages (Chatterjee et al., 2015, p. 163). To do so, firms often are required to adjust target segments, revenue models, and their value chain alongside the introduction of new product and service offerings (Teece, 2010, p. 186).

Since innovation is a multidimensional phenomenon that often necessitates adjusted value architectures to seize economic rents (Subramanian & Nilakanta, 1996, p. 634), researchers have argued for focusing on the changes that occur in the individual dimensions of *business models* (Spieth & Schneider, 2016, p. 682). As Amit and Zott (2012) pointed out, "product innovation without business model innovation may not always provide enough competitive advantage" (p. 38). To this end, scholars more recently added the *business model innovation* type to complement the traditional innovation dichotomies as presented in section 2.2.1 (Chesbrough, 2010, p. 355; Spieth & Schneider, 2016, p. 675; Teece, 2010, p. 183). It denotes innovations of a firm's business logic that are represented by the business model, which in turn defines how a firm creates and provides value to its customers as well as how a firm manages associated cost and revenue streams (Barnes, Blake, & Pinder, 2009, p. 183; Osterwalder, Pigneur, & Tucci, 2005, p. 3). Although there is no universal consensus among scholars about the constituents of a business model, we ground our discussion of how digital technologies innovate business models on four foundational dimensions (Osterwalder & Pigneur, 2010, pp. 14, 23; Rayna & Striukova, 2016, p. 217; Spieth & Schneider, 2016, p. 675), namely (a) value proposition, (b) value creation, (c) value delivery, and (d) value capture. First, the *value proposition* describes the products and services offered by a firm. Second, the *value creation* dimension encompasses the core competencies, key resources, complementary assets, and value networks that are used to render the value proposition. Third, *value delivery* refers to distribution and sales channels, target market segments, communication channels, and customer relations. Finally, *value capture* describes the underlying cost logic and the ways that a firm generates revenues from its value offerings. Taking the discussion of digital enablement in section 2.2.2 into account, the dimensions of a *digital business model* are fundamentally pervaded by digital technologies that substantially drive how a business functions and generates revenues (Veit et al., 2014, p. 48). In other words, a digital business model would not be possible or viable without the use of digital technologies in its essential building blocks.

Business model innovation denotes paradigmatic changes in a firm's business logic by developing a differentiated or entirely new business model which ideally is hard to replicate by competitors; a business model innovation may either focus on the exploitation of new opportunities in existing markets or on the exploration and creation of entirely new markets (Amit & Zott, 2012, p. 44; Markides, 2006, p. 20; Teece, 2010, p. 187). Business model innovation allows the creator of product and process innovations alike to exploit market opportunities and capture both profits and efficiency gains that are leveraged from those innovation (Bowman & Ambrosini, 2000, p. 9). Since product innovations determine changes in a firm's offerings (i.e., value proposition), and since process innovations relate to new ways of creating and delivering those offerings to customers (i.e., value creation, delivery, and capture), both are inherent parts of business model innovations (Francis & Bessant, 2005, p. 171). While a firm may choose to innovate only single dimensions of its business model, changes in one dimension may often necessitate a firm to align the other dimensions accordingly (Spieth & Schneider, 2016, p. 682). Most often, the go-to-market of a novel product with the objective of achieving competitive advantage is not possible without changing the organizational processes that cater for changed requirements in logistics, operations, marketing, or sales (Amit & Zott, 2012, p. 38). Nevertheless, this interdependency is often overlooked in innovation research (Teece, 2010, p. 173).

Thus, we argue for shifting research attention from individual product and process innovation toward an integrative business model innovation perspective for two primary reasons. First, to seize economic advantages, the mere development and introduction of new products and processes alone is most likely insufficient for achieving sustainable competitive advantage. Instead, firms need to appropriate new products and processes by coherently innovating and integrating the components of their business model (Amit & Zott, 2010, p. 2; Francis & Bessant, 2005, pp. 171, 176). Second, business models are more difficult to be replicated by competitors as opposed to single products and processes (Amit & Zott, 2010, p. 5). Hence, we particularly focus on business model innovations in our research, since they represent the focal system for creating new or enhanced profits by thoughtfully orchestrating and aligning product and process innovations across the dimensions of business models.

The research on digital innovation has led to the distinction of *conventional* and *digital business model innovations* (Gupta & Bose, 2018, p. 2). Although research acknowledges that the "connection between business model choice and technology is two-way and complex" (Baden-Fuller & Haefliger, 2013, p. 424), the interdependencies between business models and digital technologies—as well as their enabling role—are underplayed in extant literature so far. Digital business model innovations materialize by purposefully orchestrating digital innovations across the different dimensions of a business model (Fichman et al., 2014, p. 335; Rayna & Striukova, 2016, p. 217). Examples for digital business models encompass on-demand streaming services (e.g., Spotify, Apple Music), which have significantly substituted the consumption of music from other channels and have cannibalized traditional value chains of major record labels (Wlömert & Papies, 2016, pp. 316, 324). The evolution of e-books and the *digital first and print last* approach in the newspaper industry represent further examples of this trend (Karimi & Walter, 2015, p. 49; Yoo, Henfridsson, et al., 2010, p. 725). Digital business models also have the potential to reverse the structures of power and authority in traditional supply chains, such as in the publishing or music industry (Vendrell-Herrero, Bustinza, Parry, & Georgantzis, 2017, p. 73).

The questions arise as to how we can position digital business model innovations along the newness continuum and from what perspective (e.g., firm vs. market) (Garcia & Calantone, 2002, p. 124). Fichman et al. (2014) took the perspective of the adopting firm and argued that digital innovation always “requires significant changes on the part of adopters” (p. 333), and that they are different from simple sorts of innovations, such as installing commercial-off-the-shelf software to automate tasks without incurring any substantial organizational changes. Similarly, Nambisan et al. (2017, p. 229) argued that digital technologies afford radical opportunities for new products and services in firms. Nylén and Holmström (2015) took a market-level perspective and contended that digital innovations “profoundly challenge existing markets” (p. 59) and may trigger radical industry-level transformations. While these understandings attribute a universal disruptive potential to digital technologies, other scholars (e.g., Yoo, Henfridsson, et al., 2010, p. 725) have neither applied a strict radical-incremental dichotomy nor taken exclusive firm or market-level perspectives. However, the practice of implementing small, incremental improvements (even if cumulatively large) which do not require any significant organizational changes, is basically well understood in research and practice (Teece, 2010, p. 186). Such routine activities, even in the sphere of digital technologies, neither exhibit any significant degrees of newness nor are they associated with high degrees of uncertainty or unpredictability, which are typically associated with innovation activities (Chandy & Prabhu, 2011, p. 96; Damanpour, 1996, p. 696). We argue for emphasizing digital technologies’ pivotal role in the digital innovation of business models, and we agree with Fichman et al. (2014, p. 333) that not only the study of extremely radical innovations may yield fruitful insights on how firms generate digital business model innovations. From a firm perspective, research generally has argued that the results of innovation are significant when the degree of innovation as well as the number of affected business model components in an organization is high (Ho, Fang, & Hsieh, 2011, p. 601). Research further has pointed out that business model innovations primarily rely on the ability of a *particular firm* to reconfigure existing resources and capabilities (Amit & Zott, 2010, p. 3).

In taking these ideas together, our study focuses on new or changed value propositions and architectures from a *firm-level* perspective and that go beyond minimum-effort improvements yet may have the potential to create a shift in the consumer behavior or even the market structure (Baker, Grinstein, & Harmancioglu, 2016, p. 110; Garcia & Calantone, 2002, p. 113). Summarizing the previous discussions, we propose the following conceptualization of digital business model innovation, which we define as *the creation or change of ways for offering, creating, delivering, or capturing value that are new to the organization, and result from the use of digital technology.*

Our definition therefore regards digital technologies as inherent component of digital business model innovations and includes a variety of strategic outcomes that occur in one or multiple dimensions of business models. We exclude routine tasks or minor improvements that address well understood problems involving digital technology (Nambisan et al., 2017, p. 224; Yoo, Henfridsson, et al., 2010, p. 725), although these are not explicitly covered in the definition. Our proposed definition does not exclusively focus on more radical innovations using digital technologies in earlier phases of diffusing. However, we emphasize more complex activities that are geared to the establishment of sustainable competitive advantage and differentiation, which certainly privileges the study of the role of emergent technologies for digital innovations (Fichman et al., 2014, p. 333; Nambisan et al., 2017, p. 224; Teece, 2010, p. 173).

3.2 Dimensions of Digital Business Model Innovation

While the previous section provided a conceptualization of digital business model innovation, literature remains rather vague on how digital technologies influence the individual business model components of value proposition, creation, delivery and capture. Hence, by distinguishing among the different dimensions of the digital business model innovation concept and also the ways in which how digital technologies pervade them, we can better account for their unique properties and better define the scope of our empirical fieldwork by distinguishing between organizations that engage in digital business model innovations and those that do not (Chandy & Prabhu, 2011, p. 96). As technologies usually do not exert punctual influence but often afford changes across all levels of an organization (Leonardi, 2013, p. 771), we acknowledge that certain elements in our categorization may also influence other business model components. Nevertheless, we assigned elements only to one component where the literature has indicated the most significant impact to ensure parsimoniousness of our overview.

Furthermore, although we screened all major databases[6] and applied forward and backward searches (vom Brocke et al., 2015, p. 214), we do not claim exhaustiveness of our overview. However, we argue that this synopsis contains the most pivotal concepts from the extant body of knowledge (Cooper, 1988, p. 111) that currently drive the digital transformations of business models. Table II-3 provides an overview of the different elements discussed next. Subsequently, we identify challenges related to digital business model innovation.

[6] EBSCOhost, AISeL, ScienceDirect, ProQuest; using keywords such as *digital/business model innovation*

Table II-3. Dimensions and characteristics of digital business model innovation.

Dimension	Characteristics	Examples
Digitalized value proposition		
Digitally-augmented products	• Embedding of digital materiality (e.g., sensors, processors, operating systems, and storage) into physical artifacts • Granting of digital properties (e.g., programmability, addressability, senseability, traceability) to products that previously had a purely physical materiality • Decoupling of products' features from physical embodiment in which the logic is stored	Smart devices such as digital/connected household appliances, wearables, autonomous cars
Digital servitization	Novel products and services that result from the increasing digitization of formerly physical products/services or from the creation of genuine new digital products/services. These may take three major forms: 1. Complementary digital services *enhancing* physical value propositions 2. Digital services that promote the *marginalization* of physical ownership 3. *Dematerialization* (i.e., full substitution) of traditional products through digitized product-as-a-service approaches and the creation of genuinely new digital services	Digitally-enhanced car-sharing and taxi services, digital payment services, digital fitting rooms, cloud services, e-books, music streaming, social networks, virtual reality applications
Digital mashups	• Combination of data and functionalities provided through platform resources to create derivative innovations • Rearrangement of digital resources across different layers of modular architectures • Creation of new products and services, or adding of new affordance to existing digital products and services	Smartphone apps, combination of APIs to create new software
Digitalized value creation		
Digital value co-creation	Digital technologies allow a broad range of actors to be integrated for mutual value creation at virtually infinite scalability. Network effects become crucial drivers for value co-creation.	Crowdsourcing, digital platforms, partnerships for sharing digital capabilities
Cyber-physical networks	Production systems increasingly become autonomous, context-aware, distributed, and interconnected	Smart grid, smart manufacturing systems / smart factory, distributed robotics, automated pilot avionics
Direct digital manufacturing	Dissemination of advanced additive manufacturing techniques at reduced cost allows goods to be produced closer in time and space to the consumer, economically renders customized products in small volumes, and enables the cost-efficient and quick creation of prototypes and tools required for production	Rapid prototyping, rapid tooling, and home fabrication using additive manufacturing techniques (e.g., 3D printing)
Digitalized value delivery		
Personalization	Communication and customer relations increasingly become user-specific by combining context-related information and data analytics, with increasing focus on digital touch points and self-service techniques	Social computing, targeted ads, e-ethnography, tribal marketing, social selling
Continuous delivery	Over-the-air provisioning of services and tracking of products-in-use allow products to be managed and changed in a more continuous and coherent way throughout their entire lifecycle, from their initial ideation to their final disposal	DevOps, preventive maintenance, updating cars with autonomous functionality late in their lifecycle
Digitized supply chain	Digital technologies are used to revamp internal logistic processes and the upstream and downstream supply chain to realize efficiency gains and improve customer experience	Warehouse automation, digital order management, drone deliveries, intelligent container
Digitalized value capture		
Relationship-based revenue models	One-off purchase models are decreased in favor of longer-lasting relationships and multiple revenue streams	Freemium and subscription models for value-added services, sale of user data, cross-selling of physical products, in-app sales
Multisided value capture	Value capture unfolds as a networked activity; revenues are collected through hub actors and then redistributed in the network, and data becomes a direct source of revenues	Digital distribution platforms, social networks, digital marketplaces, contextual advertising
Digital cost logic	Reproducibility of digital technologies are done at a low or zero marginal cost; direct manufacturing reduces inventory costs, and there are costs for platform participation	Endless reproducibility of digital apps at no cost, new transaction cost for platform engagement

3.2.1 Digitalized Value Proposition

Digital technologies are reshaping the value proposition component, which relates to the core products and services that a company offers (Berman, 2012, p. 18). Entirely new products and services as part of the value proposition component emerge from the use of digital technologies, which will be discussed in the following paragraphs.

Closely building on the nature of digital technologies (see section 2.1), one form of digital products materializes as a combination of digital and physical components to enhance the capabilities of the physical component by equipping it with digitally-enabled logic (Porter & Heppelmann, 2014, p. 4; Yoo, Henfridsson, et al., 2010, p. 725). We understand the results of combining physical and digital materiality as *digitally-augmented products* (Barrett et al., 2015, p. 142; Gutiérrez, Garbajosa, Diaz, & Yagüe, 2013, p. 206; Yoo, Henfridsson, et al., 2010, p. 729). While this broad conceptualization already applies to products such as washing machines that are able to detect weight overload (Rijsdijk & Hultink, 2009, p. 36), increasing degrees of digitization through the embedding of sophisticated sensors, processors, operating systems, and storage may amplify the functionality and value of physical products even further, leading to so-called smart products (Porter & Heppelmann, 2014, p. 69). By integrating digital materiality into artifacts that previously had a purely physical materiality, these products may be repurposed through their programmability feature and layered modular architectures, thus jeopardizing traditional product architectures and design hierarchies (Arthur, 2009, p. 88; Yoo, Henfridsson, et al., 2010, p. 726). In many cases, embedded hardware and software enables the products to operate autonomously, respond proactively to their environment, and form networks with other products (Rijsdijk & Hultink, 2009, p. 26; Sabou et al., 2009, p. 142). The global entirety of products that are equipped with the digital properties of programmability, addressability, senseability, communicability, and traceability is commonly referred to as the Internet of Things (Nylén & Holmström, 2015, p. 60; Wortmann & Flüchter, 2015, p. 222). Common examples include smart watches and a broad range of household appliances such as autonomous vacuum cleaners, and intelligent applications for heating and lighting systems that react to their environment and human behavior (Rijsdijk & Hultink, 2009, p. 28; Wortmann & Flüchter, 2015, p. 221).

We may further understand digital innovations in the value proposition component as the outcomes of *digital servitization*, defined as the provision of services based on digital components (Vendrell-Herrero et al., 2017, p. 71). While the research stream of servitization originally revolved around offering services complementary to physical products, research has started to focus on how firms leverage digital technologies for advanced services implementation and on how firms transition from a physical product to a digital service firm (Cenamor, Rönnberg Sjödin, & Parida, 2017, p. 55; Coreynen, Matthyssens, & Van Bockhaven, 2017, p. 44). Digital servitization unfolds along a continuum; it ranges from the offering of digital product-related services to the partial or full substitution of ownership through a digital product-as-a-service approach, where digital artifacts either represent entirely new service types or exhibit superior performance that replaces traditional products (Vendrell-Herrero et al., 2017, p. 70).

Digital servitization can occur in a number of ways. First, firms may decide to implement digital services that enhance physical value propositions. For example, digital fitting rooms are used by some online shops as a virtual mirror that allows potential customers to try on clothing in real-time, and the technology also enables clients to share images to friends through social networks (Berman, 2012, p. 19). Second, digital servitization may partially substitute and marginalize physical ownership of products. The increasing proliferation of cloud services now offers a continuous provision of technological infrastructures, without requiring the user to actually own the associated hardware and software. For instance, shared-usage models such as Zipcar's car-sharing service allows customers to locate and access a vehicle through digital apps and therefore substitutes personal car ownership (Porter & Heppelmann, 2014, p. 76). However, while these forms of digital servitization substitute personal ownership on the clients' side, the physical products (e.g., hardware, cars) still reside in the material world. Finally, digital servitization may bring innovations that no longer require a physical artifact to obtain a desired functionality and that replace previously physical materiality by digital materiality, or services which serve entirely new purposes and customers (Oliva & Kallenberg, 2003, p. 164; Yoo, Henfridsson, et al., 2010, p. 725). The focus on the absolute reduction of physical inputs to suffice an economic function is referred to as "dematerialization" (Velamuri, Neyer, & Möslein, 2011, p. 9). Digital services such as Spotify now replace perpetual ownership of audio records, and they dispel traditional physical formats such as compact discs through increasing digitization (Parry, Bustinza, & Vendrell-Herrero, 2012, p. 321). In contrast to other digital servitization types, dematerialized digital services are not prone to characteristics such as perishability and inseparability, since they take an immaterial mode of being; moreover, their consumption is independent of customers' time and space (i.e., they are non-rival in use) (Faulkner & Runde, 2010, p. 7; Lerch & Gotsch, 2015, p. 46). Through the homogenization of data, individuals may consume the products (e.g., music) through a variety of mediums (e.g., smartphones, computers) instead of being spatially bound to a single physical artifact that embodies the product's features (e.g., a physical data storage such as an optical disc) (Kallinikos et al., 2012, p. 13). While these innovations fully substitute functionalities of traditionally physical products and services, other forms of digital innovations yield genuinely new digital products and services that were not physically available before (Nambisan, 2013, p. 219). Examples include new enterprise platforms, cloud-based big data analytics tools, machine learning applications, social networks, software-based simulations, virtual reality applications, and crowdsourcing and -funding platforms (Carlsson, 2004, p. 261; Lerch & Gotsch, 2015, p. 47; Lyytinen, Yoo, & Boland, 2016, p. 49; Wu, Rosen, Wang, & Schaefer, 2015, p. 10).

Many of the previously mentioned digital value propositions build on open and layered modular architectures as described in section 2.1.2, and they act as *digital platforms* (e.g., the Android ecosystem). A digital platform may act as a new product itself, but it may further allow others to innovate upon them by providing access to resources for derivative innovations (Yoo, Henfridsson, et al., 2010, p. 729). Hence, we see that *digital mashups* provide the final building block in the digitized value proposition component (Barrett et al., 2015, p. 143). Mashups combine various product-agnostic data and functionalities into novel digital products and services by drawing on resources such as software development kits (SDKs) and APIs (Yoo, 2013a, p. 144). Spurred by the malleability of layered modular architectures, reprogrammability, and the homogenization of data, digital platforms allow for an infinite number of combinatorial innovations (Fichman et al., 2014, p. 338; Tilson, Lyytinen, & Sorensen, 2010, p. 3; Tiwana et al., 2010, p. 675; Yoo, Henfridsson, et al., 2010, p. 729). Such derivative innovations may result in entirely new digital products and services, or they may add new affordances to existing digital products and services (Yoo et al., 2012, p. 1400).

Customer value is equated with benefits minus cost (Barnes et al., 2009, p. 28). Hence, digital products and services that substitute physical ones propose a higher customer value since they offer the same or increased benefit at a lower cost (Henfridsson et al., 2014, p. 30). Due to their unique material properties (see section 2.1.1), digital technologies may increase perceived benefits of products and services in terms of performance, ease of use, reliability, and flexibility (Marques da Silva & Lindič, 2011, p. 1701). For instance, e-books afford the same benefits as printed books, but they further allow users to dynamically extend their digital library at a low cost, and their consumption is not restricted to time, space, or to a specific carrier of information (Faulkner & Runde, 2010, p. 7; Lerch & Gotsch, 2015, p. 46).

3.2.2 Digitalized Value Creation

Digital technologies pervade the value creation component, which describes how firms leverage key competencies and resources to realize their value offerings (Spieth & Schneider, 2016, p. 675). The use of digital technologies in value creation may lead to a shift of core competencies in value creation (Rayna & Striukova, 2016, p. 218) and will be explained in this subsection.

Digitized value creation is increasingly interlinking different actors to one another. For example, Amazon extends its value creation by including external merchants that may list their products on the platform, and users provide product reviews for the benefits of other buyers (Marques da Silva & Lindič, 2011, p. 1700). The combination of resources from various actors on such digital platforms joined to generate mutual benefits is commonly investigated under the umbrella of *digital value co-creation* (Vargo & Lusch, 2004, 2008). Innovation in this context is seen as the result of integrating complementarity digital resources from diverse sources to "create novel resources that are beneficial . . . to some actors in a given context" (Lusch & Nambisan, 2015, p. 161). In this context, network effects become the critical success factor for value creation (Bharadwaj et al., 2013, p. 475; Katz & Shapiro, 1985, p. 439). The number of actors, the relationships among these actors, and the variety of innovative or useful assets on the digital platform impact demand in the ecosystem; they are also regarded as focal sources of value to prospect customers. Although a digital platform may have a standalone value in its own right, it must often rely on complementary digital assets that are contributed to by actors engaging on the platform to be useful (Tilson et al., 2013, p. 3). Today, the scope of many digital products is intentionally incomplete by design and instead relies on the co-creative and generative evolution of value (Nambisan, 2017, p. 1033). For example, while the standalone value of Apple's iPhone consists of telephone features, Internet access, and basic applications, its core value stems from the plethora of applications created by third-party developers (Parker, Van Alstyne, & Jiang, 2017, p. 258). This allows firms to acquire core competencies that they did not previously have and increasingly connects previously unconnected resources and needs. For example, value creation approaches such as crowdsourcing of ideas allow companies to extend their value networks far beyond traditional boundaries (Loebbecke & Picot, 2015, p. 151). Platforms and other digital infrastructures provide access to underutilized resources (e.g., customers, suppliers) for value creation which were inaccessible before, but this also results in an elevated power of previously underpowered parties as they become core contributors of the value creation process (Amit & Han, 2017, p. 230). By sharing resources for digital value creation on crowdsourcing platforms or in partnerships and alliances across industry boundaries (Bharadwaj et al., 2013, p. 476), many firms aim to benefit from a broad range of capabilities not available otherwise.

More prevalent in the industrial sector is the use of *cyber-physical networks* to enhance value creation activities. The term denotes "the composition of cyber and physical resources" (Rajkumar, Lee, Sha, & Stankovic, 2010, p. 733) into an intelligent production system that is monitored and coordinated by digital technologies. Cyber-physical networks consist of intelligent data management and analytics capabilities, and connectivity that ensures real-time acquisition of data from the physical world (Lee, Bagheri, & Kao, 2015, p. 19). Cyber-physical networks are associated with changes in production systems or service systems with the aim to reduce lead times, increase operational flexibility, and lower production costs (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014, p. 239; Rajkumar et al., 2010, p. 731). More holistically referred to as *Industry 4.0* (Lasi et al., 2014, p. 240; Lee et al., 2015, p. 18), cyber-physical networks affect both the collection and processing of information inputs to production activities as well as the subsequent creation of physical products and services. Central to this concept of augmenting physical work is the usage of real-time actor-sensor-data to enable context-awareness and situation recognition, increase of the decentralization and interconnection of production systems, and the automation of work processes. This may ultimately result in manufacturing cells and products which control and optimize their own production processes (Lasi et al., 2014, p. 240). One example is the so-called *smart factory*, which enables “the real-time collection, distribution and access of manufacturing relevant information anytime and anywhere” (Lucke, Constantinescu, & Westkämper, 2008, p. 116). A smart factory may automatically adjust production capacities according to order fluctuations or may suggest required repair activities and tools in case of machinery breakdown. Such approaches may fundamentally reshape traditional management principles (e.g., first-in-first-out) and optimize production. Advanced power grid systems (i.e., smart grids) use similar concepts to improve the management of distributed energy resources, implement load shedding, and balance power generation from various resources (e.g., wind, solar, fossil) according to predicted usage patterns of human activity and natural processes such as weather conditions (Mo et al., 2012, pp. 195–196; Rajkumar et al., 2010, p. 732). Other examples of cyber-physical networks include distributed robotics, medical monitoring, and automatic pilot avionics (Khaitan & McCalley, 2015, p. 350).

We also see that digital technologies spur *direct digital manufacturing* approaches to enhance value creation activities (Chen et al., 2015, p. 616). Direct digital manufacturing builds on the technique of additive manufacturing, which denotes the “process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies” (ASTM, 2010, p. 2). Instead of using CNC machined molds to form single parts of a good which then need to be assembled (i.e., subtractive manufacturing), direct digital manufacturing uses deposition printheads to create three-dimensional objects from 3D (e.g., CAD) models by subsequently combining planar layers of materials (Gibson, Bourell, & Campbell, 2012, p. 255). Additive manufacturing techniques have been present for more than 25 years; they employ a broad range of materials such as various heat-resistant polymers and metal alloys, wax, powders, liquids, paper, or concrete (Chen et al., 2015, p. 617; Guo & Leu, 2013, p. 215). Today, the decreasing cost of 3D printers or direct metal laser sintering are making the technology available to the general public on a larger scale (Chen et al., 2015, p. 621; Gibson et al., 2012, p. 255). Direct digital manufacturing does not require workers to produce and assemble a product within a factory, but instead it allows a product to be fabricated right at or close to the customer by using a 3D model and additive manufacturing techniques (Chen et al., 2015, p. 616; Rayna & Striukova, 2016, p. 218). Although the practice of home fabrication is still in its early stages, commercial direct digital manufacturing allows firms to produce customized goods economically even at a lot size of one since the marginal cost are much lower compared to traditional subtractive manufacturing approaches. Traditional subtractive approaches always require new molds to be created when changing production, which renders small batch sizes economically unfeasible (Chen et al., 2015, p. 624).

This shows that the materiality of specialized tools (e.g., molds, casts, and jigs) that are required as input to production routines often constrains process flexibility, since their construction is often lengthy and expensive (Rayna & Striukova, 2016, p. 216; Yoo, 2013a, p. 141). By contrast, direct digital manufacturing enables cost-efficient *rapid tooling*, which allows new manufacturing processes and production lines to be quickly set up by generating specialized tools at fractions of cost and time (Rayna & Striukova, 2016, p. 218). Direct digital manufacturing also allows prototypes to be built more quickly and in an automated fashion, instead of using manual techniques such as clay-forming prototypes. In this way, direct digital manufacturing allows spare-parts such as housings or gears to be rendered at significantly reduced time and cost where required (Gibson et al., 2012, p. 255; Guo & Leu, 2013, p. 229).

3.2.3 Digitalized Value Delivery

Digital innovations further occur in the value delivery component, which encompasses sales and distribution channels, target market segments, communication channels, and customer relations (Osterwalder & Pigneur, 2010, p. 27; Rayna & Striukova, 2016, p. 217).

Through the use of context-related data, value delivery increasingly becomes specific and *personalized* (Schmäh & Gutsche, 2017, p. 174). Products and platforms offer tailored customer services and personalized buying experiences (Kane, 2017, pp. 2–3), and they allow firms "to make the location of their customers the location of their business" (Fano & Gershman, 2002, p. 85). As customers today increasingly want to choose their own buying approach, firms need to meet higher demands for self-service through digital touchpoints (e.g., smartphone applications) (Schmäh & Gutsche, 2017, p. 173). By following an e-ethnography approach, firms constantly gather insights about users' habits and needs by monitoring ongoing product interactions to improve products and develop customer relationships (Trabucchi, Buganza, & Pellizzoni, 2017, p. 47). Furthermore, while traditional advertising companies were not able to specifically target individuals, digital advertisers are able to tailor messages based on an analysis of detailed user behavior and product preferences (Greenstein, 2010, p. 5; Tucker, 2014, p. 546). Similarly, online retailers constantly monitor customer satisfaction and consumer preferences to offer personalized product bundles (Johannessen & Olsen, 2010, p. 507).

Another aspect of personalized value delivery also encompasses an increasing focus on digital communities to identify and meet customer demands (Schmäh & Gutsche, 2017, p. 177). On the one hand, digital technologies are said to increase personal isolation and may even result in "severe social dissolution and extreme individualism" (Cova & Cova, 2002, p. 596), as people can now consume virtually anything via the Internet without any physical social interaction. On the other hand, it was observed that many people use digital technologies to resort to societal micro-groups and communities to develop and confirm their personal points of view, referred to as "digital tribalization" (Naughton, 2008, p. 196). Due to shared values, people perceive their allegiance to digital tribal-like groups to be more meaningful than their membership to the larger society that is often perceived as too vague (Danesi, 2017, p. 177). As consumers often "seek products and services less for their use than for their linking value" (Cova & Cova, 2002, p. 600), firms now often deliberately approach these groups or build affective communities themselves to allow for vivid participation, thus creating an ongoing experience around their products (Oestreicher-Singer & Zalmanson, 2013, p. 611). Here, firms leverage a broad range of social computing applications such as social networks, wikis, or blogs to facilitate interaction and communication with their customers and the highly involved tribal groups (Wang, Carley, Zeng, & Mao, 2007, p. 80). Empirical research has shown that users with an active participation within an online community that revolves around a product group are significantly more likely to pay for digital products and services (Oestreicher-Singer & Zalmanson, 2013, p. 609). Targeted engagements to foster digital word-of-mouth have been found to be more effective than traditional marketing activities, and they may ultimately increase revenue compared to firms offering only products and no digital community (Barnes & Mattsson, 2016, p. 4; Oestreicher-Singer & Zalmanson, 2013, p. 611). Hence, digital technologies affect the value delivery component in that they simplify the customization of products and by delivering a personalized user experience.

Digital technologies further pervade product lifecycle management, which denotes the "activity of managing . . . a company's products all the way across their lifecycles; from the very first idea for a product all the way through until it is retired and disposed of" (Stark, 2015, p. 15). In this context, digital technologies promote *continuous delivery* approaches that are akin to agile software development. Humble and Farley (2010, p. xxiv) initially used the term continuous delivery for the process of producing, updating, and delivering software in short cycles. Rapid and continuous improvements promise several benefits, such as enhanced software quality, an accelerated time to market, and improved user satisfaction (Chen, 2015, p. 52). The continuous delivery paradigm gave rise to the broader DevOps philosophy, which aims to remove barriers between development and operations, emphasizes constant cross-silo collaboration and business integration, and leverages automated delivery (Humble & Molesky, 2011, p. 7). Today, the practice of constantly releasing new or updating existing products at an accelerated speed now transcends the domain of software development and expands into the physical realm; this is done by tracking products-in-use and by employing over-the-air provisioning (Giaimo & Berger, 2017, p. 209). Based on insights gathered from continued product use (Dienst, Fathi, Abramovici, & Lindner, 2014, p. 192), companies leverage real-time user data to constantly improve and develop their products and services throughout the lifecycle (Trabucchi et al., 2017, p. 47). Data acquired throughout product usage may encompass structured and unstructured data, which are either automatically reported through sensors (e.g., failure data, environmental data) or may be manually reported by human actors (e.g., customer profile data) (Dienst et al., 2014, p. 194). The product-agnostic nature of modular digital technologies and their generative capacity allow for a late binding of features, which enables firms to change their products' capabilities throughout the entire life cycle (Svahn & Henfridsson, 2012, p. 3353). For example, Tesla Inc. gradually augments existing cars with improved autonomous functionality via over-the-air software updates; it also infuses data about customers' driving behavior into their testing and validation procedures (Giaimo & Berger, 2017, p. 203). Hence, the entire product lifecycle now becomes composable and malleable, since products' functionalities can be reconfigured and extended in-use without endangering the overall system and without modifying the physical embodiment in which the logic is stored (Yoo, Henfridsson, et al., 2010, p. 726). This continuous delivery does not further require the design and production phases to be separated, as in traditional integral design hierarchies (Henfridsson et al., 2014, p. 29; Tiwana et al., 2010, p. 683).

We also see that continuous delivery approaches are applied to industrial maintenance services (Smith, Ng, & Maull, 2012, p. 556). Contrary to traditional planned scheduled or preventive maintenance approaches which only consider metrics such as equipment age or meter readings, predictive maintenance considers actual equipment usage to predict failures before they occur. Recent maintenance approaches leverage sensor networks, big data techniques, and neural networks to identify abnormal behavior and onset of machinery failures in real-time (Rabatel, Bringay, & Poncelet, 2011, p. 7014; Wan et al., 2017, p. 2039). Maintenance information may be exchanged between equipment users and the supplier, and automatic software updates may be provisioned over-the-air to ensure ongoing equipment functioning (Schmäh & Gutsche, 2017, p. 176).

Finally, we see that the *digitizing of supply chain activities* aims to enhance the speed, reliability, and consistency of the entire supply chain. Here, digital technologies are used in internal logistics processes, as well as in the upstream (i.e., supply) and downstream (i.e., demand) side of the supply chain (Ayers, 2006, p. 79). Considering internal processes such as storage and warehousing, firms add value to their sales and fulfillment activities by building automated storage-retrieval systems (i.e., automated warehouses), which enable firms to realize efficient storage strategies that are too complex for humans to handle. Such warehouses aim to reduce the travel times of goods and to improve the order picking process (Amit & Zott, 2001, p. 496; Gu, Goetschalckx, & McGinnis, 2010, pp. 543–544). On the downstream side of the supply chain, firms are offering more comprehensive information in the after-sales phase by providing easy-to-use approaches to digitally track and change order processes (Schmäh & Gutsche, 2017, p. 175). Advances such as in carbon fiber manufacturing and lithium polymer batteries allowed several companies to use unmanned aerial vehicles (i.e., drones) to reduce transit times and cost required for deliveries (Chow, 2016, p. 167; Dorling, Heinrichs, Messier, & Magierowski, 2017, p. 70).

On the upstream side of the supply chain, digital technologies enable approaches for the continuous monitoring of goods while in storage or in transit, and they provide an integrated view on the entire supply chain to all participating actors (Bijwaard, van Kleunen, Havinga, Kleiboer, & Bijl, 2011, p. 618). Such interconnected sensor networks are primarily used for the transportation of perishable goods such as pharmaceuticals or food. One example is the intelligent container for the transportation of goods, such as fruits and vegetables (Lang et al., 2011, p. 688). The container is able to calculate the shelf life of its cargo by leveraging a combination of networked telematics, connected time-temperature integrators, a wireless sensor network, and corresponding middleware. Based on the microbial load and temperature of the cargo, the container corrects the cooling unit autonomously, initiates a controlled ripening, and sends alerts to supervising staff. It also provides feedback to the producers and decides based on the estimated shelf life and product quality upon arrival whether it will be transported a longer distance or promoted for quicker selling to markets closer by (Haass, Dittmer, Veigt, & Lütjen, 2015, p. 402).

3.2.4 Digitalized Value Capture

Digital technologies revamp how firms capture value, which encompasses the revenue and cost logic related to the appropriation of created value (Spieth & Schneider, 2016, p. 675).

Since digital servitization increasingly substitutes personal ownership, and many traditional products and services nowadays compete against cheap or free digital alternatives, firms move from transactional one-off purchase models to *relationship-based revenue models* (Oliva & Kallenberg, 2003, p. 168), such as subscription and freemium models (Teece, 2010, p. 190). Some firms offer free standard versions of their digital products in addition to premium versions or value-added services including additional functionality (Rietveld, 2017, p. 171; Teece, 2010, p. 179). Although research found that freemium models may harm consumers' perceptions of value (Rietveld, 2017, p. 186), relationship-based revenue models also promote multiple revenue stream approaches. Depending on the unique value proposition, companies may offer free versions of their products that are combined with subscription models for value-added services; they may also collect revenue fees from contextual advertising, cross-sell physical products or offer in-app sales, charge transaction fees, and leverage big data analytics to target users through personalized ads (Lambrecht et al., 2014, pp. 332, 335; Trabucchi et al., 2017, p. 46). Increasing personalization of digital products and digital servitization increasingly force companies to engage relationship-based revenue models. For example, while consumer electronics companies may profit from the one-off sale of innovative products (i.e., smartphones), they cannot seize benefits from the products' continuous use. By contrast, firms such as Apple are not only engaged in one-off sales of innovative products, but they manage to extract ongoing rents throughout the product's lifecycle by introducing other services such as music streaming and by maintaining a profitable ecosystem (Amit & Zott, 2012, p. 43). Here, a relationship-based revenue model allows firms to generate revenues through the continuous provision of targeted services that are based on detailed user insights, instead of haphazardly selling products to anonymous customers (Venkatraman, El Sawy, Pavlou, & Bharadwaj, 2014, p. 6).

Platform owners in particular often pursue *multisided revenue models*. By bringing together various groups (e.g., users and developers), platform owners may collect revenues from multiple parties and in different ways. For example, the platform owner may charge licensing fees to end users, while developers providing complementary apps may participate for free or even get subsidized in order to spur network effects (Pagani, 2013, p. 626). In the mobile ecosystem, the complex value capture network has spanned across the digital distribution platform, users, app developers, hardware manufacturers, carriers, and other service providers, where one actor (e.g., the platform owner) serves as the hub that collects revenues from customers and then distributes shares to other actors (e.g., developers) in the value network (Bharadwaj et al., 2013, p. 478; Pagani, 2013, p. 624).

Firms' *cost logic* also changes when using digital technologies. First, as opposed to physical artifacts, many digital technologies have little or no marginal cost for reproduction due to their immaterial mode of being, and cloud infrastructures allow digital resources to be flexibly adjusted to changing requirements (Henfridsson et al., 2014, p. 30). Hence, the reduced cost allow firms to rapidly scale their value creation almost infinitely (Bharadwaj et al., 2013, p. 475). For example, while physical books require certain material inputs for production (e.g., paper or ink), e-books may be reproduced and distributed globally without physical input constraints. Second, since many digital technologies are non-rival in use (Faulkner & Runde, 2010, p. 8), their consumption by one customer does not decrease their availability to others. Finally, the usage of platform infrastructures may change traditional cost structures and profit allocation. Firms operating on proprietary platforms (e.g., Apple's Appstore) typically need to cede parts of their profits to platform owners (Rayna & Striukova, 2016, p. 219), depending on whether a firm owns or operates on such a platform. In the industry sector, we see that approaches such as direct manufacturing and rapid tooling (e.g., using 3D printing) have the potential to reduce the cost for the creation, storage, and transport of goods and tools (Rayna

& Striukova, 2016, p. 218), yet these approaches require investments into these technologies and required capabilities.

3.3 Digital Business Model Innovation Challenges and Thrusts

In addressing our first research question, this chapter provided a conceptualization of digital business model innovation and a systematic overview of how digital technologies revamp individual business model components. When taken together, digital innovations within the business model components focus on the novel application of digital technologies across all organizational processes to achieve efficiency gains and to cater for new or changed customer expectations. We also see that digital technologies enable business models to become more modular and adaptable, and they allow companies to tap sideways into new markets more easily. For example, Amazon moved from a startup online bookstore to a provider of business solutions (e.g., warehousing), cloud services, and media streaming services (Marques da Silva & Lindič, 2011, p. 1697). Companies may further rapidly move upstream or downstream in the value chain. For example, design companies that were previously dependent on manufacturing firms to produce their products may now decide to use 3D printing technologies to take over manufacturing activities by themselves, and in doing so they can thus extend the reach of their business model (Rayna & Striukova, 2016, pp. 219–220).

The previous discussion of digital business model innovation highlights that many organizations may yet need to understand why they should digitally-enable their business models. Christensen (1997, p. 258) pointed out that exclusively focusing on innovations that aim to sustain existing paths may not result in long-lasting competitive success. As our overview illustrates, customers today increasingly demand digital products and services, seamless and personalized value delivery, and the opportunity to participate in the value creation process. Firms need to shift their business model towards digital in order to seize profit and growth opportunities, and also to avoid adverse effects of changing customer demands and technological shifts (Rayna & Striukova, 2016, p. 220). Hence, to stay in sync with market and technological trajectories, firms need to accordingly adapt their business model components (Nambisan, 2017, p. 229; Svahn et al., 2017, p. 244). However, adapting the business model always poses challenges to incumbent firms that are typically prone to inertia (Henfridsson, Yoo, & Svahn, 2009, p. 2). Although digital technologies promise major opportunities for business model innovation, implications and challenges are manifold.

Table II-4 re-addresses the key challenges for firms that are identified earlier by Bessant (2003, p. 762 ff.), which must be dealt with in order to obtain a competitive edge through digital business model innovation. First, even if companies acknowledge the need to digitalize their business logic, they often struggle with *identifying appropriate* *potentials for what to digitalize*. Literature suggests that many organizations lack the awareness and understanding about digital innovations and the associated impacts for their business models (Gupta & Bose, 2018, p. 3). Here, we see that the phenomenon of digitalization may aggravate partial views of digital innovation in organizations, either by overly emphasizing fulfilling unmet customer demands or by only promoting technological aspects (Bessant, 2003, p. 764). This tension between market-pull, where innovation is derived from customer requirements, and technology-push, where innovation originates from the use of novel technological knowledge, is a longstanding debate in academia (Coombes, Walsh, & Saviotti, 1987, p. 102).

Table II-4. Challenges and thrusts associated with digital business model innovations.

Challenges	Description	Strategic thrusts
1) What to digitalize?	Organizations struggle with the identification of digitization potential within their business model components	Implement digital market scanning, allow for experimentation, balance the risks, develop an agenda and portfolio of digital initiatives
2) How to deal with uncertainty?	Organizations face uncertainty with regard to rapidly shifting customer needs and technologies, as well as new market entrants that erode traditional business models	Implement mechanisms to detect early signals of disruption, enable cross-functional collaboration to identify emerging digital opportunities
3) How to organize for digital innovation?	Many firms lack effective routines and structures to generate sustainable digital business model innovations	Implement organizational learning and firm culture geared toward digital innovation; establish appropriate sensing, seizing, and reconfiguring capabilities; build interfirm capabilities

The dominant view in the early 2000s focused on serving unmet customer demands (i.e., market-pull) with novel solutions that build on existing technologies (Shepherd & Ahmed, 2000, p. 103). During this time, competition has become increasingly technology-driven (i.e., technology-push), and customers have gained a more sophisticated understanding of technologies' capabilities. Moreover, rapid development and diffusion cycles of digital technologies may spawn new solutions without addressing any immediate market needs. However, while digital technologies may often be a source for innovation, novel digital products and services still need a market to capture their value (Di Stefano, Gambardella, & Verona, 2012, p. 1292). Technology-push may today quickly turn into market-pull, with potential severe consequences for established businesses (Kilkki, Mäntylä, Karhu, Hämmäinen, & Ailisto, 2018, p. 277). To understand the assets and drawbacks, firms need to understand the evolutionary dynamics of digital innovations (Yoo, Lyytinen, Boland, et al., 2010, pp. 24–25); they also need to recognize that traditional linear progression approaches may not be suitable to explain the diffusion of digital innovations (Boland et al., 2007, p. 631). This idea highlights the need for organizations to maintain a holistic and integrated view on digital technologies, their evolution, and their potentials to appropriate them in an adjusted business logic.

To engage in digital innovation, firms need to find new ways to bundle and digitalize innovative products, services, and processes across their entire business model (Nylén & Holmström, 2015, p. 62). However, identifying the potential for digital innovation is not easy. Christensen (1997) already argued that "we cannot expect our customers to lead us toward innovations that they do not now need" (p. 258). Successful digital business model innovation requires significant investments, a constant monitoring of profit and growth opportunities, the timely identification of shifts in technologies and demands, and the ongoing scrutinization of revenue models (Rayna & Striukova, 2016, p. 220). Here, a poor choice of technologies for new digital business models may dampen profits (Baden-Fuller & Haefliger, 2013, p. 422) and may hold the risk that organizations become dependent on immature digital technologies with low potentials for sustainable benefits (Whittington, 2018, p. 23). Investment in innovation is always a hazardous endeavor, and it requires the processing of a substantial amount of information, as well as experimentation with different ideas (Christensen, 1997, p. 259). Although initial investment costs may be high, once capabilities are in place, digital technologies' low marginal costs of reproduction can reduce the risks for experimenting with lateral moves into neighboring markets (Henfridsson et al., 2014, p. 30). Hence, firms need to build a portfolio of digital initiatives, balance risks, implement environmental screening mechanisms, and allow for experimentation to identify suitable opportunities for digital innovation (Bessant, 2003, p. 762).

Second, many firms struggle with *uncertainties when facing digital innovation*. Traditionally, only technology-push innovations were considered as disruptive, although market-pull innovations that were initially spurred by digital technologies may prove disruptive. The complex socio-technical nature of digital innovations' evolution makes it "difficult to pinpoint who is pulling and who is pushing" (Boland et al., 2007, p. 643). Although not all new digital innovations are radical or disruptive, firms need appropriate mechanisms to detect early signals of disruption from established competitors or new market entrants (Teece, 2010, p. 190). Lowered entry barriers allow small and agile firms to disrupt the business models of incumbents through complementation and substitution by means of digital technologies (Loebbecke & Picot, 2015, p. 151). New entrants that use digital technologies to develop new products that complement or substitute traditional products constantly erode the advantages of established business models (Karimi & Walter, 2015, p. 41). To withstand unforeseen disruption, research had advocated a close collaboration between business and technology teams to allow for an interdisciplinary identification and realization of new digital business model opportunities (Kane, 2017, p. 6). This coalescence of technological and market forces requires firms to find methods for coping with uncertainty about future environmental states and actions that may impede a business.

Finally, firms need to *build appropriate routines, structures, and competencies to organize for digital business model innovation*. Sensing early signals of disruption or shifts in technology or markets is typically not enough to sustain a business; instead, firms need appropriate capabilities for sensing, seizing, and reconfiguring their business (Teece, 2010, p. 190). Firms are forced to identify and account for a multiplicity of technologies and customer needs as they unfold (Boland et al., 2007, pp. 631, 641); they may have to invest in appropriate processes and structures that allow for an effective management of digital business model innovations (Yoo, Henfridsson, et al., 2010, p. 725). Referred to as the *innovator's dilemma* (Christensen, 1997), many organizations face challenges when trying to adapt to the new logic of digital innovation (Hylving et al., 2012, pp. 8, 17), since structures and practices for organizing innovations are institutionalized over long periods of time and are tailored to a dominant product design.

From a technical perspective, firms need to also synchronize the different clock speeds of digital and physical product developments (Porter & Heppelmann, 2014, p. 15), deal with hardware resource limitations, ensure seamless communication across artifacts while warranting security and privacy, manage a plethora of information obtained from diverse sources in varying quality (Sabou et al., 2009, p. 9), and establish the required technological infrastructure (Yoo et al., 2012, p. 1400). Digital product and platform innovators alike have to spur digital co-creation through the provision of APIs; they also need to create novel forms of customer experience by considering interface technologies, such as touch-sensitive control-display units and augmented reality devices (Porter & Heppelmann, 2015, pp. 104–105). Due to the low marginal costs of reproduction for genuine digital products and services, firms need to establish safeguards that prevent theft of IP and also set up digital rights management mechanisms to mitigate product piracy (Henfridsson et al., 2014, p. 30; Thongmak, 2015, p. 7).

From the organizational perspective, structures, resources, and competences are the fundamental basis to make sense of innovation-related information from the environment; these accordingly translate them into new digital business model components (Di Stefano et al., 2012, p. 1292). Firms need to build internal digital capabilities, referred to as the "collection of routines to leverage digital assets to create differential value" (Kahre, Hoffmann, & Ahlemann, 2017, p. 4712). However, as single firms are often not able to seize digital opportunities alone, organizations are increasingly required to build interfirm capabilities (Rai, Pavlou, Im, & Du, 2012, p. 254). This may give rise to new forms of interorganizational partnerships that were not required before, particularly with suppliers of sensors, software, analytics, and connectivity (Porter & Heppelmann, 2014, p. 76). Customers and end users further play a pivotal role in co-creational innovation processes. Thus, companies need to coordinate different actors by establishing an ecosystem-wide governance (Huber, Kude, & Dibbern, 2017, p. 581); they also need to nurture network effects in order to foster growth and sustainability (Ondrus, Gannamaneni, & Lyytinen, 2015, p. 262). Related activities contain the building of organizational learning mechanisms and establishing an innovative culture of participation (Bessant, 2003, pp. 763–764).

Overall, we argue that addressing the challenges in Table II-4 fall into the responsibility of a dedicated digital IM (Nambisan et al., 2017, p. 224). Although digital technologies may have an unprecedented impact on how firms innovate their business models, little attention from research so far has been devoted to this topic. In the next chapter, we discuss the role of digital IM in more detail, thereby clarifying the aforementioned key challenges and thus addressing our second research question.

4 Management of Digital Business Model Innovation from an Information Processing Perspective

4.1 Digital Innovation Management and Information Processing

The characteristics and architectures of digital technologies (see section 2.1), the nature and logic of digital innovations (see section 2.2), and the multifacetedness of digital business model innovations (see Chapter 3) all highlight that digital technologies' impacts may span across all building blocks of how businesses organize (Bharadwaj et al., 2013, p. 473; Loebbecke & Picot, 2015, p. 151). To seize economic benefits embodied in digital technologies, an organization is required to create new strategic paths by "mindfully deviating from the existing path and creating an alternative future" (Henfridsson et al., 2009, p. 2). To create alternative futures, organizations need to flexibly adapt their existing products, processes, and business models to changing market conditions and digital trajectories, and they also need to provide mechanisms to extract economic rents from innovations (Woodard et al., 2013, p. 540). To translate environmental information about market needs and technical developments into new products and services, innovations typically traverse in dedicated units such as R&D or corporate innovation management departments, which are charged with the creation and management of innovations (Bowonder & Miyake, 1992, p. 320; Utterback, 1971, p. 76).

The common goal of IM is to generate blueprints for new products, services, and processes by leveraging knowledge about technologies and customer needs, and by realizing the blueprints on the market by means of systematic processes (Burns & Stalker, 1961; Eversheim, Baessler, & Breuer, 2008, pp. 5–6; Kießling, Wittig, & Kolbe, 2012, p. 2). To this end, IM may be regarded as the focal platform for entrepreneurial activities that embeds the actors who envision new digital products and processes (Garud, Hardy, & Maguire, 2007, p. 961). In doing so, innovations typically pass through discrete steps such as initiation, development, and exploitation (Kohli & Melville, 2019, p. 203). Carrying out innovation activities is described as highly complex and ambiguous, since both the final outcomes and the appropriate means for achieving the outcomes are difficult to predict (Russell & Russell, 1992, p. 642). Unlike the stable routine activities for rendering core goods and services, innovation activities are typically non-routine work that require the apprehension and creative utilization of internal and external information flows that are characterized by fuzziness (Basadur & Gelade, 2006, pp. 45, 49). Since effective IM is crucial for meeting customer demands and pioneering new markets, research has framed it as one of a firm's dynamic capabilities which "determine the firm's ability to integrate, build, and reconfigure internal and external resources/competences to address, and possibly shape, rapidly changing business environments" (Teece, 2012, p. 1395).

Innovation literature has indicated that the *organizational structure* applied to plan and execute innovation activities is found to represent the critical factor for innovation success, since organizational structures aim to effectively orchestrate information flows related to innovation activities (Burns & Stalker, 1961; Kießling et al., 2012, p. 7; Russell & Russell, 1992, p. 642; Tidd, 2001, p. 179; Utterback, 1971, pp. 81–82). Here, information flows are related to activities such as generating new products, processes, or business models that are of value for the innovating firm and its customers (Chesbrough & Rosenbloom, 2002, p. 549). In general, organizational structures define a number of areas, namely the activity allocation (i.e., division of labor), the coordination and control hierarchies, decision-making powers, logical groupings of employees, and communication mechanisms, all of which are designed to carry out organizational activities (Daft, 2009, p. 90; Miles, Snow, & Coleman, 1978, p. 551). Research has demonstrated that the *right* organizational structure can lead to higher degrees of innovation by enabling faster reaction to changes through improved information flows, and it can provide support in achieving a sustainable competitive advantage (Chen & Huang, 2007, p. 113; Child, 1972, p. 9). Furthermore, empirical research has shown that the way in which firms manage and organize innovation activities significantly impacts innovation (Ali et al., 2016, p. 5321; Camisón & Villar-López, 2014, p. 2897; Hernández-Perlines et al., 2016, p. 5385). The related task set of OD adjusts the structural variables to the specific organizational context to ensure effective vertical and horizontal information flows to accomplish overall goals (Daft, 2009, p. 92). Over the past decades, OD researchers have identified common configurations of structural variables, such as functional and divisional groupings, matrix organizations, machine bureaucracies, and ad hoc structures (Burton & Obel, 2004, p. 46).

In traditional product development units, many innovations require up to a decade of effort until they achieve market readiness (Gerpott, 2005, pp. 51–53). However, in times of rapid digital developments and fast obsolescence of products, the organizational ability to quickly develop and deploy digital innovations in short cycles becomes paramount for competitive success and survival (Bharadwaj et al., 2013, p. 476). Benner and Tushman (2015) heralded that “our core organizing axioms . . . may be challenged or fundamentally changed” (p. 498), since the nature and logic of digital innovations make them difficult to manage with conventional means. Thus, scholars have called for identifying new ways to connect and translate heterogeneous knowledge from a diverse range of sources (Lyytinen et al., 2016, p. 55) and to re-investigate how firms organize for innovation in the digital era (Nambisan et al., 2017, p. 224). The identified challenges related to digital business model innovation (see section 3.3) highlight that organizations need to design appropriate structures that enable them to constantly monitor their environment, disseminate relevant information, and seize the opportunities offered by digital technologies as soon as they emerge.

In this context, *digital IM* is considered the appropriate frame, as it subsumes “the practices, processes, and principles that underlie the effective orchestration of digital innovation” (Nambisan et al., 2017, p. 224). The related activity set may contain tasks such as analyzing the advancement of digital technologies, sensing unexpectedly changing customer behaviors, identifying dynamic competitive forces, and recombining digital and non-digital resources into novel configurations—thus addressing the *what and how to digitalize* challenges identified in section 3.3 (Frishammar & Åke Hörte, 2005, p. 254; Nylén & Holmström, 2015, p. 63). Today, traditional structural stereotypes for IM such as the traditional mechanistic–organic dichotomy may no longer apply to the context of digital innovation. The mechanistic–organic dichotomy summarizes configurational sets of formal–informal and centralized–decentralized structural designs that are found to have separate yet linear effects on innovativeness (Debrabander & Edström, 1977, p. 195). More recently, organizational structures that build on this dichotomy have been found to significantly hamper digital innovation (Henfridsson et al., 2009, pp. 15, 17). In contrast to earlier suggestions (e.g. Ettlie et al., 1984, p. 693), research reports that the effects of higher levels of formalization and centralization are not necessarily negatively related to higher degrees of innovation, and the effects vary significantly depending on a firm’s context (Brender-Ilan, Meirovich, & Meirovich, 2007, p. 241). Considering the nature and logic of digital innovations, we posit that the fundamental building blocks for designing effective digital IM structures must be revisited and updated. However, little is known today about how a firm may design effective digital IM structures that support firms “to break away from the existing path and create a new digital path” (Henfridsson et al., 2009, p. 4). Hence, our study focuses on identifying digital IM structures that facilitate the effective orchestration of digital technologies to harness digital business model innovations, depending on a firm’s specific context (Nambisan et al., 2017, p. 224; Tushman & Nadler, 1978, p. 615).

Researchers previously theorized IM as a “deep search process” (Trantopoulos, von Krogh, Wallin, & Woerter, 2017, p. 289), “a quest to coordinate and integrate knowledge” (Peppard, 2018, p. 82), and a “problem-solving activity” (Nambisan et al., 2017, p. 230) that matches problems (e.g., customer needs) with potential solutions (i.e., digitalized artifacts). Since IM is an organizational task that depends on the orchestration of substantial amounts of diverse information (Tatikonda & Rosenthal, 2000, p. 75), others have suggested to view IM as an “information processing organism” (Lievens & Moenaert, 2000, p. 47). We may broadly understand *information* in the context of digital IM as any facts, ideas, expertise, meanings, and judgments relevant to decision making and to the carrying out of activities in the context of digital IM, but information can also entail all message flows or sets of data that are organized and put to use for digital innovation (Albino, Garavelli, & Schiuma, 1998, p. 54; Galbraith, 1977, p. 25; Nonaka, 1994, p. 15; Van de Ven, 1986, p. 597; Wang & Noe, 2010, p. 117).

Despite these initial theoretical considerations, structural features of digital IM have received scant attention and little theoretical integration. To fill this gap, we draw on Galbraith's (1973, 1974) OIPT, which focuses on organizational structures' capacities to enhance the transfer and transformation of information. OIPT posits that resolving environmental *uncertainty* and *equivocality* is the central task in OD (Goodhue, Wybo, & Kirsch, 1992, p. 298). According to Daft and Lengel (1986), uncertainty refers to "the absence of information" (p. 556), while equivocality denotes ambiguity or a "confusion and lack of understanding" (p. 556) that may result in multiple or conflicting interpretations. Uncertainty results in the inability to assign probabilities about how the environment will affect the success or failure of innovation options, and equivocal situations lack the basis to make reliable forecasts about future states (Karimi, Somers, & Gupta, 2004, pp. 176–177). Together, uncertainty and equivocality pose challenges, since they render a "firm unable to plan and operate deterministically" (Bode, Wagner, Petersen, & Ellram, 2011, p. 835). Uncertainty and equivocality drive the *needs for information processing*. The need for information processing signifies that organizations are open systems that must process information to coordinate diverse activities and accomplish various tasks, but they have limited capacity to do (Daft & Lengel, 1986, p. 555).

As uncertainty and equivocality increase, the amount of information that must be processed to achieve a given level of performance also increases (Daft & Macintosh, 1981, p. 219; Qu, Pinsoneault, & Oh, 2011, p. 105). We may assume that digital innovations create substantial increases in the amount and diversity of environmental information, which impels more extensive searches for relevant information. We see that uncertainty and equivocality are pertinent traits of digital innovations' logic, since the breadth of innovation opportunities offered by digital technologies is significant and is often characterized by unpredictability (Woodard et al., 2013, p. 540). The final outcome of digital innovation activities is highly unpredictable and uncertain since digital innovations have *option-like* properties; in other words, the potential recombination of digital technologies creates the ability but not the necessity to do something in a new way, and the adoption of actually exerted options is highly uncertain (Baldwin & Clark, 2006, p. 1117). The dissemination of layered modular architectures increase the multiplicity of digital options, since layered modular architectures are "tolerant of uncertainty" (Baldwin & Clark, 2006, p. 1117) by allowing for rapid design changes over time and in parallel without compromising the overall system integrity (Woodard et al., 2013, p. 542). Firms face risks in terms of path dependencies resulting from unpredictable digital evolutions, uncertainty about investment returns, and potential technical debts (Svahn & Henfridsson, 2012, p. 3349; Woodard et al., 2013, p. 540). Overall, digital technologies induce uncertainty and ambiguity that may result in unclear and conflicting ideas about future digital paths. The information processing needs resulting from digital innovations are described more in detail in section 4.2.2. In taking these ideas together, we see that the need to process a growing amount of ambiguous information increases, and that organizations need to find appropriate mechanisms to support information processing in the context of digital IM (Fiedler, Grover, & Teng, 1996, p. 19). OIPT argues that the OD represents the primary catalyst for dealing with uncertainty and ambiguity by enhancing the abilities to process information from the environment (Daft & Lengel, 1986, p. 559; Tushman & Nadler, 1978, p. 617).

OIPT's basic assumption is that for firms to be successful, they need to match their internal structure to the nature and demands imposed by their environment (Bode et al., 2011, p. 835; Galbraith, 1973, p. 19). As information processing needs change, a firm needs to scrutinize accordingly whether its OD still represents an effective solution. Uncertainty requires organizations to acquire and process a greater amount of information from their environment, whereas equivocality requires the exchange of views about how to resolve ambiguities and the generation of rich information for decision making (Karimi et al., 2004, p. 177). Thus, it is OD's basic function to provide a sufficient amount of information to reduce uncertainty and provide suitably rich information to reduce equivocality that pertain to digital IM activities (Daft & Lengel, 1986, p. 555). The collection of structural mechanisms employed by organizations to ensure the effective collection, dissemination, and utilization of information represent their *information processing capabilities* (Jantunen, 2005, p. 340). Firms can employ various strategies to design the macro-organizational structure of digital IM, and such a structure acts to channel and enrich information flows for innovation activities (Egelhoff, 1982, p. 438), which are described in more detail in section 4.2.3.

In sum, we understand effective digital IM as *matching the innovation-related information with the structural capacity to process this information for digital innovation activities*. This perspective thus acknowledges the previous considerations geared to the search, coordination, integration, and matching of information that is relevant to digital IM. The next sections detail our understanding of digital IM from an OIPT perspective by first discussing relevant constructs, followed by hypothesizing their relationships and by presenting an overall integration into a comprehensive research model.

4.2 Definition of Constructs

4.2.1 Digital Business Model Innovativeness

While we laid out the *concept* of digital business model innovation in Chapter 3, we regard it as not fully adequate to represent a *construct* in our research for three important reasons. First, the concept needs to be clearly specified in an operational way that allows its measurement, thus enabling the comparison of empirical instances of the construct (Whetten, 1989, p. 490). Second, while the previously discussed nature and dimensions are pivotal in understanding the main conceptual tenets of digital business model innovation, they do not allow us to judge whether an organization exhibits digital business model innovation to a degree that is more significant than others (Dubin, 1969, p. 28). Finally, since neither all new digital innovations emerge from traditional R&D departments, nor are digital innovations always patented (Acs, Anselin, & Varga, 2002, p. 1080), we argue that consulting common proxies such as financial resources or patent output (c.f. Han et al., 2012, p. 301) may not be appropriate for assessing innovativeness in the digital age.

To this end, we propose to focus on *digital business model innovativeness*. Innovativeness is defined as the *degree of newness* embedded in the output of innovation activities (Garcia & Calantone, 2002, p. 125; Spieth & Schneider, 2016, p. 681). While examining individual digital business model innovations across organizations enables the comparison of *differences in kind*, investigating digital business model innovativeness allows the *differences in degree* between organizations to be compared (Winch, 2007, p. 71). For specifying the unit of analysis, we follow our arguments from section 3.1, and we thus focus on digital business model innovativeness from the firm-level perspective by considering digitally-enabled changes in a business model, namely the changes that are new to a particular firm but go beyond minor improvements and routine activities. We therefore propose to examine the degree of digitally-enabled changes that occur across a firm's business model dimensions. In this way, we understand digital business model innovativeness as the *creation of newness* that focuses on the ability of a firm to create or reconfigure existing resources and competences by channeling digital technologies into business model components. This idea contrasts with the *consumption of newness* perspective, which focuses on adopting new technologies more quickly than others (Roehrich, 2004, p. 671).

Digital business model innovativeness encompasses designing digital value offerings by addressing unfulfilled or creating new customer demands. As outlined in Chapter 3, this may be achieved by approaches such as the embedding of digital materiality in previously pure physical artifacts, or by the substitution of traditional products through digitalized services. Furthermore, value creation activities may be innovated by putting greater emphasis on digital core competencies and resources, and an increasing engagement in digital value co-creation activities (e.g., via platform approaches). Moreover, the value delivery may be innovated by improving the customer experience through the use of digital technologies. Finally, digital technologies may change the ways of how value is captured, since technologies alter cost structures and embody new opportunities for generating revenues. To capture the degree of newness of innovation in the business model, we focus on the relative newness from the viewpoint of the particular firm (Spieth & Schneider, 2016, p. 681).

4.2.2 Information Processing Needs: Turbulence

Organizations' are not closed entities that act in isolation; instead, outside elements impose the need for them to appropriately adapt to the surrounding environment (Aldrich, 1979, pp. 20–21). The organizational environment is commonly seen as the primary source of information that is required to attain goals (Dess & Beard, 1984, pp. 52–53; Tushman & Nadler, 1978, p. 614). The environment is characterized by uncertainty and equivocality that impact organizations' ability to achieve their goals, and that imposes information processing needs that must be addressed by obtaining a sufficient amount of rich information (Daft & Lengel, 1986, pp. 556–557). The joint presence of environmental uncertainty and equivocality has been described as the degree to which an environment is characterized by *turbulence* (Aldrich, 1979, p. 74; Goodhue et al., 1992, p. 298; Karimi et al., 2004, p. 178).

In general terms, Webster's dictionary (Mish, 2009) describes turbulence as a state of unrest and disturbance that is "characterized by up-and-down currents" (p. 1348). Miller and Friesen (1982, p. 6) argued that increasing turbulence creates a greater need for innovation and thus a greater need to process innovation-related information. Prior research has suggested that dealing with turbulence is one of the primary underlying determinants for innovation performance (Gupta, Raj, & Wilemon, 1986, p. 10; Han, Kim, & Srivastava, 1998, p. 40). Turbulence influences organizational goal setting, innovation activities (Shortell, 1977, p. 276), and the ability to obtain and transform the resources required for digital business model innovation. Here, research posits that a turbulent environment is positively correlated with a firm's innovativeness (Huse, Neubaum, & Gabrielsson, 2005, pp. 318–320). Studies have argued that such an environment forces companies to quickly adapt to emerging trends and moves to stay competitive, and that it bears plenty of growth opportunities due to numerous demands that need to be met (Miller & Friesen, 1982, p. 3). Since the turbulence construct has been previously applied in OIPT studies to frame information processing needs (e.g., Chen et al., 2014, p. 331; Karimi et al., 2004, p. 178; Miller & Friesen, 1982, p. 6), we regard this conceptualization as highly suitable for our research setting.

Inputs from the environment influences organizational decision making and subsequent strategic action (Song & Montoya-Weiss, 2001, p. 64; Zahra, Neubaum, & Huse, 1997, p. 62). However, managers have only limited foresight and imperfect information due to the inherent turbulent nature of the environment resulting from digital innovation's logic (Mithas, Tafti, & Mitchell, 2013, p. 512). Previous research argues that turbulence is constituted by separate characteristics, such as demand as well as both technological and competitive turbulence (e.g. Jaworski & Kohli, 1993, pp. 57–58). Here, we argue that the nature of digital innovations induces a form of socio-technical turbulence that diminishes the distinctive separation of different forms of turbulence. The effects of digital innovations go beyond a mere technological dimension, since they are part of a broader socio-technical, cultural, and economic process that transforms organizational structures, value creation activities, the competitive natures of markets, and the society at large (Hess et al., 2016, p. 124; Lusch & Nambisan, 2015, p. 157). We posit that convergence, generativity, distributedness, and the pace of digital innovation (see section 2.2.2) significantly spur this turbulence, and that firms need to ensure effective information processing structures in order to excel at digital business model innovations. As digital technologies evolve, meanings become increasingly ambiguous and require more heterogeneous information to innovate (Lyytinen et al., 2016, pp. 50, 56; Svahn et al., 2009, p. 5; Yoo, Lyytinen, Thummadi, et al., 2010, p. 6). Boland et al. (2007) described the evolution of digital technologies as non-linear wakes and intersecting paths that produce an unpredictable, complex landscape which is "sporadic, messy, rife with ambiguity" (p. 642). Marton (2009) put forward that technology "seems to be capable of becoming complex and unpredictable in its own right" (p. 154).

Given these ideas, we therefore seek to conceptualize the turbulence that is spurred by the development of digital technologies by investigating more fine-grained nuances motivating the need for a dedicated digital IM. To this end, our study follows seminal publications from Miller and Friesen (1983, p. 222), Dess and Beard (1984, p. 55), Keats and Hitt (1988, pp. 572–573), and Zahra et al. (1997, p. 28), who have conceptualized turbulence as being reflected by three major attributes: (a) *complexity,* referring to heterogeneity in technologies, products, and customers' habits, and the degree of sophisticated knowledge required to innovate; (b) *dynamism,* referring to the rate, unpredictability, and volatility of environmental change; and (c) *hostility*, referring to the availability of resources and the degree of competition.

First, we see that the nature and the logic of digital innovations increase *complexity*. Complexity refers to the variations among the firm's markets and the multiplicity and dissimilarity in technologies, products, customer needs, as well as the heterogeneity of information that is required to innovate in the environment (Sharfman & Dean Jr, 1991, p. 683; Teo & King, 1997, p. 192). Particularly high technology markets are found to be complex, since they often lack long-lasting product standards or dominant designs (Weiss & Heide, 1993, p. 222). Complexity represents uncertainty and equivocality as such that organizations often lack required information in sufficient richness, which result from the diversity of factors that may hold many different meanings (Newkirk & Lederer, 2006, p. 382). Organizations face complexity when engaging with digital innovations, since convergence brings together previously unrelated technologies (i.e., the combination and unification of diverse functions and devices) and thus requires the combination of more diverse and previously unconnected knowledge to innovate (Lyytinen et al., 2016, p. 48; Yoo, Lyytinen, Boland, et al., 2010, p. 3). Digital technologies are complex since they often lack an accepted meaning, or they may have multiple or changing contradictory (i.e., equivocal) meanings (Brusoni & Prencipe, 2013, pp. 171–172), which necessitates a substantial effort for organizational sensemaking and interpretation (Lyytinen et al., 2016, p. 55).

Generativity and rapid pace enabled by malleability spur complexity since they allow for fast and almost infinite options of reconfigurations, thereby reshaping product boundaries (Nylén & Holmström, 2015, p. 59; Yoo, Henfridsson, et al., 2010, p. 730). Fluid generativity implies "that knowledge resources will be increasingly heterogeneous and often only temporarily integrated" (Yoo et al., 2012, pp. 1401–1402). Layered modular architectures often do not prescribe fixed design rules that need to followed by third-party developers, and they further allow components to be recombined across layers in new and unexpected ways, which may complicate the overall technology landscape (Um, Yoo, & Wattal, 2015, pp. 2–3). Constant changes in product meanings and boundaries that result from the active reshaping of product designs can add further complexity (Yoo, Henfridsson, et al., 2010, p. 730). This is spurred by exponential price-performance improvements, thus making the realization of an increasing number of new digital technologies economically feasible (Fichman et al., 2014, p. 333). The distributed locus of digital innovation further amplifies complexity, since required information are "distributed across heterogeneous disciplines and communities" (Yoo, Henfridsson, et al., 2010, p. 730). Individual building blocks of digital products and services no longer emerge in splendid isolation from within the boundaries of a single firm but from the interactions among complex networks of actors (e.g., customers, competitors) with ambiguous and conflicting ideas about digital technologies (Lyytinen et al., 2016, p. 50). Both generativity and distributedness together compound complexity, since they enable a multitude of various artifacts that spawn from the combinatorial and unprompted evolution of technologies inside and outside the firm's boundaries (Lee & Berente, 2012, p. 1430; Yoo et al., 2012, p. 1402). In addition, this increases the diversity of tools, methods, and knowledge that are required to digitally innovate the business model.

Second, digital innovations put forward *dynamism*. Dynamism reflects the rate of instability, volatility, and unpredictability of changes in the environment (Huse et al., 2005, p. 318; Keats & Hitt, 1988, p. 572). Dynamism encompasses factors such as the rate of product and process obsolescence, the unpredictability of demand changes and competitive moves, and sudden shifts in technology and customer preferences, and changing regulatory requirements (Milliken, 1987, p. 136; Teo & King, 1997, p. 192). Dynamism represents uncertainty and equivocality as such that organizations are lacking sufficiently rich information to reliably control or predict the future states of their environment (Miller, 1993, p. 694; Newkirk & Lederer, 2006,

p. 382). Highly dynamic environments require firms to continuously and rapidly amalgamate information from various sources (Jantunen, 2005, p. 342; Teece, Pisano, & Shuen, 1997, p. 511). Digital innovation environments are dynamic, since the constant recombination of technologies may spontaneously spawn derivative innovations in a non-linear fashion beyond the original design intent (Yoo, Henfridsson, et al., 2010, p. 728; Zittrain, 2006, p. 1980). The generative nature is the primary reason why the evolution of digital innovations is difficult to control and predict (Nylén & Holmström, 2015, p. 59). Intersecting wakes and the cascades of innovation provide platforms for subsequent innovations at an unparalleled rate (Boland et al., 2007, p. 640). Generativity encompasses the occurrence of "unpredictable changes from inside and outside the firm's ecosystem" (Yoo et al., 2012, p. 1402). Here, uncertainty results from entrepreneurial opportunities that may be harnessed from these rapidly evolving cascades of innovation (Nambisan, 2017, p. 1039). Since technological development progresses at an exponential rate (Kurzweil, 2005, p. 27), many firms are vulnerable to the "lethal effects of technological shifts" (Rayna & Striukova, 2016, p. 220). Increased clock speeds in release and diffusion cycles resulting from convergence and programmability further promote relentlessly varying customer preferences and needs, as well as frequent technological changes (Pavlou & El Sawy, 2010, p. 446; Yoo, Lyytinen, Boland, et al., 2010, p. 23). The open architectural design of many digital technologies further compounds dynamism since it allows product scopes to quickly change (Lee & Berente, 2012, p. 1430).

Finally, digital innovations increase the *hostility* of a firm's environment. Hostility refers to the vigor and intensity of the competition, as well as the scarcity of resources and capabilities required to carry out innovation activities (Sharfman & Dean Jr, 1991, pp. 683–684). Hostile environments are perceived as harsh and difficult to navigate, and they threaten the firm's ability to effectively innovate (Miller & Friesen, 1983, p. 223). Hostile forces that impede maneuverability may include low margins, scarcity of labor and resources, as well as competition in price, product quality or product differentiation (Huse et al., 2005, p. 319; Newkirk & Lederer, 2006, p. 382; Teo & King, 1997, p. 192). Hostility represents uncertainty and equivocality as such that organizations are lacking sufficiently rich information about competitors' moves, beneficial opportunities, and the availability of resources for innovation (Newkirk & Lederer, 2006, p. 382). Digital innovation environments are characterized by hostility since the increasing ubiquity and affordability of digital technologies allow a greater number of actors to digitally-enable their business models (Nylén & Holmström, 2015, p. 59). Today, firms from previously unrelated industries compete with one another, and new market entrants disrupt incumbents' business models (Pon et al., 2015, p. 30; Tilson, Lyytinen, & Sorensen, 2010, p. 3). Here, emerging digital products and services that complement or substitute traditional ones increasingly jeopardize established value propositions. Furthermore, digital ecosystems are most often winner-take-all markets characterized by domination of a few actors (Frank &

Cook, 1996, pp. 107–108). Due to a nearly zero search cost (e.g., feedback and recommendation systems, search engines), customers usually choose the *best* product or service available (i.e., that which promises the highest customer value), while even only *slightly worse* go extinct (Maurer & Huberman, 2003, p. 2205). Yet, digital technologies promote long tail effects, which describe the demand shifts from dominant products to niche products (Anderson, 2008, p. 22). Here, the reduced search cost also enable the adoption of niche products that address diversified and previously unmet customer preferences (Zhou & Duan, 2012, p. 277). Winner-take-all and long tail effects may combine to a *superstar effect*, denoting that few products dominate the highest selling quantiles of a market, while the lower quantiles are populated with a vast number of niche products (Oestreicher-Singer & Sundararajan, 2012, p. 67). Hence, these mechanisms make it more difficult for firms to figure out their position in the digital ecosystem, as firms are threatened by either market dominators subduing them or by emerging niche actors surpassing them. Environmental hostility is aggravated by a scarcity of resources required for digital business model innovations. Although technologies have become increasingly ubiquitous and affordable, many firms face challenges with the appropriate resources required for digital business model innovation (Yoo, Henfridsson, et al., 2010, p. 730). Creating digital innovations necessitate a new set of capabilities and resources, which many incumbent firms do not necessarily possess (Karimi & Walter, 2015, p. 49). In highly concentrated digital market structures such as digital platform ecosystems, key resources are often held by large corporations (Haucap & Heimeshoff, 2014, p. 56). Hence, to close digital resource gaps, organizations are often required to access complementary resources by building digital inter-firm capabilities to develop and commercialize digital innovations that no single firm could have created alone (Partanen, Chetty, & Rajala, 2014, p. 8; Rai et al., 2012, p. 254). However, being too dependent on external partners that possess critical resources may lead to a vendor lock-in (Zhu & Zhou, 2012, p. 536), as well as power asymmetries when the exchange of resources is not equally important to all participating actors (Nienhüser, 2008, p. 10; Pfeffer & Salancik, 2003, p. 53).

Although digital technologies hold great potentials for firms, technologies also pose challenges when it comes to harnessing their benefits for business model innovation. We therefore propose to investigate the structures organizations employ to extract and transform the information that is relevant for digital business model innovations from the turbulence based on the heterogeneity, dynamism, and hostility caused by the nature and logic of digital technologies. This aligns with Galbraith's (1974, p. 28) understanding of information processing needs: Since a greater analytical effort is required to discern innovation-relevant information in turbulent environments, such environments require a more diligent approach to IM and a high degree of information processing to "avoid anachronistic products and practices" (Miller & Friesen, 1983, p. 223). Table II-5 summarizes how the nature and logic of digital innovations contribute to contextual turbulence and subsequently to substantial information processing needs.

Table II-5. Dimensions of turbulence in digital innovation environments.

Dimension	How the nature and logic of digital innovation increases turbulence
Complexity	*Environmental heterogeneity in technologies, products, and customers' habits, and the degree of sophisticated knowledge required to operate in such an environment* • Bringing together previously unrelated technologies (i.e., convergence) requires more diverse knowledge • Generativity and rapid pace enabled by malleability spur complexity since they allow for fast and almost infinite options of reconfigurations • Distributed locus of innovation increases complexity of innovation activities, since more actors need to be orchestrated to generate successful products and services
Dynamism	*The rate, unpredictability, and volatility of environmental change* • High volatility of technologies, since constant recombination may spontaneously spawn derivative innovations in a non-linear fashion that is not anticipated by the original actor (i.e., generativity) • Development progresses at an exponential rate, and increased clock speeds in release and diffusion cycles result in relentless shifts in technologies and customer preferences
Hostility	*Degree of threats and unfavorable external forces in an environment: Increasing competition and scarcity of resources and capabilities* • Competitors from previously unrelated industries and new market entrants disrupt incumbents' business models • Winner-take-all, long tail, and superstar effects make it difficult to determine a valuable competitive position • Many firms face challenges with appropriate resources required for digital innovation, while digital key resources are concentrated and absorbed by comparably few players; setting up digital innovation partnerships may have adverse effects

4.2.3 Information Processing Capabilities: Organizational Design Strategies

Our previous discussion demonstrates that digital IM needs to mitigate turbulence by monitoring a variety of information in its task environment including the product and factor markets, as well as the general environment encompassing technological, economic, and legal concerns (Yasai-Ardekani & Nystrom, 1996, pp. 188–189). The broad literature base on OIPT contains several design strategies related do organizational structures that firms can use to address the uncertainty and equivocality resulting from complexity, dynamism, and hostility. Table II-6 provides an overview of suggested strategies, based on seminal OIPT contributions (Daft & Lengel, 1986; Galbraith, 1973; Tushman & Nadler, 1978) and contemporary work from the IM domain. The key design variables symbolize the managerially controllable characteristics, which denote that the result of a genuine implementation can take several different forms in practice (Chiesa, Frattini, Lamberti, & Noci, 2009, p. 420). When taken together, these strategies constitute the *information processing capabilities* of an organizational unit, denoting a unit's capacity to effectively handle and utilize information for successful task execution despite their ambiguity and uncertainty (Galbraith, 1974, p. 29).

Table II-6. Overview of design strategies.

Dimension	Nature and purpose	Key design variables	IM examples
Meso-level design			
Basic structure	Definition of the unit's basic organizational anchoring, including hierarchy, rules, and procedures charged with collecting and processing information	Goals, employee grouping and unit size, formalization, centralization	Centralized unit, secondary task of another department, committees/boards, staff function, dedicated legal entity, temporary projects (e.g., matrix organization), and decentralized tasks across the firm
Micro-level design			
Slack resources	Increase buffer inventory to reduce the need for coordination	Buffer times, excess capital equipment, human resources, and other materials	High-density workforce and dedicated resources for experimentation with new technologies
Self-containment	Reduce the division of labor and grant greater decision-making autonomy at lower levels to decrease efforts for coordination	Horizontal (i.e., division of work) and vertical differentiation (i.e., division of authority)	Semi-independent teams and multiskilled employees
Internal lateral relations	Establish relationships that cut across units to distribute information across the organization in a timely way	Internal interfaces	Personal interaction and close collaboration with operational business throughout all IM stages
External lateral relations	Establish information-sharing routines with external parties	Vertical (e.g., suppliers, customers) and horizontal (e.g., competitors) interfaces	Customer involvement, external networking and partnerships, equity investments, contracting, and inward IP licensing
Information systems	IS-enabled collection of information to enable the right people at the right time to process the information	Systems and tools in support of information flows	Systems for project and resource management, knowledge management, and cooperative work

Galbraith (1973, p. 10) proposes that fundamental rules, procedures, hierarchies, and goals build an unit's *basic structure*. This structural foundation serves as the basis for the division and coordination of activities (Burton & Obel, 2004, p. 46). By grouping a set of individual job positions within an organization into units of different size (Mintzberg, 1979, p. 104) and by adjusting overarching lines of authority, firms arrive at common organizational forms such functional, divisional, or matrix structures (Burton & Obel, 2004, p. 73; DeWitt, 1993, pp. 31, 33). This basic structure specifies how digital IM is embedded in the surrounding corporate structures on the firm (or meso) level, as well as how it standardizes internal rules and procedures (i.e., formalization), defines the degree of internal discretion over decisions in relation to direct top management involvement (i.e., centralization), sets a unit's goals and targets, and influences managerial conduct (Burton & Obel, 2004, pp. 78, 80; DeWitt, 1993, p. 33; White & Hamermesh, 1981, p. 220). Besides having a centralized or dedicated digital IM structure located within or outside of a focal organization (Gaubinger, Rabl, Swan, & Werani, 2015, p. 239; Kaschny & Nolden, 2018, p. 147), digital IM may also be implemented as a sub-task of the IT department, or it may unfold contextually across multiple business units (Böhl, Hoffmann, & Ahlemann, 2016, p. 7; Gibson & Birkinshaw, 2004, p. 209). While one structure may have a higher baseline information processing capacity than another, at some point all structures reach their information processing limits if turbulence exceeds a certain threshold (Daft & Lengel, 1986, p. 556). To improve this baseline capacity, organizational *design strategies* can be implemented on the unit (i.e., micro) level. In this research, we focus on these unit-level strategies, since (a) traditional OD research extensively investigated organizational-level archetypes (e.g., functional vs. divisional structures) based on variables such as formalization and centralization, and (b) analyzing design strategies allows for a micro-level perspective on digital IM that promises richer insights.

Literature offers five different design strategies. First, firms may decide to create *slack resources*, which primarily act as buffers to reduce the resource interdependence to other units in the organization (Galbraith, 1974, p. 30). Here, firms increase the number of resources that are available to the unit for innovation activities instead of using existing resources more efficiently (Flynn & Flynn, 1999, p. 1024). Slack manifests in resources such as excess capital reserves, a high number of employees, overqualified staff, underutilized knowledge bases, and extensive equipment (Burton & Obel, 2004, p. 197; Garcia, Calantone, & Levine, 2003, p. 326). Firms may further try to maintain a creative workforce of high-density that can provide a rich source of ideas (Chen & Huang, 2010, p. 412), and can devote certain shares of working time and attention to experimentation with new technologies and ideas (Troilo, De Luca, & Atuahene-Gima, 2014, p. 262). Slack enhances information processing since the information overload of existing resources is reduced (Galbraith, 1974, p. 30).

Second, firms may strive to strengthen the innovation unit against disturbances and create a protected internal atmosphere by increasing digital IM's degree of *self-containment* (Faraj & Yan, 2009, p. 606; Flynn & Flynn, 1999, p. 1028). The primary objective of this strategy is to enable fast and effective decision making and to reduce the efforts for coordination and sharing of resources (Galbraith, 1973, p. 16). This may be achieved in two ways, namely through reducing functional specialization and division of labor (i.e., horizontal differentiation) and the decentralization of the decision-making authority (i.e., vertical differentiation) (DeWitt, 1993, p. 31; Galbraith, 1977, pp. 85–86; Louw, 1996, p. 27). Task diversity and flexibility resulting from the reduction of horizontal differentiation provide employees the opportunity to integrate knowledge from heterogeneous sources, but they also require installing employees with a broad skill base and fostering continuous learning (Huang, Kristal, & Schroeder, 2010, p. 517; Louw, 1996, p. 27). Reducing vertical differentiation empowers employees and establishes a sense of mutual ownership by allowing for local decision autonomy. This ensures more efficient and effective decision processes, since a flat chain of command is less prone to bureaucracy, opportunistic behavior, and short-term results orientation (Laurie, Doz, & Sheer, 2006, p. 87; Martinsuo, 2013, p. 800; Salomo, Talke, & Strecker, 2008, p. 565). Thus, to avoid critical resource and decision bottlenecks in the digital IM, firms may decide to enlarge the breadth (i.e., diversity of tasks an employee performs) and depth (i.e., the individual autonomy for planning and controlling tasks) of job positions. The self-containment strategy resembles what Takeuchi and Nonaka (1986, p. 139) characterized as self-organizing and autonomous units that are engaged in multilevel learning, and the strategy may consequently protect the unit from perceived micromanagement by senior management (Elenkov & Manev, 2005, p. 385). Sometimes discussed as bottom-up approach or agile innovation (Lee & Xia, 2010, p. 93; Wilson & Doz, 2011, p. 19), lower degrees of vertical and horizontal differentiation are commonly associated with higher degrees of path-breaking improvisation and experimentation, greater levels of risk-taking, and a higher willingness to embrace new ideas, as a multi-skilled base of empowered employees is better able to sense and absorb relevant knowledge (Chen, Mocker, Preston, & Teubner, 2010, p. 248; Lyytinen & Rose, 2003, p. 582). Today, firms such as Google employs flat hierarchies and a semi-independent workforce to foster its innovation activities (Steiber & Alänge, 2013, p. 250). Self-containment fosters information processing since information is equally pooled among various actors, and task-related coordination efforts are reduced (Galbraith, 1974, p. 31).

Third, firms may strengthen *internal lateral relations* by establishing interfaces between the digital IM and other corporate units (Galbraith, 1973, p. 18). This strategy refers to the practice of breaking down functional barriers and silos by establishing collaborative and synchronized processes among interrelated units to improve the achievement of innovation goals (Barratt, 2004, p. 33; Flynn, Huo, & Zhao, 2010, pp. 59–60). Since innovation units often lack the required capabilities to commercialize new products entirely on their own, cross-functional interfaces with operational business and upper management are found to be vital for innovation success (Gassmann, Widenmayer, & Zeschky, 2012, p. 122). Establishing internal lateral relations in innovation activities may entail strategies such as joint innovation roadmapping and project initiations, job rotation, task forces, informal exchange of ideas, and establishing personal ties with decision makers (Bajwa et al., 2008, p. 147; Gassmann et al., 2012, p. 125; Song & Montoya-Weiss, 2001, p. 65). Internal lateral relations enhance digital IM's information processing capability in that leveraging market-based know-how from business units can reduce innovation-related uncertainties, ensure effective channeling of rich information into the innovation unit, and avoid negative consequences such as the not invented here syndrome (Flynn et al., 2010, p. 62; Galbraith, 1973, p. 19; Gassmann et al., 2012, p. 124).

Fourth, firms may establish *external lateral relations* to improve their information processing capabilities, which Galbraith (1977) briefly referred to as cooperative strategies as part of an "environmental management" (p. 209). This strategy refers to the vertical (e.g., suppliers, customers) and horizontal (e.g., competitors) integration of outside actors in innovation activities (Barratt, 2004, p. 32). Due to the turbulent nature of digital innovation environment, firms need to appreciate externalities by identifying suitable external partnerships and by dynamically balancing heterogeneous knowledge resources from outside the firms' boundaries (Piccinini, Hanelt, Gregory, & Kolbe, 2015, p. 10; Selander, Henfridsson, & Svahn, 2010, p. 9). Previous studies have shown that firms which maintain comprehensive external relations outperform those with a more narrow or internal focus (Srinivasan & Swink, 2015, p. 851). To absorb external knowledge, many firms today draw on diverse sources in different intensity and variety. External lateral relations may be established through formal agreements such as buying or outsourcing contracts, directly involving customers in the innovation process (e.g., crowdsourcing), establishing alliances and partnerships (e.g., with suppliers, competitors, or universities), having equity investments in new or established enterprises (e.g., startups), or licensing IP related to digital technologies (Laursen & Salter, 2006, p. 140; van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009, p. 425). Although firms have always been dependent on resource inputs from their environment (Nienhüser, 2008, p. 12; Pfeffer & Salancik, 2003, p. 48), the co-developing of capabilities through external relations becomes more important, since digital value creation increasingly relies on complementary contributions from outside actors (Tilson et al., 2013, p. 3). Maintaining all required resources in-house further incurs the risk of sunk cost compared to market acquisition (e.g., consulting) or partnerships, as owning those assets in rapidly changing environments may turn out to have little long-term value (Qu et al., 2011, p. 110). Although associated with higher transaction cost, external lateral relations may enhance digital IM's information processing capabilities since they allow the resource base to be properly reconfigured as needed; they may also reduce lead times and uncertainties about inputs to innovation (Fairbank et al., 2006, p. 296; Srinivasan & Swink, 2015, p. 825) and "enable a rapid sense-and-respond to customer needs" (Bharadwaj et al., 2013, p. 479).

Finally, firms may make use of *information systems* (IS) for the collection of innovation-relevant information and their timely distribution. Galbraith (1977) originally employed the concept "vertical information systems" (p. 103) rather than IS to refer to any systems that provide information vertically up a hierarchy to decision makers. However, he emphasized that the strategy's primary goal is "to collect information at the points of origin and direct it, at appropriate times, to the appropriate places" (Galbraith, 1973, p. 17). We therefore draw on more recent research and subsume any IS used in the context of digital IM under this strategy that improves information flows (Adams, Bessant, & Phelps, 2006, p. 24; Roberts, Campbell, & Vijayasarathy, 2016, p. 50). Here, IS's role is to support the collection and utilization of information during all stages of the innovation process. More specifically, IS's purpose is to facilitate the detection of early signals about the shifts in technological and market structures for several purposes, namely (a) to allow for a proactive behavior, model complex situations, and possible consequences of alternative decisions; (b) to enhance collaboration and communication; and (c) increase resource sharing (Fiedler et al., 1996, p. 17; Simon, 1973, pp. 272–273; Yasai-Ardekani & Nystrom, 1996, p. 187). Research has recognized the important role of high-quality IS information for new product development at an early point in the 1990s (Cook & Eining, 1993, p. 53; Pavitt, 1990, p. 22). IS in the innovation context may encompass systems for project and resource management, knowledge management, cooperative work (Pavlou & El Sawy, 2006, p. 204), business intelligence, communication technologies (Park, El Sawy, & Fiss, 2017, pp. 654–655), design and development tools, and systems for coordinating activities beyond the boundaries of the firm (Fairbank et al., 2006, p. 296; Sanders, 2005, p. 6). The use of IS enhances digital IM's information processing capability since such systems may provide more rich information and more often to decision makers (Galbraith, 1974, p. 32).

4.2.4 Institutional Context: Strategic Posture

Aside from the external environment, the organizational environment surrounding digital IM plays a vital role for understanding how OD unfolds (Cooper & Zmud, 1990, p. 124; Kohli & Melville, 2019, p. 203; White & Hamermesh, 1981, p. 220). Evidence has suggested that managers need to consider the institutional contingencies when designing organizational elements to optimize performance (Volberda et al., 2012, p. 1050). Based on previous research, we posit that a firm's *strategic posture* represents the primary institutional contingency that needs to be considered in order to ensure an efficient, effective, and viable digital IM (Burton, Lauridsen, & Obel, 2002, p. 1463; Priem, 1994, p. 430).

Strategy typically describes a firm's "intended future domains" (Shortell, 1977, p. 284) and may be broadly defined as a firm's overall objectives to be achieved (Covin & Slevin, 1989, p. 77). The overall strategic direction is based on a firm's product-market scope and "the nature of its distinctive competences" (Miller, 1982, p. 135); this direction guides an organization in interpreting its environment and shapes structural choices in OD (White & Hamermesh, 1981, p. 217). The strategy is different to the business model: While the strategy defines the overall goals, purpose, values, and competitive scope, the business model may be understood as the customer-focused reflection of the firm's strategy implementation (Morris, Schindehutte, & Allen, 2005, p. 728; Porter, 1985, p. 34; Zott, Amit, & Massa, 2011, p. 1031). Despite this separation, empirical research has found that the strategy and the business model mutually influence a firm's performance in the market (Zott & Amit, 2008, p. 19).

The strategic posture describes the degree of aggressiveness that a firm exhibits during its pursue of goal attainment in terms of risk willingness, financial assertiveness, and marketing intensity (Burton et al., 2002, p. 1465). A common distinction is made between a prospector and a defender strategy. While a defender strategy focuses on maintaining a relatively stable market and realizing efficiencies, an aggressive prospector strategy fosters the active tapping into new markets and products, and it also entails high risk and cost (Miles & Snow, 1978, pp. 56–58).

A firm's degree of engagement in digital business practices is influenced by its strategic posture (Mithas et al., 2013, pp. 513–514). Depending on the firm's strategic posture, different importance may be placed on the digital technologies, the resource investments that are devoted to digital technologies, and the managerial involvement in related strategic planning (Lai, Li, & Wang, 2008, pp. 248, 262; Mithas et al., 2013, p. 514). According to theory, firms operating in stable environments often tend to pursue a defender strategy, whereas firms operating in turbulent environments more often follow a prospector approach (Burton et al., 2002, p. 1465). Industries with highly standardized products (i.e., high degree of dominant product designs) with significantly long lifecycles that do not leave room for differentiation often suggest a more defensive posture (Faems, Van Looy, & Debackere, 2005, p. 244; Porter, 1985, p. 487). Similar to our arguments laid out in section 4.2.1, employing strategic posture instead of a generic strategy construct allows us to compare *differences in degree* (Winch, 2007, p. 71).

In the institutional context, some scholars argue that other concepts such as organizational culture or climate may be viewed as relevant antecedents of innovativeness and performance (Barney, 1986, p. 660). Other research has asserted that "strategy and culture are essentially synonymous" (Saffold, 1988, p. 551), since strategy formulation represents an outcome of organizational culture (Weick, 2009, p. 147). This implies that one reflects the other, and that culture and strategy converge over time. Furthermore, organizations are unlikely to pursue *counter-cultural* strategies successfully (Hult, Hurley, & Knight, 2004, p. 431). Although they may not be perfect substitutes, we regard the strategic posture construct to be appropriate for also acknowledging a firm's organizational culture when engaging in digital innovation.

4.3 Research Model and Hypotheses

Figure II-4 illustrates our OIPT-informed understanding of the interplays between the previously discussed constructs in the context of digital IM. OIPT's basic premise is that the higher the uncertainty and ambiguity, the more information need to be processed to sustain a given performance level (Daft & Lengel, 1986, p. 556; Galbraith, 1973, p. 19). We argue that the environmental dynamism, heterogeneity, and hostility (i.e., turbulence) caused by the logic of digital innovations increase the extent of uncertainty and ambiguity over the information required to innovate (see section 4.2.2). Increasing turbulence requires that greater amounts of information from diverse sources in greater richness need to be collected and processed to make better decisions about digital business model innovation (Daft & Lengel, 1986, p. 556; Weiss & Heide, 1993, p. 222).

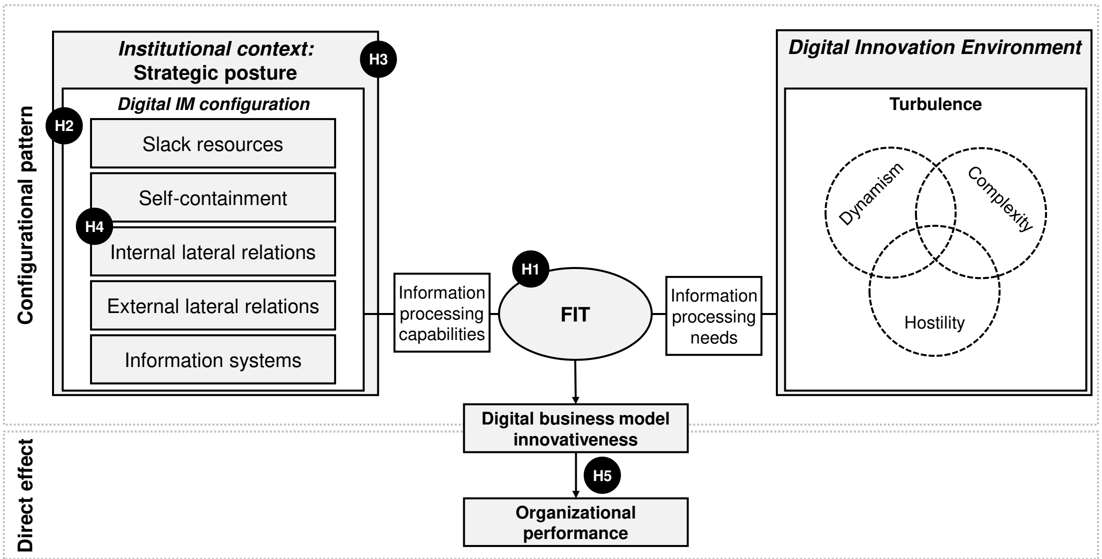

Figure II-4. Research model (adapted from Kim, Umanath, & Kim, 2005, p. 298).

To seize opportunities for digital business model innovations, organizations facing high turbulence need to become aware of emerging trends and competitive moves in a timely manner, such as by constantly scanning the environment for shifting demands and detecting weak signals of technological changes (Yasai-Ardekani & Nystrom, 1996, p. 189). Extant research suggests that firms operating in more stable environments require less frequent monitoring of the environment, while firms in highly turbulent environments have a substantial higher need for information processing (Miles et al., 1978, p. 551), and thus require extensive and frequent scanning of technological and market conditions. Enabling digital IM to timely accommodate changing customer needs and the digital developments in novel business model components is key for high digital business model innovativeness (Farjoun, 2010, pp. 220–221; Svahn & Henfridsson, 2012, p. 3353). However, shifts in the environment may increase the gap between the information required to perform innovation tasks and the information that is already possessed by the digital IM (Galbraith, 1973, p. 4). The information gap increases the overall task uncertainty of the digital IM (Tatikonda & Rosenthal, 2000, p. 75) and may threaten or disrupt a business, since other firms may seize emerging opportunities more rapidly (Grover & Kohli, 2013, p. 656). This demands more sophisticated structures that enable the digital IM to continuously scan, analyze, translate, and distribute up-to-date information for digital business model innovation (Galbraith, 1974, p. 28).

If the current OD of digital IM proves insufficient for the current information processing requirements, the situation necessitates that an organization applies corrective measures to rectify the information gap and to avoid the disruption of business practices (Mathiassen & Sørensen, 2008, p. 324). More sophisticated levels of information processing may be achieved by applying the previously discussed design strategies to the structure of digital IM.

Following the argumentation of OIPT, digital business model innovativeness will be higher when there is a *fit* between the given information processing needs and the organizational structure's capabilities to provide participants with the required information to a reasonable extent and in suitable richness for their tasks (Daft & Lengel, 1986, p. 559; Tushman & Nadler, 1978, p. 618). Depending on the unique environmental context, the OD must enable the digital IM to trace and seize the combinatorial and non-linear evolution of digital innovations in order to ensure the timely digital revitalization of the business model. The effectiveness of employed design strategies might vary depending on the turbulence an organization is exposed to. For example, building excessive internal relations incur high efforts for cross-functional coordination and coordination, and it may prove inefficient in situations of high turbulence where fast decision making is paramount (Song & Montoya-Weiss, 2001, p. 66). Research emphasizes that no single structural setting meets all requirements for high innovativeness in all situations (Bergfors & Lager, 2011, p. 1117; Salerno, Gomes, Silva, Bagno, & Freitas, 2015, p. 69). Hence, we argue that digital business model innovativeness is best examined as the outcome of a fit between the OD applied to digital IM (i.e., its information processing capability) and the requirements imposed by the turbulence caused by digital innovation (i.e., the information processing needs) that they seek to reconcile (Premkumar, Ramamurthy, & Saunders, 2005, p. 260; Yoo, 2013b, p. 231).

To overcome the traditional reductionism that investigates the effects of individual structural elements on performance independently, Drazin and Van de Ven (1985, p. 519) advocate to investigate the simultaneous effect of design strategies in a holistic fashion. Since the causal relationships between design strategies and their mutual influence on innovativeness can be complex and multifaceted, their coalignment should be regarded as an isomorphic and *multivariate vector of variables* (Boudjellaba, Dufour, & Roy, 1992, p. 1082; Galbraith, 1977, p. 81; Randolph & Dess, 1984, p. 115). Instead of examining static relationships between OD and digital business model innovativeness, we therefore suggest a fit perspective on the coalescence of design strategies, which in turn must fit the needs imposed by the environment to achieve innovativeness (Kim et al., 2005, p. 300; Priem, 1994, p. 426). This argumentation considers the OD in terms of the coherence between all employed design strategies (Miller & Friesen, 1977, p. 253), and that an “understanding of the parts within an organization can be gained only by looking at the pattern of the total design” (Greenwood & Hinings, 1988, p. 294). Scholars argue that the *total designs* of particular structural arrangements form “design archetypes” (Greenwood & Hinings, 1988, p. 296; Miles & Snow, 1978, p. 29), “archetypal templates for organizing” (Greenwood & Hinings, 1996, p. 1025), organizational “configurations,” or “gestalts” (Miller & Friesen, 1980, p. 593; Mintzberg, 1979, p. 299). Our conception therefore draws on a *gestalt* understanding of OD and fit (Venkatraman, 1989, p. 432). A gestalt approach assumes that organizations represent unique configurations (or gestalts) of design strategies that are believed to determine an outcome of interest (i.e., digital business model innovativeness) as a whole (Doty & Glick, 1994, p. 240). We thus propose our first hypothesis (H) as follows:

> **H1.** *To exhibit high digital business model innovativeness, the design configuration of digital IM must fit the turbulence from the digital innovation environment.*

One assumption of the gestalt understanding is that organizations in practice are constrained to a limited number of structural configurations that are economical meaningful and empirical feasible (Greenwood & Hinings, 1988, p. 294). The gestalt approach further posits that a fit and thus performance “can be achieved through multiple different organizational structures even if the contingencies the organization faces are the same” (Gresov & Drazin, 1997, pp. 403–404). Similarly, Galbraith (1973) stated that “there is no one best way to organize” (p. 2). Thus, we may assume that a limited number yet multiple common configurations of design strategies exist that are equally effective in achieving digital business model innovativeness. For example, firms may defer investments into own digital resources and instead rely on external partnerships (Qu et al., 2011, p. 110). Here, a company that lacks required specialized digital skills may either recruit or train organizational members, or it may substitute the deficiency by engaging external consultants or by building technology partnerships; this could bring in potentially similar effects on digital business model innovativeness (Nylén & Holmström, 2015, p. 62). Thus, we argue:

> **H2.** *No single best design configuration of digital IM to achieve high digital business model innovativeness exists; instead, there are disparate, equally effective configurations.*

We posit that the coherence between turbulence and OD is necessary but not sufficient to achieve an effective digital IM configuration that exhibits high digital business model innovativeness. Among others, Mintzberg (1979, p. 126) argued that organizational fit is achieved when the OD, the environment, *and* the organizational strategy co-align. The importance of the overall *strategy-structure-environment fit* for achieving performance received strong support in empirical research (Miller, 1982, p. 138; Priem, 1994, p. 430; Volberda et al., 2012, p. 1051). Therefore, the general ability to innovate is company-specific and rooted in the strategic context (Cohen & Levinthal, 1990, p. 148; Francalanci & Morabito, 2008, p. 298). For instance, empirical evidence suggests that firms which are strategically focused on knowledge creation, constant renewal, and the ongoing search for new opportunities provide the context that is necessary to cater for higher innovativeness (Forés & Camisón, 2016, p. 832). This highlights that some digital IM configurations may be more accessible to some organizational strategies in light of certain turbulence than others (Burton et al., 2002, p. 1462). In other words, varying organizational strategies that surround the digital IM may influence the fit between the bundle of design strategies and the turbulence, and subsequently their total effect on digital business model innovativeness (Miller & Friesen, 1977, p. 253; Priem, 1994, p. 422). The rationale is that certain design strategies are more important to digital IM in some organizations, while other design strategies are more important to digital IM in organizations with a different strategic background (Fairbank et al., 2006, p. 313; Rodriguez, Doloreux, & Shearmur, 2016, p. 646). Most importantly, while digital IM may well generate a high output of digital innovations, the firm's strategic orientation needs to allow for an appropriate utilization in the form of new or adjusted digital business models (Teece, 2010, p. 183). For instance, while Kodak made excessive resource commitments to digital imaging and created separate digital sub-units, it failed to timely capitalize on digital photography, mostly owing to strategic inertia (Lucas & Goh, 2009, p. 52). By contrast, IBM was quite successful at generating significant new businesses by applying fairly similar strategies in its IM (De Backer & Cervantes, 2008, pp. 97, 101). Thus, a firm should determine its idiosyncratic digital IM configuration that not only fits the demands imposed by the turbulent nature of digital innovation but also matches its strategic context (Miller, 1982, p. 138; Priem, 1994, p. 430; Volberda et al., 2012, p. 1041). According to Hansen and Birkinshaw (2007), design strategies that are otherwise successful may be "wasteful, even harmful" (p. 2) if applied to the wrong context. Thus, we propose the following:

H3. *The effectiveness of the OD for digital IM depends on a firm's strategic posture.*

While these hypotheses convey the required conditions of a fit as gestalt perspective on digital business model innovativeness, they are yet insufficient to explicate the fine-grained details of the deeper causal mechanisms at work. Theory has suggested that design strategies in a configuration ideally support each other synergistically (Galbraith, 1973, p. 19; Goodhue et al., 1992, p. 298). However, this does not imply that firms should arbitrarily employ as many design strategies as possible to achieve high degrees of innovativeness, since research argues that "parts or elements of structure must fit together in harmony" (Miller, 1982, p. 135). Empirical evidence reveals that the effects of certain design strategies could vary in their magnitude or may even have detrimental effects if an *optimal* application level is exceeded or if there is a misfit between different design strategies (Huang & Chen, 2010, p. 425; Kim et al., 2005, p. 300). For instance, excessive resource commitments (i.e., slack resources) conceived to enhance flexibility and cultivate ideation (e.g., by increasing budgets or workforce) may breed inefficiencies or may promote unnecessary risk-taking behavior (Troilo et al., 2014, p. 262). Here, research demonstrated that the relationship between slack and innovativeness often manifests as inverse U-shape (Nohria & Gulati, 1996, p. 1250). The distributed nature of digital innovations requires firms to engage in interorganizational arrangements such as cross-industry partnerships to gain access to complementary resources.

However, innovation partnerships do not necessarily lead to high innovation performance per se, and they often result in substantial costs and no immediate returns (Sadovnikova, Pujari, & Mikhailitchenko, 2016, p. 1830). Nevertheless, research has shown that innovativeness may be well accelerated by fueling external partnerships via appropriate IS to mitigate information asymmetries and to combine knowledge (Laursen & Salter, 2014, p. 876; Yoo et al., 2012, p. 1400) and by having adequate internal innovation resources in place (Rodriguez et al., 2016, p. 646). Similarly, research has indicated that negative effects of an increased cross-functional coordination and communication associated with extensive internal lateral relations may be mitigated by utilizing task-oriented IS (Bajwa et al., 2008, p. 138). Since this highlights that design strategies may influence each other in unexpected ways (Miller & Friesen, 1977, p. 253), we argue that depending on their combination with others, specific design strategies may have either positive or negative effects on digital business model innovativeness (Berg-Schlosser et al., 2009, p. 8). This implies that *causal asymmetry* is at work, denoting that different design strategies may appear in configurations of high and low degrees of digital business model innovativeness. We thus propose the following:

> **H4.** *Single design strategies may be present or absent in configurations that exhibit high or low digital business model innovativeness, depending on how they combine with other design strategies.*

It is noteworthy that digital business model innovativeness is not a means to an end. Empirical research has shown that innovativeness is positively and directly associated with *organizational performance* (Ali et al., 2016, p. 5321; Damanpour & Evan, 1984, p. 406; Gunday, Ulusoy, Kilic, & Alpkan, 2011, p. 672; Hernández-Perlines et al., 2016, p. 5385). Market research has found a strong correlation between profit margin and digital innovation (Anand, Begonha, & Caldo, 2015), and extant discourse suggests that digital business model innovativeness may take a central role within the nomological network of factors that influence organizational performance (Fichman et al., 2014, p. 335; Sambamurthy, Bharadwaj, & Grover, 2003, p. 239; Zott & Amit, 2008, p. 19). As shown in Figure II-4, we separate the phenomenon into firstly the configurational patterns that result from the effect of the strategy-structure-environment fit and then the direct predictive effect of digital business model innovativeness on organizational performance. While a configurational approach is highly suited for understanding the different and contextual configurations of digital IM that may be influenced by causal asymmetry (Berg-Schlosser et al., 2009, p. 9; Miller & Friesen, 1977, p. 254), we cannot infer asymmetrical effects for the relationship between digital business model innovativeness and the organizational performance from extant theory or empirical evidence. Investigating the relationship is particularly important, since empirical evidence has shown a direct effect of conventional innovativeness for predicting organizational performance (Ali et al., 2016, p. 5321; Camisón & Villar-López, 2014, p. 2897; Hernández-Perlines et al., 2016, p. 5385), while the *productivity paradox* traditionally suggests indifferent direct contributions of digital technology to performance (Brynjolfsson, 1993, p. 76). Therefore, we propose our final hypothesis:

> **H5 (Direct Effect Hypothesis):** *Digital business model innovativeness relates positively to organizational performance.*

Figure II-5 shows a parsimonious nomological network detailing Hypothesis 5 and describes the direct effect of digital business model innovativeness on organizational performance. A noteworthy point is that the relationship between organizational structure and realizing intended innovation outcomes unfolds over time and is path dependent (Damanpour, Walker, & Avellaneda, 2009, p. 652; Schmidt & Buxmann, 2011, p. 175; Zahra & Covin, 1995, p. 44). Thus, we assume that organizations with a longer history of established digital IM structures may perform better at digital innovativeness and has therefore included the digital IM-level control variable unit age on digital business model innovativeness (c_1). Moreover, prior research has suggested that business units operating in fast-clockspeed contexts may perform better at innovativeness (Mendelson & Pillai, 1998, p. 431). Hence, we modeled whether the organization's primary industry of operation is located in the IT domain as second control for digital business model innovativeness (c_2).

Furthermore, organizational size and age have been found to play strong roles for resource availabilities and firm performance (Song & Montoya-Weiss, 2001, p. 65). Some researchers have indicated that larger and more mature firms benefit from greater resource pools and cumulative experience-based advantages, and they thus have a greater ability to achieve at least a single innovation and perform better (Chen et al., 2014, p. 333; Jansen, Van Den Bosch, & Volberda, 2006, p. 1667; Yeoh & Roth, 1999, p. 639). Others have noted that larger and older firms tend to have a greater need for information processing due to the interdependencies between product-market domains (Yasai-Ardekani & Nystrom, 1996, p. 190). Furthermore, compared to young and small firms (e.g., startups), large firms are often found less likely to introduce more path-breaking innovations since they are typically more prone to bureaucratic inertia (Chandy & Tellis, 2000, p. 4). Schumpeter (1934) already argued that more discontinuous innovation is less likely to occur in incumbent firms: "New combinations are, as a rule, embodied . . . in new firms which generally do not arise out of the old ones but start producing beside them; . . . it is not the owner of stage-coaches who builds railways" (p. 66). Thus, on the firm level, we include the control variables firm age (c_3) and firm size (c_4), which are commonly hypothesized to directly influence organizational performance in the innovation context (Hernández-Perlines et al., 2016, p. 5385; Lubatkin, Simsek, Ling, & Veiga, 2006, p. 664).

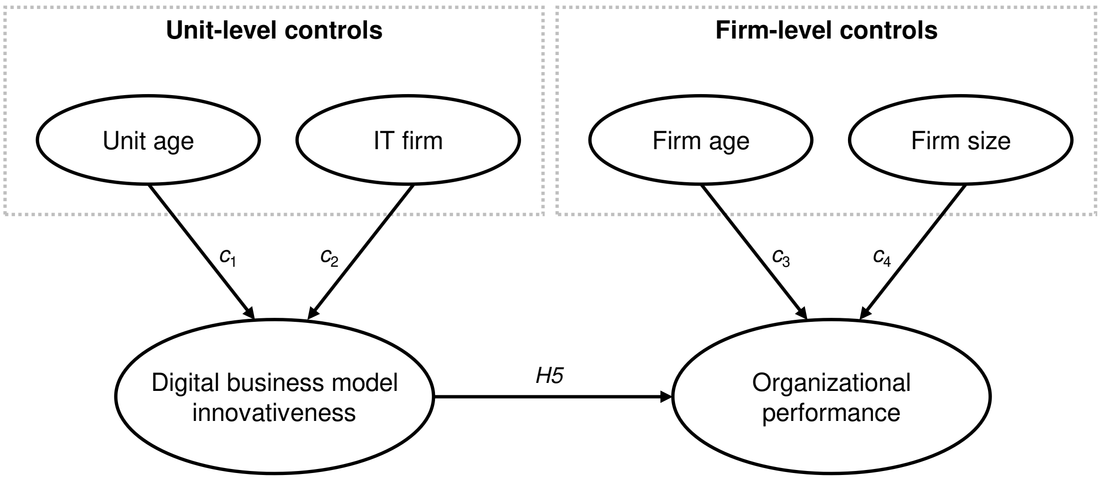

Figure II-5. Nomological network of digital business model innovativeness and organizational performance.

5 Research Design

5.1 Overview of Research Process

Since no public dataset offered all of the information required to address our hypotheses, we conducted a survey study (Pinsonneault & Kraemer, 1993, p. 78). We used a web-based questionnaire for data collection; we employed partial least squares structural equation modeling (PLS-SEM) to validate our measurement model and to test direct effects, and we took a set-theoretic approach for the identification of common configurations of digital IM. Finally, we applied a MANOVA to test whether identified digital IM configurations are positively related to firm performance. Figure II-6 provides an overview of this study's research process.

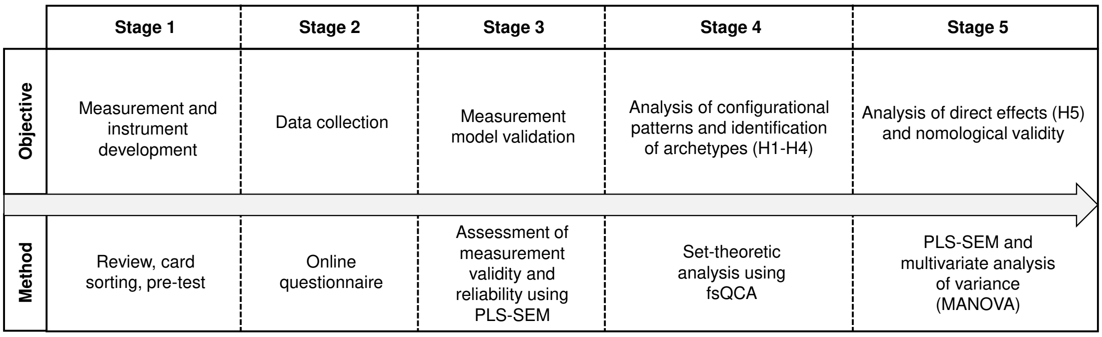

Figure II-6. Overview of research process.

In the first stage, we developed our measurement models by adapting existing measurement items from the extant literature to the context of digital IM; this was after we carefully investigated the fit of the original measures to our constructs presented in section 4.2 (Fowler, 2013, p. 98). To ensure initial validity, we subjected our instrument to a card-sorting procedure and a pre-test. Having achieved satisfactory levels of validity, the survey was then administered to the target population for data collection in the second stage. During the third stage, we assessed measurement models' validity and reliability using PLS-SEM (Hair, Hult, Ringle, & Sarstedt, 2016, p. 106).

For analyzing our data in the fourth stage, we took a set-theoretic approach (or configurational analysis) that is particularly suited for the identification of structural archetypes (→*Hypotheses 1-4*) (Berg-Schlosser et al., 2009, p. 11; Miller & Friesen, 1977, p. 253). More specifically, we analyzed our collected data using fsQCA, developed by Charles Ragin (2000, 2008). This method of fsQCA is deemed highly suited for unraveling causal complexity in phenomena that encompass many different dimensions with a high degree of variation and interaction among these elements (Rihoux & Ragin, 2009, p. 149) and for building context-sensitive theories of modest generalization in the field of IS in complex areas with high turbulence (El Sawy, Malhotra, Park, & Pavlou, 2010, p. 840; Woodside, 2016a, p. 76). We chose fsQCA over an explorative qualitative case study approach because OIPT offered us a solid theoretical foundation for our research model to be empirically tested at a larger scale, and hypothetico-deductive large-*N* applications "present one of the most promising areas to extend the set-theoretic approach" (Greckhamer, Misangyi, & Fiss, 2013, p. 55). We also chose fsQCA over other approaches such as cluster analysis, since they only offer limited insights into the internal causal structures of identified archetypes (Fiss, 2011, p. 410). Instead, we sought to uncover the complex causal configurations of digital IM's design strategies that are associated with digital business model innovativeness, and not in mere similarities across the performance spectrum (Greckhamer, Furnari, Fiss, & Aguilera, 2018, p. 3). In contrast to traditional cluster or profile deviation analyses, fsQCA allows one to examine *how* different *causal conditions* (i.e., exogenous variables) work together in certain effective archetypes that produce an *outcome* of interest (i.e., endogenous variable) (Fiss, 2007, p. 1181). Moreover, fsQCA has been extensively adopted by behavioral science researchers from a wide range of fields (Thiem & Dusa, 2013, p. 87), including innovation research (e.g., Ordanini & Maglio, 2009) and IS research (e.g., Liu, Mezei, Kostakos, & Li, 2017). By applying fsQCA, we respond to scholars' calls to apply novel methods such as a configurational analysis for studying digital IM (El Sawy, Malhotra, YoungKi Park, & Pavlou, 2010, p. 847; Nambisan et al., 2017, pp. 231–232).

In the fifth stage, we sought to test the hypothesized direct effect of digital business model innovativeness on organizational performance (→*Hypothesis 5*). Since a direct predictive effect of innovativeness to the corporate bottom line was empirically confirmed in previous studies (Ali et al., 2016, p. 5321; Camisón & Villar-López, 2014, p. 2897; Hernández-Perlines et al., 2016, p. 5385), we used PLS-SEM for the examination of the direct effect of digital business model innovativeness on organizational performance. The benefits of the joint use of PLS-SEM and fsQCA for measurement validation and testing direct and configurational causal relationships have also been demonstrated by prior research (Mikalef & Pateli, 2017, p. 6). Finally, to assess nomological validity, we ran a MANOVA to assess the effect of the previously identified configurational groups on digital business model innovativeness and organizational performance. In Chapter 7, we derive a contingency framework that provides theoretically-grounded explanations on the inner mechanisms of the identified configurations that fsQCA is not able to provide (De Meur, Rihoux, & Yamasaki, 2009, p. 160). We complement the discussion by reflecting on the associated implications for research and practice, as well as future research opportunities.

5.2 Construct Measurement

Where possible, we adapted previously validated multi-item measures from extant literature, and we adjusted their wording to the context of digital IM where necessary (Bourgeois, 1979, p. 446). All measurement indicators can be found in Appendix II-A. Most of our constructs were measured using seven-point Likert scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), if not stated otherwise.

We relied on perceptual and self-reported measures, although there is some controversy about their usage (e.g. Boyer & Swink, 2008, p. 339). However, perceptual measures were repeatedly "found to be highly correlated with objective measures" (Priem, Rasheed, & Kotulic, 1995, p. 921) and have been shown to be sufficiently reliable (Dawes, 1999, p. 72; Dess & Robinson, 1984, p. 271). Furthermore, surveying for objective measures (e.g., financial data) in innovation research often negatively impacts response rates, since such data is often unavailable at the unit of analysis (Hart, 1993, pp. 25–26). Perceptual measures also allow respondents to consider digital business model innovations that have just recently entered the market and which are not yet entirely reflected in financial reports (Salomo, Weise, & Gemünden, 2007, p. 294). Hence, we regard the use of perceptual and self-reported measures as appropriate for our study's context. Nevertheless, we acknowledge that they are not interchangeable substitutes for objective measures, such as financial data. We describe taken measures of how we addressed concerns regarding common method variance (CMV) in section 5.4.

To assess *digital business model innovativeness*, the second-order measurement model by Spieth and Schneider (2016, p. 686) was adopted and implemented as a formative-formative Hierarchical Component Model (HCM) in PLS-SEM (i.e., a second-order formative construct consisting of three first-order formative constructs) (Hair et al., 2016, p. 282). We changed the wording of items to make clear that the type of business model innovations we are interested in are digitally-enabled ones, not any generic type. The first-order constructs build on the business model components as described in Chapter 3. Furthermore, we adopted existing reflective measures for *organizational performance* (Powell & Dent-Micallef, 1997, p. 402). For *strategic posture*, we adopted the reflective measure from Covin and Slevin (1989, p. 86) to differentiate between firms following a prospector or defender strategy.

The scale for *turbulence* as proxy for information processing needs is based on Jaworski and Kohli (1993, pp. 68–69), and it reflectively captures the importance of technological change and the difficulty of forecasting technological change. Two items were added to capture the heterogeneity and hostility aspects of that change in order to adequately reflect all turbulence characteristics as presented in section 4.2.2 (Karimi et al., 2004, p. 190; Miller, 1987, p. 73, 1987, p. 73; Teo & King, 1997, pp. 213–214).

We employed various measures to account for the design strategies applied to a firm's digital IM, and the measures jointly constitute digital IM's information processing capabilities. *Slack resources* are reflectively measured by surveying the digital IM's availability of excess resources to initiate new digital innovation projects at short notice (De Luca & Atuahene-Gima, 2007, p. 110). The extent of digital IM's *self-containment* is measured as reflective-formative

HCM (i.e., a second-order formative construct consisting of two first-order reflective constructs) via two components, namely the degrees of employee multifunctionality within the unit (i.e., reducing horizontal differentiation by reducing functional specialization and division of labor) and internal decentralization (i.e., reducing vertical differentiation by decentralizing the internal decision-making authority) (Huang et al., 2010, p. 527). The usage of *internal lateral resources* is reflectively measured via the extent of the application of intrafirm integration approaches, such as frequent formal and informal exchanges of information between the digital IM and operational business (Brettel, Heinemann, Engelen, & Neubauer, 2011, p. 266). To measure the extent of how firms draw from different *external lateral relations* for digital business model innovation, we surveyed the technology exploration strategies from van de Vrande et al. (2009, p. 428) using a Likert scale ranging from 1 (*never*) to 7 (*always*). We argue that the technology exploration measure is suited to represent the external lateral relations construct, as both aim to reduce uncertainty through enhancing information flows by means of cooperative strategies (Fairbank et al., 2006, p. 296; Galbraith, 1977, p. 209). The formative measure encompasses the strategies customer involvement, external networking and partnerships, equity investments, contracting/outsourcing, and inward IP licensing. The use of *information systems* for digital IM activities is reflectively measured by adapting Wang et al.'s (2012) measure for the IT support for innovative differentiation, which denotes "the extent of IT use in improving the capability of new product development, shortening innovation cycles, and facilitating business process innovation" (p. 334). As OIPT's original notion of IS (Galbraith, 1977, p. 52) and subsequent extensions likewise encompass efficiency and effectiveness improvements of information flows for task execution (Adams et al., 2006, p. 26; Roberts et al., 2016, p. 54), we regard this measure as highly appropriate.

During the set-theoretic analysis, we used the *fuzzyand(x,...)* function in fsQCA to create fuzzy variables that represent each case's degrees of memberships in the identified configurations (Pappas, Giannakos, Jaccheri, & Sampson, 2017, p. 10). By using the computed scores as factor variables, we related each case's membership in the configurations of micro-level digital IM design strategies to the basic *meso-level unit structures* (e.g., centralized or decentralized structural anchoring in the surrounding organization). This was done to gain insights into the dominant unit-level structures serving as the foundations for effective and ineffective digital IM designs.

For our analysis of the direct effects hypothesis (H5), we applied several measures to control for possible confounding effects, which have been found to be relevant in the innovation context (Hernández-Perlines et al., 2016, p. 5385; Lubatkin et al., 2006, p. 664). To control for *industry* effects, we used the North American Industry Classification System (NAICS) as categorical dummy variables (US Census Bureau, 2017b, p. 26). We summarized the sub-industries 5112, 518, 54151 to an aggregate category called *information technology* (US Census Bureau, 2017a, p. 1) to test whether IT firms perform better at digital business model innovativeness. To measure *firm size*, we asked for the number of employees working for the entire organization. Since the U.S. Small Business Administration's standards to differentiate between large and small/medium firms varies across NAICS categories (C.F.R., 2008), we employed commonly applied size differentiations from previous research: If a firm exceeded the employee threshold of 500, it was coded 1 (large firm), otherwise 0 (small/medium firm) (Acs & Audretsch, 1988, p. 679). *Firm age* was measured as the number of years from the founding of a firm to 2019 (Fang, Randolph, Memili, & Chrisman, 2015, p. 1026). We measured the *unit age* of the digital IM by asking participants to estimate the age of the current structures of the unit responsible for digital IM (Jansen et al., 2006, p. 1667).

Table II-7 shows how we used measures across the different analysis stages in fsQCA and PLS-SEM. The configurational group variable distinguishes cases into three configurational groups based on the results from the fsQCA analysis in Stage 4 and is described in section 5.6.

Table II-7. Usage of measures across analysis stages.

Variable	Code	Stage 4: fsQCA	Stage 5a: PLS-SEM	Stage 5b: MANOVA
Turbulence	TURB	Condition	-	-
Slack resources	SLR	Condition	-	-
Self-containment	SCT	Condition	-	-
Internal lateral relations	ILR	Condition	-	-
External lateral relations	ELR	Condition	-	-
Information systems	IS	Condition	-	-
Strategic posture	STRAT	Condition	-	-
Digital business model innovativeness	INV	Outcome	Independent variable	Dependent variable
Organizational performance	OP	-	Dependent variable	Dependent variable
Industry	IND	-	Control variable	-
Firm age	AGE_F	-	Control variable	-
Firm size	SIZE	-	Control variable	-
Unit age	AGE_U	-	Control variable	-
Meso-level unit structure	STRUCT	Factor variable	-	-
Configurational group	LOW / HIGH / NONE	-	-	Factor variable

5.3 Data Collection

We collected cross-sectional data in a structured online survey from firms in the United States, which is a market that is ranked first among the world's four largest economies (USA, China, Japan, and Germany) in terms of "digitally-led economic productivity" (Accenture, 2015, p.

7). Our target population consisted of organizations across all industries that engage in digital innovation activities, or more specifically, those that use digital technologies to create or change the firm's value proposition, creation, delivery, or capture. Research has indicated considerable differences between how small and larger companies carry out innovation, for example in terms of applied structures, uncertainty avoidance, collectivism, and empowerment (Çakar & Ertürk, 2010, p. 346; Karlsson & Olsson, 1998, p. 44). Thus, to enhance the internal validity of the observations and to control for some homogeneity and boundary conditions of the sample, we applied the principle of "similar system, different outcome" (Berg-Schlosser & De Meur, 2009, p. 21) by excluding very small enterprises with fewer than 50 employees from our sampling strategy (Padilla-Meléndez & Del Aguila-Obra, 2006, p. 101). Nevertheless, we sought to include a broad range of industries to reveal how companies execute digital IM in environments with varying degrees of digitalization and turbulence (Manyika et al., 2015, p. 5). To ensure knowledgeability of our respondents, we surveyed their role (Chen et al., 2014, p. 332). In particular, we tailored the sampling frame to senior business and technology executives as well as innovation managers.[7] These managers are generally considered appropriately informed about their firm's organizational structures and capabilities as well as how their firms sense and respond to changes in the environment (Benlian, Koufaris, & Hess, 2011, p. 111; Chen et al., 2014, p. 332; Roberts & Grover, 2012, p. 245). To verify knowledgeability, we implemented a screening heuristic in the beginning of our questionnaire. Here, we asked participants about their job role and whether they are aware about digital IM structures and outcomes in their organization. Only those who passed these qualifying questions could proceed to answer the rest of the survey. Due to the non-parametric nature of the fsQCA analysis, nonrandom samples do not pose a threat to statistical validity (Fiss, 2011, p. 402).

Before dispatching the survey to participants, we calculated the minimum sample size to achieve statistically significant results when applying PLS-SEM. The common *ten-times rule* yielded a minimum sample size of at least 50, since the sample size should be equal to at least "10 times the largest number of formative indicators used to measure a single construct" (Hair et al., 2016, p. 24). In our study, this calculation was based on the external lateral relations measures (i.e., 5 items × 10 = 50). Due to some criticism with this heuristic approach (Marcoulides & Saunders, 2006, p. iv), we also performed an additional power analysis to estimate sample size requirements (Chin, 1998, p. xi). We build on the properties of linear multiple regression as provided by Cohen (1988, p. 56) and used the G*Power[8] software to compute the required sample size (shown in Figure II-7). Again based on the largest number of formative indicators (i.e., five indicators in the external lateral relations measures), analyses at an

[7] In the survey, we asked for the following job roles: chief executive officer, chief financial officer, chief operating officer, chief information officer, chief digital officer, chief technology officer, vice president of IS/IT, new product development manager, IT/digital innovation manager, R&D manager, business development manager

[8] http://www.gpower.hhu.de/

alpha level of .05 revealed a minimum sample size of 80 that is required to achieve an acceptable statistical power level (1- β = .80) while detecting small effect sizes (f^2 = .10) (Hair et al., 2016, p. 25; Westland, 2010, p. 480). Literature has also proposed performing this calculation by taking the number of relationships leading to the endogenous variable. Redoing the analysis with a value of 7 instead of 5 (strategic posture, turbulence, and five digital IM design variables), the computation yielded the same result. In sum, the power analysis estimated a larger minimum sample size than the ten-times rule. Results of the power analysis are shown in Figure II-7.

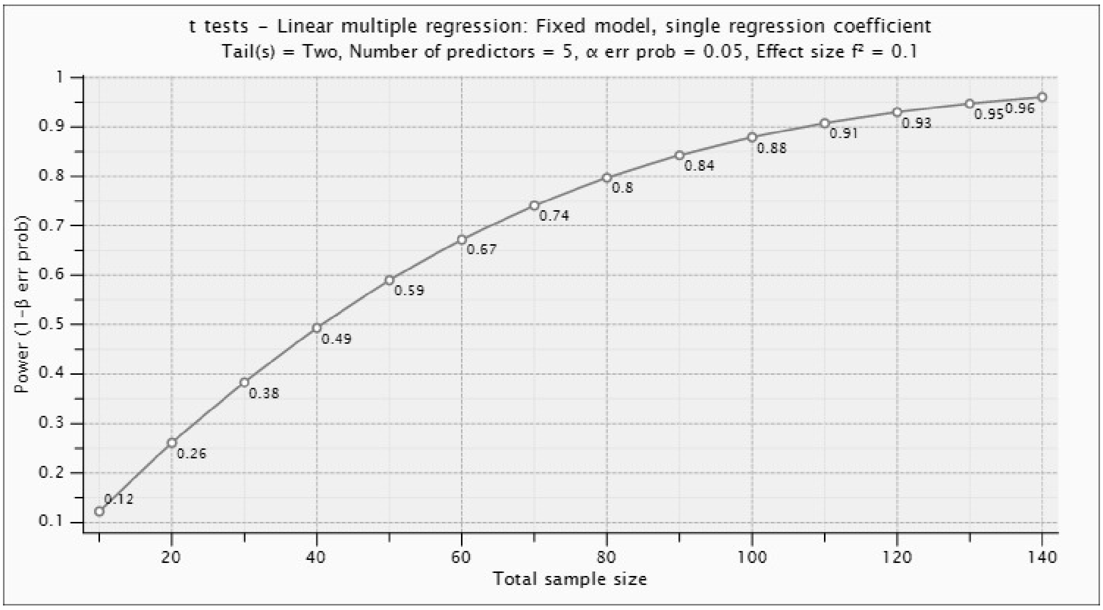

Figure II-7. Results of the minimum sample size estimation from the power analysis.

While these sample requirements applied to PLS-SEM, we also had to consider the sample requirements and restrictions for our analysis with fsQCA. Although fsQCA was initially conceived for small-*N* studies (i.e., 15 to 50 observations), our research builds on more recent work that has demonstrated its usefulness for intermediate-N and large-N settings (Fiss, 2011, p. 402; Ragin, 2008, p. 6). However, fsQCA has limitations in the number of variables it can handle even with large samples. As their number increases, the number of possible combinations of these variables increases exponentially, which possibly leads to configurations which are unique to single empirical observations if the sample size is too small and homogeneous (Ragin, 2008, p. 110). To avoid generating results on random data, fsQCA methodologists recommend a sufficiently large sample size in relation to the number of variables (Berg-Schlosser & De Meur, 2009, p. 27; Greckhamer et al., 2013, p. 70). Statistical simulations demonstrated that researchers should at least consider a minimum sample size of approximately 50 when including eight variables (see Table II-7 in section 5.2), including the outcome condition (Marx, 2010, p. 155; Marx & Dusa, 2011, p. 114). Hence, our minimum sample size estimate of 80 resulting from the power analysis also exceeds the methodological requirements of fsQCA.

To recruit survey respondents, we used a panel provider through the Qualtrics platform.[9] Qualtrics is one of the most widely applied and accepted source for panel data in the field of management research (Porter, Outlaw, Gale, & Cho, 2019, p. 328). Panel providers invite respondents to complete online surveys in return for a cash honorarium or other incentives. An increasing number of research in general and top-tier IS publications in particular rely on panel providers to survey managers (e.g. Li, Sarathy, Zhang, & Luo, 2014, p. 489; Roberts & Grover, 2012, p. 246). A recent meta-analysis indicated that consistency of data obtained through panels is on a par with conventionally sourced data, and it concluded that panel data does "not seem to suffer from potential sources of biases in a way systematically different from conventional data samples" (Walter, Seibert, Goering, & O'Boyle, 2016, p. 5). Making use of panel providers eases data collection and allows a larger sample size to be obtained; this is generally seen as a valid approach as long as the panel firm ensures reliability and quality of data, and also makes sure that respondents are engaged and unique (Schoenherr, Ellram, & Tate, 2015, p. 298). To ensure data quality and reliability, Qualtrics and its panel partners use various techniques to verify the identities and knowledge level of panelists. The verification procedures encompass approaches such as validations of postal addresses and demographic information, as well as knowledge-based questions to verify whether respondents are qualified to take a survey. Additionally, the number of surveys a person can take per week is limited, and the reward structures and technical mechanisms penalize participants that rush through questionnaires (Qualtrics, 2014, pp. 6–7). The survey was soft-launched on February 14, 2019 and was fully launched on February 16, 2019. The soft-launch phase allowed us to review screen-outs and validity of responses at 10% of the total recruiting. All respondents were contacted by the panel provider and stayed anonymous to the researchers. Data collection of the main study finished on February 20, 2019 with 263 completed responses.

We took measures to mitigate sample contamination through satisficing behavior, which refers to the behavior of respondents who are not investing substantial cognitive efforts to actively complete the survey purposively (Krosnick, 1999, pp. 547–548). As an a-priori measure, we included one attention check to eliminate respondents who were not diligently reading and answering the questions (Oppenheimer, Meyvis, & Davidenko, 2009, p. 871). The sample only contained respondents who successfully passed the attention check and who took the survey in at least half the median time of 8 minutes from the soft-launch phase. We further examined post hoc data quality indicators to identify satisficing behavior. Since our sample only contained complete responses, early termination and skipped items posed no issues to data quality.

[9] https://www.qualtrics.com/

To distinguish between quick responders and straightliners, we performed a joint examination of *non-differentiating* and *rushing behavior* of respondents (Barge & Gehlbach, 2012, pp. 187–188). First, we investigated the variance of the individuals' answering behavior within and across individual item banks (i.e., groups of questions). We calculated a non-differentiation metric by dividing the instances of zero variance in item banks by the opportunities for non-differentiation (i.e., 9 item banks). Second, we combined this analysis with the examination of the speed with which respondents worked through the survey. We calculated the seconds-per-item indicator (SPI) by dividing the number of seconds spend on the survey by the number of total items, and by subsequently dividing the fastest response rate (minimum SPI) by the individual's SPI for respondents with a SPI lower than the modal value (others are coded with 0; i.e., *non-rushers*). Finally, we build a composite satisficing index from both metrics that ranged from 0 to 1, where a value of 1 indicates strong degrees of potential satisficing behavior. After carefully examining all values, such as how respondents answered reverse coded items, we choose a satisficing value of ≥ .6 as threshold for excluding suspicious responses.[10] Consequently, we removed 12 responses from the sample.

The final sample included 251 valid responses across 20 different industries and thus exceeded the calculated minimum sample size by more than a factor of three. Sample demographics are shown in Table II-8; further sample statistics are in Appendix II-B. Organizational and unit age was divided across three common groupings (Chen et al., 2014, p. 332). The distribution indicates the external validity due to sample heterogeneity, which serves as a well-suited basis for the subsequent analyses in fsQCA (Marx & Dusa, 2011, p. 120).

[10] In comparison, 28% of respondents had a satisficing value of 0, and 85% of respondents had a satisficing value of less than or equal to .3. Up till now, literature lacks statistically sound standard thresholds for this index. Although this approach is not able to detect completely random responses, this procedure guided us in the qualitative assessment of satisficing behaviour in the sample.

Table II-8. Sample demographics.

N = 251	Frequency	Percentage
Respondents		
IT executive (chief information officer, chief digital officer, chief technology officer, vice president of IS/IT, etc.)	129	51%
Business executive (chief executive officer, chief financial officer, chief operating officer, etc.)	81	32%
Innovation manager (new product development manager, IT/digital innovation manager, R&D manager, business development manager, etc.)	41	16%
Firm size (number of employees)		
50–249	55	22%
250–499	41	16%
500–4,999	111	44%
5,000–50,000	33	13%
50,000+	11	4%
Organizational age (in years)		
1–5	21	8%
6–20	114	45%
More than 20	116	46%
Digital innovation management structures		
Centralized or dedicated unit/department	111	44%
Committees/boards	30	12%
Decentralized task across the firm	22	9%
Dedicated/Separate legal entity (e.g., a subsidiary or startup)	4	2%
Staff function	23	9%
Secondary task of a business department	8	3%
Secondary task of the IT department	41	16%
Sub-unit of another department (e.g., a digital task force)	7	3%
Temporary projects (no organizational department/unit)	5	2%
Age of the digital innovation management structures (in years)		
1–3	46	18%
4–6	91	36%
7–10	70	28%
More than 10	44	18%
Industry		
Accommodation and food services	5	2%
Administrative and support services, waste management, and Remediation services	6	2%
Agriculture, forestry, fishing, and hunting	2	1%
Arts, entertainment, and recreation	5	2%
Construction	23	9%
Educational services	16	6%
Finance and insurance	22	9%
Health care and social assistance	20	8%
Information technology (IT)	65	26%
Management of companies and enterprises	1	0.4%
Manufacturing	25	10%
Media and telecommunication (e.g. offline publishing and broadcasting, motion pictures, telecommunication carriers)	4	2%
Professional, scientific, and technical services	17	7%
Public administration	3	1%
Real estate and rental and leasing	2	1%
Retail trade	8	3%
Transportation and warehousing	9	4%
Utilities	1	0.4%
Wholesale trade	4	2%
Other services (except public administration)	13	5%

5.4 Instrument and Measurement Validation

Since we applied some changes to adopted items to fit them to our study's context, we performed two rounds of card-sorting analysis using computer-based spreadsheets with experienced faculty members (4 and 5 judges, respectively) to ensure initial construct validity (Moore & Benbasat, 1991, p. 200). Here, we asked judges to allocate randomized items to the best-fitting target construct. Judges were allowed to provide comments on the items and select the category of "ambiguous / unclear" if they could not decide upon a corresponding construct. To identify convergence of the sorting procedure, we calculated and evaluated Fleiss's (1981) kappa coefficient (κ), which is an extension of Cohen's (1960) kappa to assess inter-rater agreement for more than two judges. Furthermore, to likewise assess convergent and discriminant validity, we calculated Moore and Benbasat's (1991, p. 212) *item placement ratio* (or hit ratio),[11] which indicates how many items were placed within their respective target constructs by the judges. The objective was to at least achieve substantial inter-rater agreement ($\kappa \geq .61$) (Landis & Koch, 1977, p. 165) while achieving an item placement ratio of at least 50% on the item and construct levels; this was done to ensure face, convergent, and discriminant validity (Urbach, Smolnik, & Riempp, 2009, p. 1707). The first round resulted in an average item placement ratio of 66% with a moderate strength of agreement ($\kappa = .50$, significant at α .01). Based on the first round's feedback, we reduced the total item pool from 59 to 51; we also changed the wording of individual items and subjected all items to the second round of card sorting with a different set of judges. The results for the revised item pools are presented in Table II-9. The results indicated *almost perfect* agreement ($\kappa = .86$, significant at α .01) with an average item placement ratio of 93%. The lowest hit ratio of 40% on the item level was related to an indicator that was aimed at measuring digitized value architecture. Since the indicator was of a formative nature, it was finally reworded after discussions with the judges. Since all constructs proved to have good validity, the instrument was considered to have a high potential for achieving good reliability scores during the main study.

All items with complementary notes on terminology were integrated into a preliminary text-based questionnaire, including descriptions about the scope and objective of the study. To alleviate any confusion about the study's context, the wording in our questionnaire made it clear that the structures responsible for carrying out digital IM are to be considered. The first page of the web-based questionnaire provided information about the scope and objectives of our study, guaranteed anonymity of responses, and asked for informed consent and the voluntary nature of participation. To further increase validity and identify any ambiguities in terms

[11] The formula for calculating the item placement ratio (or, hit ratio) per construct is as follows: *actual placements / theoretical placements = actual placements / (number of construct's items × number of judges)*

of clarity of instructions, the questionnaire was firstly reviewed by researchers who are experienced in the field of strategic IT management during a test trial, and it was then iteratively refined based on their feedback.

Table II-9. Item placement ratios after two rounds of card sorting.

Construct	Number of items	Item placement ratio
Decentralization	4	100%
Digitized value architecture	4	70%
Digitized value capture	2	90%
Digitized value offering	3	80%
Employee multifunctionality	5	100%
External lateral relations	5	92%
Information systems	3	100%
Internal lateral relations	5	100%
Organizational performance	5	100%
Slack resources	4	100%
Strategic posture	5	88%
Turbulence	6	90%
Total	**51**	**93%**
κ = 0.86 (almost perfect agreement, significant at α .01)		

Subsequently, the survey instrument was pretested extensively in its final web-based version and modified in response to comments from four academics. We alternated scale formats and anchors to avoid survey fatigue and drops in attentiveness and also to reduce covariation among the constructs that may result from overly consistent scale properties (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003, p. 884). For example, we alternated grid style questions with slider style questions for our Likert scale items, which was found appropriate for increasing cognitive engagement of respondents in web-based surveys (Roster, Lucianetti, & Albaum, 2015, p. 16).

A drawback of using self-reported survey measures on dependent and independent variables simultaneously is that respondents explain the variance between variables, and thus they may partly explain the study's results. Hence, since our dependent and the independent variables came from the same source, CMV was a concern (Lindell & Whitney, 2001, p. 114). Negative side effects resulting from sources such as evaluation apprehension, consistency motif, and social desirability could lead to a distortion of results (Fisher & Katz, 2000, p. 115). A neutral wording of items and the anonymous online administration of the survey, the assurance that there are no right or wrong answers, and different response scales mitigated these potential issues (Podsakoff et al., 2003, p. 888). To further alleviate the risks of CMV and to control for priming effects, we applied a psychometric separation of items belonging to the dependent and the independent variables in the questionnaire, and we counterbalanced the order of items belonging to the same construct to avoid evidence of direct connections between concepts (Podsakoff et al., 2003, pp. 887–888). During our analysis stage, we employed Harman's (1967) single factor test to test for evidence of CMV. However, due to some criticism with Harman's single factor test in general (Podsakoff et al., 2003, p. 889) and in particular in the context of PLS-SEM (Ringle, Sarstedt, & Straub, 2012, p. x), we also performed a full collinearity test in PLS-SEM to assess for CMV (Kock, 2015, p. 6; Kock & Lynn, 2012, p. 558).

SmartPLS 3 (Ringle, Wende, & Becker, 2015) was used for a confirmatory factor analysis to examine latent variables' validity and reliability as a recommended step before applying fsQCA (Liu et al., 2017, p. 59). Statistical analyses not available in SmartPLS were performed in SPSS 25 (IBM Corp, 2017), such as assessing the significance of correlations or computing condition indices. We followed established recommendations for the evaluation of the reflective, formative, and higher-order measurement models (Hair et al., 2016, p. 106; Hair, Sarstedt, Ringle, & Mena, 2012, pp. 429–430). In doing so, we iteratively adjusted individual measurement models until we achieved satisfactory parameter estimates. For the PLS algorithm, we used the path weighting scheme, ran a maximum number of 300 iterations, and applied 10^{-5} as stop criterion for the change in the outer weights between two iterations. For the bootstrapping procedures, we ran 5,000 subsamples using the individual sign change option (Hair et al., 2012, p. 429).

For assessing reflective outer models, we assessed individual indicator reliabilities and constructs' internal consistency reliabilities, as well as convergent and discriminant validities (Hair et al., 2016, p. 111). In contrast to reflective measures, convergent and discriminant validities cannot be assessed for formative measurement models by conventional means (Hair et al., 2012, p. 423). Instead, we assessed the relevance and significance of the formative indicators in terms of evaluating their outer weights and the t-statistics. We used the t-values obtained from the bootstrapping procedure for testing significance of weights, with critical values of 1.65 (α = .10), 1.96 (α = .05), and 2.57 (α = .01) (Hair, Black, Babin, & Anderson, 2014, p. 134). We further tested the formative constructs for critical levels of multicollinearity by examining the variance inflation factors (VIF) on the item level (Diamantopoulos & Winklhofer, 2001, p. 272) and by assessing the condition indices (CI) on the construct level (Belsley, 1984, p. 184; Hair, Black, et al., 2014, p. 221).

After having validity and reliability of the first-order components examined, we employed the repeated indicator approach for assessing our HCMs, which was found superior over other approaches in estimating indicators and variables (Becker, Klein, & Wetzels, 2012, p. 376). This approach replicates the manifest variables of the first-order latent variables in the second-order variables. We subsequently evaluated the formative higher-order constructs similar to the procedures described in the previous paragraph.

5.5 Set-Theoretic Analysis with fsQCA

5.5.1 Basic Concepts of fsQCA

Since the instrument exhibited good measurement properties, we proceeded with the data analysis using fsQCA. As mentioned, fsQCA is a set-theoretic method developed by Charles Ragin (2000, 2008) that is designed to empirically examine the relation between one property defined as the *outcome* (i.e., the endogenous/dependent/criterion variable, or phenomenon) and other properties defined as *causal conditions* (i.e., the exogenous/independent/explanatory variables, or predictors) that produce the outcome (Kent, 2009, p. 190; Wagemann & Schneider, 2010, p. 380). On the whole, fsQCA posits an understanding of causality that leaves room for complexity, which corroborates our research model's fit as gestalt stance as laid out in section 4.3 (Bedford & Sandelin, 2015, p. 8). The key operations of fsQCA rely on set logic, Boolean algebra, and minimalization algorithms to identify parsimonious causal patterns among observations. It allows researchers to logically reduce the numerous combinations of causal conditions into a parsimonious collection of configurations that generate the outcome of interest (Fiss, 2011, p. 402). This section briefly describes the basic principles of fsQCA, whereas the next section elaborates on the specific analytical steps we took.[12]

One aim of using fsQCA is to find answers to the question of which conditions and configurations thereof are "necessary and/or sufficient for the occurrence of an outcome" (Greckhamer et al., 2013, p. 52). Accordingly, the core idea of fsQCA is that relationships between the conditions that determine a phenomenon are often best understood in terms of sets (Ragin, 2000, p. 82). A *set* contains entities which possess certain shared conceptual properties, and the set defines the boundary criteria for inclusion and exclusion (Schneider & Wagemann, 2012, p. 24). In addition, fsQCA uses *set memberships* and *set relations* to define whether an entity (i.e., an observation) belongs to a set or not, and if so, to what degree.

The *set membership* denotes to what degree an observation is member of a certain set (Rihoux & Marx, 2013, pp. 168–169). A membership score defines a number of traits, such as whether a firm belongs to the group that exhibits high digital business model innovativeness. Single

[12] In-depth explanations and recommendations related to fsQCA can be found in several seminal books that guided our research (e.g., Ragin, 2000, 2008; Rihoux & Ragin, 2009; Schneider & Wagemann, 2012). Further, Greckhamer et al. (2018) recently published a paper synthesizing best practices on qualitative comparative analysis.

cases in the sample can more or less belong to a specific set and can have different degrees of set membership (Fiss, 2007, p. 1183). To denote membership in different sets that may result in an outcome of interest, fsQCA applies Boolean algebra where • means *logical AND*, + means *logical OR*, and ~ means *negation*, resulting in terms such as A + B • ~C → Y (read: "Condition A or B and the absence of C result in the presence of the outcome Y") (Rihoux & De Meur, 2009, p. 35). The degree of set membership of a case is assigned in terms of a fuzzy membership score which ranges from 0 (i.e., full non-membership in the set) to 1 (i.e., full membership in the set). The crossover point at .5 indicates a point of maximum indifference regarding the set membership, where maximum indifference here refers to whether a case is *more in* or *more out* of a set (Ragin, 2009, p. 90).

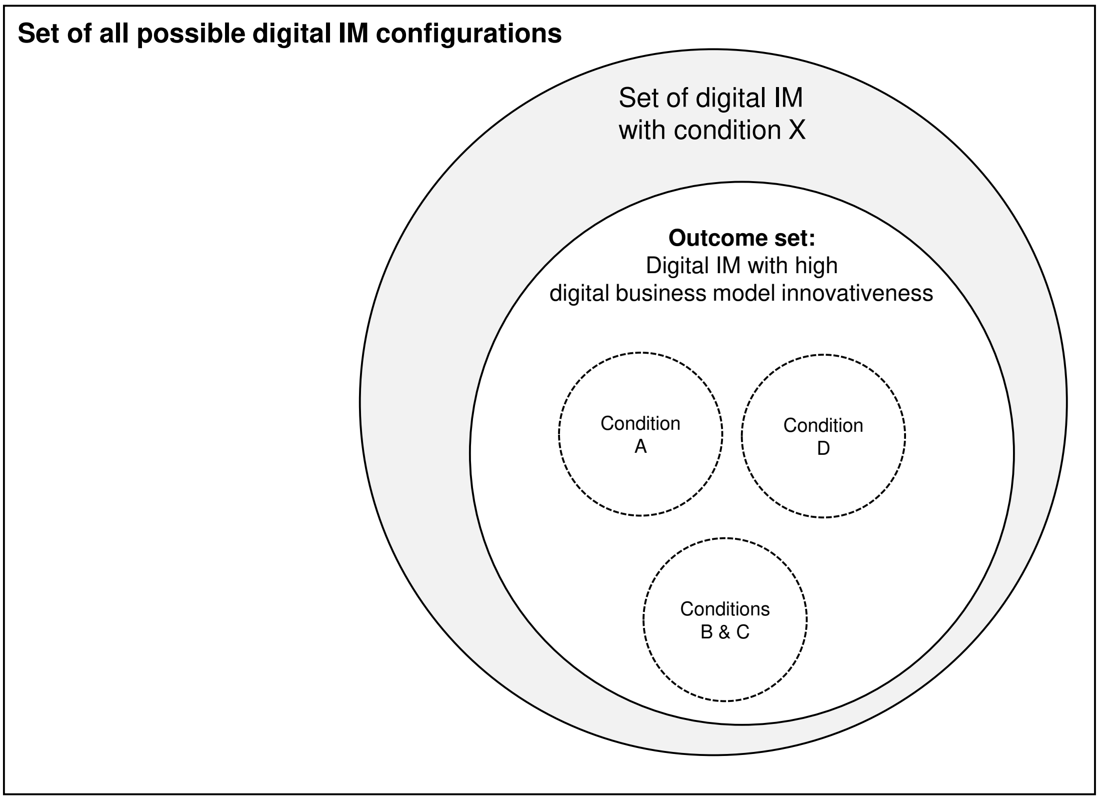

Figure II-8. Necessary and sufficient conditions and set-theoretic relationships (adapted from Kane et al., 2014, p. 202).

In term*s* of *set relations*, fsQCA exerts a specific understanding of the causal necessity and sufficiency of individual conditions to produce a certain outcome, building on supersets and subsets, causal asymmetry, and equifinality (Ragin, 2008, p. 15). For example, the clade of humans is a subset in the set of mammals, while in turn the group of vertebrates is the superset of mammals (Schünke, Ross, Schulte, Lamperti, & Schumacher, 2006, p. 2). A variable may serve as a sufficient or necessary condition for the outcome variable. *Necessary* conditions are almost always present when the outcome occurs and exhibit a superset relation (i.e., the outcome cannot occur without the presence of the condition). A condition is *sufficient* for the outcome if the outcome is present when the condition is present, and thus the condition exhibits a subset relation with the outcome; however, the outcome could also result from the presence of other conditions (Kane, Lewis, Williams, & Kahwati, 2014, p. 202; Liu et al., 2017, p. 61). In the simplified example shown in Figure II-8, condition X is a necessary condition for high digital business model innovativeness to occur, since it exhibits a superset relationship with the outcome set. However, condition X is not sufficient for the outcome, since the digital IM unit may exhibit condition X without exhibiting high digital business model innovativeness. Conditions A to D are sufficient conditions, since they exhibit subset relationships with the outcome set. In this example, the presence of condition A, condition D, or the combination of conditions B and C in a digital IM unit are equally effective and sufficient for the outcome of high digital business model innovativeness to occur.

This understanding implies *conjunctural causation* and *equifinality*, which denote that configurations of several factors as a whole lead to the outcome (→*Hypothesis 1*), and that potentially alternative and equally effective configurations may exist (→*Hypothesis 2*) (Berg-Schlosser et al., 2009, p. 8). In other words, fsQCA focuses on the *combined effects* of a configuration of variables on a certain outcome and not on the independent (or, *net* or *additive*) effects of causal variables, as in a traditional regression analysis (Ragin & Fiss, 2008, p. 190). Furthermore, fsQCA implies *causal asymmetry* while it neglects the *uniformity of causal effects*. Here, depending on its combination with different other variables and the institutional context (→*Hypothesis 3*), a single variable may sometimes have a positive and sometimes a negative effect on the phenomenon of interest (→*Hypothesis 4*) (Berg-Schlosser et al., 2009, p. 8). Thus, entirely different combinations of conditions might explain negative outcomes, which requires the configurations of high and low performing organizations to be separately examined (Fiss, 2011, p. 399). Related to causal asymmetry is the occurrence of *contrarian cases*—sometimes referred to as outliers, exceptions, contradictions, anecdotal stories, or nonconforming cases that run counter to theoretical expectations. These are observations that have an antecedent condition with a negative (positive) effect on the outcome, while most others show a positive (negative) relationship with the outcome (Wu, Yeh, Huan, & Woodside, 2014, p. 1647). Contrarian cases that run counter to the main statistical effects and cause causal asymmetry are present in varying degrees in almost any empirical data set, but they are often neglected in other analysis approaches (Woodside, 2016b, p. 17). Therefore, scholars advise actively exploring the degree of asymmetry that result from the occurrence of contrarian cases before engaging with any form of data analysis (Berg-Schlosser et al., 2009, p. 7; Ragin, 2008, p. 139; Schneider & Wagemann, 2012, p. 299; Woodside, 2014, p. 2496).

When these considerations are taken together, fsQCA allows multiple, equally effective "causal recipes" to be generated (Ragin, 2013, p. 172), while other statistical approaches in general do not yield multiple results that are equally effective in generating the phenomenon of interest. Since these properties of fsQCA offer unique opportunities that traditional approaches do not offer, we sought to explore the different structural configurations of digital IM that result in *high* as well as *low* digital business model innovativeness. Since the fsQCA's configurational approach is quite different to traditional symmetric modeling approaches such as regression analysis, Table II-10 contrasts the main tenets of configural and symmetric approaches, such as regression analysis. Individual terms are explained in detail in the following sections.

Table II-10. Symmetric modeling versus configural modeling (adapted from Olya & Gavilyan, 2017, p. 2).

Symmetric modeling	**Configural modeling**
Independent variable	Condition (or antecedent, ingredient)
Dependent variable	Outcome
Measurement	Calibration
Contrarian cases are often ignored	Contrarian cases are recognized and modeled
Counterfactual estimation	Counterfactual analysis
Correlation matrix	Truth table
Additive / net effects	Conjunctural causation: Causal recipe/model
Uniformity of causal effects	Combined with others, conditions may act differently
Causal symmetry	Casual asymmetry
Linear / permanent causality	Equifinality (multiple conjunctural causation)
Correlation methods / regression	Boolean algebra and minimization
Coefficient of determination (R^2)	Coverage
Significance of the correlation coefficient (p)	Consistency
Arrows and either squares or circles for model presentation	Configurational charts for model presentation

5.5.2 The fsQCA as Analytical Technique

Figure II-9 illustrates the analytical steps we took. As the first step, we analyzed the data for contrarian cases to underpin the rationale of performing configurational analysis (Woodside, 2016b, p. 25). We then calibrated the raw data (i.e., questionnaire responses) by allocating set membership scores to cases and thus assigned the set memberships of individual cases (Ragin, 2008, p. 72). Following, we analyzed whether any necessary conditions for the presence or absence of digital business model innovativeness emerged from the data (Ragin, 2008, p. 20). We then constructed the so-called truth table, which contains rows representing all mathematically possible combinations of conditions (= 2^k rows, where k = number of conditions) and its corresponding number of empirical observations (Schneider & Wagemann, 2012, pp. 92–93). Here, we applied common thresholds to judge whether certain configurations are in fact producing digital business model innovativeness or not. Subsequently, we addressed the issue of logical remainders, which represent unobserved empirical instances of configurations in the truth table (Ragin, 2008, p. 147). We then ran the fsQCA algorithm to extract multiple sufficient combinations (i.e., causal pathways) of design strategies that produce high *and* low business model innovativeness. The results of the analysis are multiple, equally effective configurations, which we assessed in terms of fit parameters in a following step. Finally, to gauge causality, we evaluated the robustness and predictive validity of the results to verify whether solutions remain stable under varying conditions (Emmenegger, Schraff, & Walter, 2014, p. 17; Woodside, 2013, p. 466). We employed the fsQCA 3 software (Ragin & Davey, 2016) for the calibration of the data and creation of truths tables, as well as for the Boolean minimization procedure.

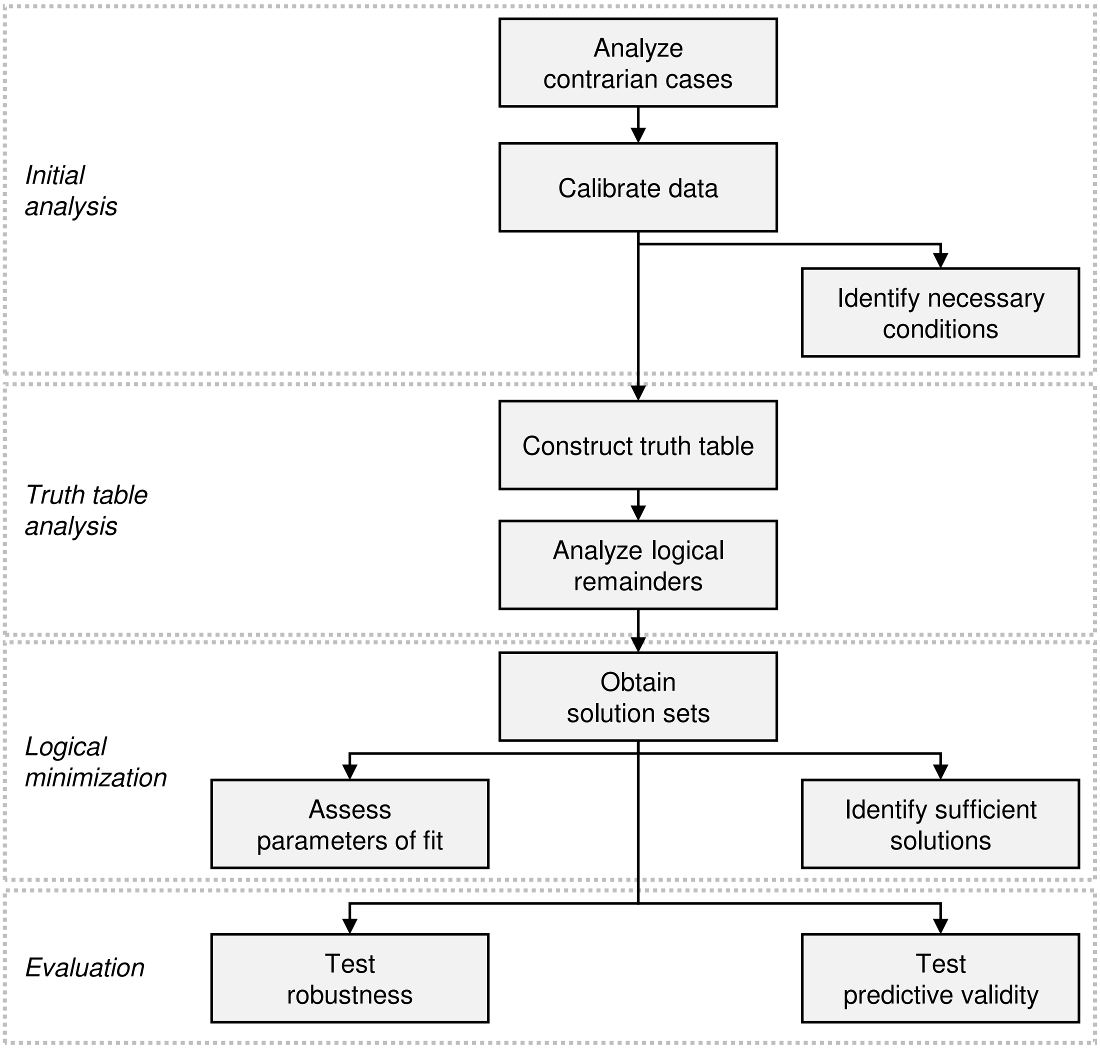

Figure II-9. Analytical steps of fsQCA (adapted from Kane et al., 2014, p. 203).

5.5.3 Contrarian Case Analysis and Calibration

To ascertain the degree of asymmetric relationships between the conditions and the outcome of our study, we examined the presence and magnitude of contrarian cases that run counter to statistical main effects (Woodside, 2016b, p. 23). To this end, we cross-tabulated the unstandardized latent variable scores that were extracted from PLS-SEM of the outcome and the condition variables in SPSS. Subsequently, we analyzed the cross-tabulation by examining whether a substantial number of cases which run counter to the main effects exists.

We then translated the base variables (i.e., the raw data) into fuzzy set membership scores, called *calibration* (Ragin, 2000, p. 166). Since fsQCA is not able to analyze multi-item measures, we extracted the unstandardized latent variable scores from PLS-SEM for calibration (Schlittgen, Ringle, Sarstedt, & Becker, 2016, p. 4589).[13] To transform base variables into set membership scores, the calibration procedure requires researchers to specify the three anchor points for having a full membership, the crossover point of maximum ambiguity, and full non-membership, respectively (Ragin, 2008, p. 88). Since we lacked external standards for defining the breakpoints, we followed previous research for the specification of the anchor points (Ali et al., 2016, p. 5321; Torres, Augusto, & Godinho, 2017, p. 56). We regarded manifestations of variables as relative qualities and chose the 10th percentile as breakpoint for full non-membership, the 90th percentile for full membership, and the 50th percentile (i.e., the median) as the crossover point. The detailed breakpoint values for each individual variable is found in Appendix II-C. As one of the most widely-adopted approaches for calibrating the data, we applied a logistic (or direct) membership function to assign continuous fuzzy membership scores (Thiem & Dusa, 2012, p. 55). The logistic membership function μ_{log_i} shown in Table II-11 transforms variables by using the metric of log-odds; this is done based on the raw value's distance from the crossover point and from the full membership and full non-membership thresholds (Ragin, 2008, p. 87). As recommended by Fiss (2011, p. 407), we added a constant of 0.001 to all calibrated variables to avoid algorithmic difficulties.

Table II-11. Logistic membership function for fuzzy set calibration (Ragin, 2008, p. 88; Thiem, 2010, p. 9).

Formula	Domain
$\mu_{log_i} = \begin{cases} \left(1 + e^{-\left[(x_i-\tau_c)\left(\frac{-\log(19)}{\tau_e-\tau_c}\right)\right]}\right)^{-1} \\ \left(1 + e^{-\left[(x_i-\tau_c)\left(\frac{\log(19)}{\tau_i-\tau_c}\right)\right]}\right)^{-1} \end{cases}$	if $x_i < \tau_c$, if $x_i \geq \tau_c$.
x_i : base variable value τ_e, τ_c, τ_i : anchor for exclusion cutoff $\alpha_{0.05}$; anchor for crossover $\alpha_{0.5}$; anchor for inclusion cutoff $\alpha_{0.95}$	

5.5.4 Analysis of Necessity

Subsequently, we analyzed whether the data set contains *necessary conditions* for the outcome to occur, where necessary conditions refer to the presence of superset relations between con-

[13] In SmartPLS 3, these values are available when conducting an importance-performance map analysis (IPMA)

ditions. Here, fsQCA computes a *consistency* score for indicating a necessary relationship between two variables, where the consistency score ranges from 0 to 1. Consistency of a necessary condition indicates the degree by which each case's membership score in the condition set is equal to or greater than the membership score in the outcome set (Schneider & Wagemann, 2012, p. 139). We applied probabilistic criteria to assess whether the observed consistencies are significantly greater than the benchmark of .90 (i.e., almost always necessary) (Schneider, Schulze-Bentrop, & Paunescu, 2010, p. 254). We used the *z*-test (Ragin, 2000, p. 111) as shown in Table II-12 to verify significance, where *n* refers to the number of cases exhibiting the outcome, C_O refers to the observed consistency of necessity, and C_B refers to the consistency benchmark of .90. The formula evaluates "the difference between the observed consistency and the benchmark consistency relative to the standard error of the benchmark" (Dwivedi, Joshi, & Misangyi, 2018, p. 396), as represented by the denominator. We evaluated the significance by considering one-tailed significance levels of α .10 ($z \geq 1.29$), .05 ($z \geq 1.65$), and .01 ($z \geq 2.33$) (Cohen & Lea, 2003, pp. 226–229).

Table II-12. *z*-score formula (Ragin, 2000, p. 111).

Formula
$$z = \frac{(C_O - C_B) - \frac{1}{2n}}{\sqrt{\frac{C_B(1 - C_B)}{n}})}$$
C_O : observed consistency C_B : benchmark consistency (.90) n : number of cases with nonzero membership in the set of cases that exhibit the outcome

If the consistency score indicated necessity, we then investigated the *coverage* score that ranges from 0 to 1. The coverage indicates how much smaller the outcome set is in relation to the condition set. Coverage is high when the outcome and condition set are of approximately equal size. In turn, coverage is smaller if the condition set is much greater in size than the outcome set, and it may indicate trivialness of a necessary condition (Schneider & Wagemann, 2012, p. 144). Trivial necessary conditions are those which are nearly always present independent from the outcome, or if the condition set is disproportional large compared to the outcome set. Ragin's (2008, p. 57) original formula for calculating the coverage of necessary conditions received some criticism, since the formula is not helpful to differentiate between *relevant* and *trivial* necessary conditions (Goertz, 2006, p. 98). The presence of trivial necessary conditions may be caused by skewed set memberships or large datasets. To gauge the relevance of necessary conditions, we calculated Schneider and Wagemann's (2012, p. 236) *relevance of necessity* (RoN) score (formula shown in Table II-13) in addition to the default coverage score. Triviality is likely given when the consistency score indicates that a condition is almost always necessary while it exhibits a low RoN. There are no guidelines available as to what constitutes a *good* RoN score in terms of thresholds such as for consistency, but similar thresholds may apply.

Table II-13. Relevance of necessity formula for calculating the coverage of necessary conditions (Schneider & Wagemann, 2012, p. 236).

Formula
$$RoN = \frac{\sum(1 - x_i)}{\sum(1 - \min(x_i, y_i))}$$
x_i : condition (fuzzy value exhibited by a particular case) y_i : outcome (fuzzy value exhibited by a particular case) $\min(x_i, y_i)$: selection of the lower of the two values

5.5.5 Sufficiency Analysis: Identification of Configurations

In the next step, we constructed and explored the *truth table* from the calibrated data (Rihoux & De Meur, 2009, p. 44). The truth table represents all hypothetically possible *AND* combinations between the conditions (Schneider & Wagemann, 2012, p. 92). Since we employed seven conditions that may lead to the outcome, our truth table contained 128 rows (= 2^7; see Table II-7 in section 5.2). In relation to the truth table, fsQCA requires the researcher to manually define which rows of the truth table can be effectively combined to produce the outcome, based on the interrogation of *frequency* and *consistency* values of each row. The analysis of these values is important, since rows naturally contain logically contradictory yet empirically observed configurations; these denote configurations that result in the presence of the outcome in most cases but not in all—which is the primary reason why we performed the contrarian case analysis (Rihoux & De Meur, 2009, p. 49; Schneider & Wagemann, 2012, p. 187).

The truth table rows first report the *frequency* (i.e., number of cases) for a specific causal combination. An observation that exhibits the outcome is assigned by the algorithm to exactly one best-fitting causal combination (i.e., truth table row) in which its membership exceeds .5. Based on the frequency value of causal combinations and common threshold recommendations, we then decided which combinations effectively produce the outcome and which combinations are to be excluded from the subsequent analysis. Ragin (2009, p. 107) recommends to apply a frequency threshold that at least retains 80% of all empirical observations in the truth table. Hence, we applied a frequency threshold of two cases, which retained 218 out of 251 observations (87%). Causal combinations with a lower frequency were not considered during the following analysis.

The truth table further reports the *consistency* per row, which is the measure for assessing the extent to which the statement of sufficiency (i.e., the presence of a subset relation between the combination of conditions and the outcome) for an individual truth table row is in line with the empirical evidence at hand (Ragin, 2008, p. 143). The consistency score serves as a probabilistic heuristic to assess the magnitude of contradictory cases in the truth table; that is, rows with cases that share the same combination of conditions but generate different outcomes (Schneider & Wagemann, 2012, pp. 57, 128). Here, we analyzed two different consistency measures. The first is *raw consistency*, which denotes the degree and relevance to which the combination of causal conditions has a subset relationship with the outcome set (i.e., membership scores in the configuration are consistently less than the outcome membership scores. The second measure is the *proportional reduction in inconsistency (PRI) consistency*, which eliminates the influence of cases from the raw consistency score that have simultaneous membership in both the outcome set (e.g., presence of innovativeness) and its negation (e.g., absence of innovativeness) (Greckhamer et al., 2018, p. 8). Raw consistency scores that are between 0.0 and 0.75 usually indicate "substantial inconsistency" (Ragin, 2008, p. 136). The selection of the consistency threshold should be guided by examining gaps between rows with relatively high and low consistency values, and also by considering common thresholds (Ragin, 2008, p. 135). For assessing consistency, we considered only combinations of conditions (i.e., truth table rows) with a raw consistency of at least 0.9 and a PRI consistency of at least 0.65 as very reliably resulting in digital business model innovativeness for two reasons. First, there was a small gap in PRI consistency between 0.67 and 0.63, indicating a more substantial difference and thus a preferred break point (Ragin, 2008, p. 136). Second, a combination with a raw consistency of 0.9 may be considered as *almost always sufficient* (Ragin, 2000, p. 110), and PRI scores of 0.65 and above further indicate that the combination is a consistent subset of the outcome of interest, but not simultaneously of its absence (Schneider & Wagemann, 2012, p. 243). Cases below these thresholds were considered as not exhibiting the outcome.

After analyzing the rows from the truth table, fsQCA further requires researchers to make a final set of assumptions. Summarized under the phenomenon of *limited diversity*, the truth table typically contains so-called *logical remainders* or counterfactual cases, which refer to empirically-unobserved configurations (i.e., frequency = 0) (Ragin, 2008, p. 150). Out of 128 mathematically possible configurations, our truth table empirically covered 42 configurations (i.e., rows). To address logical remainders, we made simplifying assumptions and applied *counterfactual analysis*. To carry out counterfactual analysis, fsQCA asks for each individual condition to be specified as to how they theoretically contribute to the presence or absence of the outcome (Ragin, Strand, & Rubinson, 2008, p. 52). Due to diverging opinions on design strategies, strategic posture, and environmental turbulence, we did not include counterfactuals related to these constructs. This reasoning is based on our previous discussion of the theoretical constructs (see section 4.2).

To infer *sufficient solutions* that lead to an outcome, fsQCA applies Boolean algebra to *logically minimize the truth table* using the Quine–McCluskey algorithm (Rihoux & De Meur, 2009, p. 36; Schneider & Wagemann, 2012, p. 188). Specifically, the algorithm performs a pairwise comparison of conjunctions of truth table rows and subsequently omits logically redundant and irrelevant conditions for producing the outcome (Schneider & Wagemann, 2012, p. 104).[14] The algorithm yields three kinds of results: the complex, intermediate, and parsimonious solutions (Ragin, 2009, p. 111). Here, the *complex solution* term does not consider assumptions related to empirically-unobserved configurations (i.e., it excludes empty truth table rows); the *intermediate solution* rests on counterfactuals consistent with theoretical knowledge and the empirical evidence at hand, and the *parsimonious solution* considers only the empirical evidence at hand without evaluating its theoretical plausibility. Intermediate solutions are subsets of the parsimonious solutions as well as supersets of the complex solutions (Ragin & Sonnett, 2005, p. 192).

Each solution term typically contains multiple *prime implicants* (i.e., configurations, or causal pathways) that lead to the outcome, and it is represented in Boolean notation (e.g. A • B • C) (Rihoux & De Meur, 2009, p. 35). For assessing the *sufficiency and fit* of the solutions, we considered the key parameters of consistency and coverage. While *consistency* refers to the degree of sufficiency for the existence of a subset relation with the outcome set, *coverage* expresses how important this subset relation is. Here, fsQCA differentiates between the consistency of individual prime implicants and the consistency of the overall solution term. The consistency of prime implicants explains how reliable an individual configuration yields the outcome, akin to a *p*-value (i.e., significance level) in a regression analysis (Bedford & Sandelin, 2015, p. 10). More specifically, it quantifies "the number of cases that exhibit a given configuration of attributes as well as the outcome divided by the number of cases that exhibit the same configuration of attributes but do not exhibit the outcome" (Fiss, 2011, pp. 402–403). The overall solution consistency parameter aggregates the consistency scores across all prime implicants and thus indicates the degree to which all configurations together consistently result in the outcome to occur (Schneider & Wagemann, 2012, p. 129).

Coverage scores allow the empirical importance of different causal combinations to be evaluated (Ragin, 2008, p. 44) and is akin to an R^2 score in traditional regression analysis (Bedford & Sandelin, 2015, p. 10). Here, fsQCA differentiates between raw, unique, and solution coverage. While *raw coverage* indicates the degree of cases exhibiting the outcome covered by a prime implicant (i.e., including cases covered by multiple configurations), *unique coverage* reports the proportion of outcome cases covered uniquely by a given prime implicant (i.e., no

[14] Consider the two simple configurational terms of A • B • C and A • C, that both exhibit the outcome. The reduced term is A • C, since the presence of B is irrelevant for the outcome to occur.

other configurations cover those cases). The overall *solution coverage* provides the degree of outcome cases covered by all prime implicants in a solution term (Rihoux & De Meur, 2009, p. 64). Like for the assessment of coverage of individual necessary conditions, no formal threshold for *good* coverage of solution terms and prime implicants exists in literature. In addition, the solutions which cover only a small portion of the outcome set may be of substantive importance and may yield theoretical implications (Schneider & Wagemann, 2012, pp. 138–139). However, for an prime implicant to be a relevant predictor for an outcome, scholars recommend that the consistency should be above .80 and the unique coverage should be above .01 (Woodside, 2016a, p. 69).

5.5.6 Assessing Robustness of Results

A number of factors can influence fsQCA results, namely the researcher-centered selection and calibration of conditions as well as the choice of consistency and frequency thresholds. Furthermore, simulations conducted by Hug (2013, p. 262) revealed that fsQCA is sensitive to measurement errors and prone to type I error (i.e., accepting false positives). Hence, methodologists have advised assessing the *robustness* of fsQCA's results (Emmenegger et al., 2014, p. 26; Skaaning, 2011, p. 392). In general terms, robustness refers to the ability of a predictive model "to perform reasonably well even when the underlying statistical assumptions have been violated in some manner" (Hair, Black, et al., 2014, p. 34). Hence, we investigated the primary factors that may influence robustness of our findings, namely the factors of the *sensitivity to thresholds* and the *sensitivity to the sample* (Schneider & Wagemann, 2010, p. 399; Skaaning, 2011, pp. 394–395). During our analysis, we only assessed the robustness of configurations for achieving high digital business model innovativeness, since these represent our core solutions of interest.

First, fsQCA is sensitive to applied *thresholds*. Threshold sensitivity relates to researchers' choices regarding the thresholds related to the calibration of raw data and the thresholds related to the frequency of cases linked to configurations and their associated consistency values (Skaaning, 2011, pp. 394–395). Since we did not have intimate relations to our observed cases due to the quantitative nature of our study, we could not systematically adjust thresholds based on *substantive knowledge* about our respondents' organizations (Ragin, 2008, p. 30). Nevertheless, we applied several remedies as suggested for larger *N* studies (Emmenegger et al., 2014, p. 26; Skaaning, 2011, pp. 394–395). We followed Ordanini et al. (2014, p. 143) and others (e.g., Fiss, 2011, p. 410), and we examined whether results change when applying different choices for the calibration thresholds. Changes in the calibration thresholds may affect consistency and coverage of solutions, but they should not lead to substantially different configurations (Greckhamer et al., 2018, p. 9). Therefore, we re-calibrated the latent variable scores by using two threshold combinations that are different to the original calibration as explained in section 5.5.3. Subsequently, we re-ran the truth table analysis and Boolean minimization and compared the resulting configurations, as well as the consistency and coverage scores of resulting solution terms with our original findings. If results showed no or only minor differences (e.g., representing subsets of the original solution), we regarded our calibration as sufficiently robust (Emmenegger et al., 2014, p. 28). In contrast to calibration cut-offs, changes in the minimum frequency, raw consistency, and PRI consistency thresholds for including truth table rows during the Boolean minimization may change results in that "an increase (decrease) in these thresholds will lead to new solutions that are more (less) consistent and have lower (higher) coverage" (Greckhamer et al., 2018, p. 10).

Second, fsQCA is sensitive to the *sample* in terms of the ratio of observed cases to the number of variables incorporated in the analysis, and also the presence and mitigation of logical remainders. As explained earlier, the number of possible combinations—and therefore, truth table rows—increases exponentially with the number of variables incorporated into the study. If the ratio of variables and observed cases is insufficient, researchers may arrive at a genuine description for each individual case instead of deriving the core elements and causal mechanisms that explain a phenomenon of interest at large (Berg-Schlosser & De Meur, 2009, p. 27). However, since we incorporated and fulfilled recommendations on the minimum sample size for conducting fsQCA studies in our data collection strategy (see section 5.3) (Marx & Dusa, 2011, p. 114), we regard this less of an issue. Nevertheless, even if the sample size is sufficient, unobserved empirical instances of combinations (i.e., logical remainders) needed to be addressed during the analysis of the truth table. By incorporating counterfactuals to mitigate missing empirical observations, the Boolean minimization process is primed by a researcher's reasoning. Since we based the rationale for our counterfactual analysis on substantive theory, we did not see any legitimate reason to include other counterfactuals that run counter to existing theoretical knowledge.

5.5.7 Testing for Predictive Validity

Previous studies have shown that a high model fit (i.e., high consistency and coverage scores) may still result in in low predictive validity (Gigerenzer & Brighton, 2009, p. 114; Woodside, 2013, p. 466). Hence, methodologists advise fsQCA results to be tested for predictive validity (Woodside, 2016a, p. 59). In general terms, predictive validity refers to the degree a model is able to predict a certain behavior or outcome in the future (Pedhazur & Schmelkin, 1991, p. 40). The overall objective of assessing predictive validity is to assess whether or not a model predicts the outcome from separate data sets (Woodside, 2013, p. 466). Since we did not have additional samples, we employed a cross-validation with a split-sample approach, where the sample is divided into two equally sized, random subsamples. Successively, one is used as the modeling sample, and one serves as the holdout (or validation) sample. The resulting configurations of the modeling sample are then used to verify how well they fit the holdout sample (and vice versa). Since the holdout sample was not used to generate the solution terms, the holdout sample allows the model to be independently validated (Hair, Black, et al., 2014, p. 202). We then compared the raw coverage and consistency scores of the configurations in both samples. The goal is to verify that consistency and coverage scores for the solution from the subsample are similar to the original sample, although configurations may differ. Similar to our robustness analyses, we only assessed the predictive validity of configurations for achieving high digital business model innovativeness.

5.6 Analysis of Direct Effects, Nomological Validity, and Utility

By testing the nomological network (see Figure II-5 in section 4.3) including our direct effect hypothesis (→*Hypothesis 5*), we sought to examine the behavior of the innovativeness construct in connection to another plausibly related construct to ascertain *nomological validity* (Cronbach & Meehl, 1955, p. 294). In other words, we examined "whether measures are related to other constructs in a theoretically meaningful way" (Van Ittersum, Pennings, Wansink, & van Trijp, 2007, p. 1178). Thus, we strived to test whether the direct effect of digital business model innovativeness aligns with expectations generated from earlier studies and theories on innovativeness and performance (Peter, 1981, p. 135). A direct effect relationship promotes PLS-SEM as a prediction-oriented approach to test our hypothesis (Rigdon, 2012, p. 353). We deemed PLS-SEM to be appropriate for the analysis of the direct effect hypothesis, since PLS-SEM represents a multivariate data analysis technique that allows us to estimate the magnitude of the causal relationship between digital business model innovativeness and organizational performance, and it also allows us to consider potentially important control variables (Hair et al., 2016, p. 27). For the PLS-SEM analysis, the set-theoretic outcome condition (i.e., endogenous variable) of digital business model innovativeness from the previous research stage served as an exogenous variable to our analysis of the direct effect on organizational performance (i.e., endogenous variable). We build on the following established guidelines for estimating structural models (Hair et al., 2016, p. 191, 2012, p. 430): (a) evaluating the coefficients of determination (R^2 values) to estimate in-sample predictive validity, (b) evaluating the out-of-sample predictive power (Q^2 values) of the model, (c) assessing size and significance of path coefficient estimates (β weights and *p*- or *t*-values), and (d) evaluating effect sizes (f^2 and q^2 values).

While the previously described approach allows us to test the direct effect hypotheses introduced in section 4.3 based on prior theoretical expectations, we further examined whether firms employing one of the identified digital IM configurations achieve overall higher organizational performance. In doing so, we sought to judge the specific utility of the identified configurations of digital IM from the firm level. To perform the analysis, we ran a one-way MANOVA, which extends the analysis of variance (ANOVA). It allows us to measure the differences for two or more dependent variables based on a set of groups serving as factor variables (Hair, Black, et al., 2014, p. 665). In our study, the membership in the configurations identified during the fsQCA procedure served as a factor variable. To perform the analysis, we first coded cases either according to their membership in the effective or ineffective digital IM configurations, or according to their non-membership in both. Following this, we investigated the joint effect of the group membership (i.e., factor variable) on the digital business model innovativeness variable and on the organizational performance variable (i.e., dependent variables). The MANOVA combines digital business model innovativeness and organizational performance into one composite dependent variable. In our study, this composite variable may be considered as a measure for reflecting the overall organizational shift to digital technologies in business operations and processes (Nwankpa & Roumani, 2016, p. 2), and it thus serves as a proxy "for evaluating performance in terms of achieving digital transformation" (Heavin & Power, 2018, p. 43). In other words, this composite variable may be regarded as a measure for the extent of successful utilization of digital innovations within a company's business (Armbruster, Bikfalvi, Kinkel, & Lay, 2008, pp. 654–655). However, this composite construct's theoretical grounding is rather limited and is not in the main focus of this study; thus, future research is required to more thoroughly evaluate the measures for assessing the performance of digital transformation strategies (Heavin & Power, 2018, p. 44). To address this issue, the MANOVA procedure additionally performs two follow-up univariate one-way ANOVAs to evaluate which dependent variable contributes to the statistically significant MANOVA for each configurational group.

To generate valid results from the MANOVA and corresponding ANOVA procedures, we tested for the underlying assumptions and requirements: (a) any presence of univariate and multivariate outliers, (b) multivariate normality, (c) no multicollinearity among digital business model innovativeness and organizational performance, (d) linear relationships between configurational groups and the dependent variables, (e) homogeneity of variance-covariance matrices, and (f) homogeneity of variance (Hair, Black, et al., 2014, p. 684).

6 Results

6.1 Measurement Model Validation

Table II-14 presents descriptive statistics of our measures based on the unstandardized latent variable scores extracted from the PLS analysis. We assessed our sample for skewness and kurtosis, where absolute values above 2.0 usually indicate non-normality (Schutz & Gessaroli, 1993, p. 918); skewness refers to the symmetry of the distribution, and kurtosis refers to either the peakedness or flatness of the distribution. The statistics show that our sample data is more peaked than the normal distribution and skewed to higher values. The Shapiro-Wilk test confirmed that the data does not follow a normal distribution (p = .01). Although PLS-SEM was found to be particularly suited in cases of extremely non-normal data (Reinartz, Haenlein, & Henseler, 2009, p. 338), heavily skewed data in fsQCA may result in flawed statements, particularly when determining necessity of conditions (Schneider & Wagemann, 2012, p. 248). However, the steps explained in section 5.5.4 guided us to mitigate the non-normal nature of our data.

Table II-14. Descriptive statistics based on the unstandardized latent variable scores.

Constr.	Min	Max	Mean	Median	Range	SE	SD	VAR	Skewness	Kurtosis
DEC	1.000	7.000	5.281	5.535	6.000	0.074	1.172	1.374	-1.137	1.711
ELR	1.706	7.000	5.245	5.394	5.294	0.061	0.960	0.921	-0.864	1.077
ILR	1.213	7.000	5.620	5.697	5.787	0.058	0.920	0.847	-1.151	3.079
INV	1.000	7.000	5.798	6.011	6.012	0.061	0.963	0.928	-1.904	5.824
IS	1.000	7.000	5.714	6.000	6.000	0.060	0.952	0.906	-1.230	3.205
MFE	1.000	7.000	5.882	6.000	6.000	0.058	0.923	0.852	-1.702	5.435
OP	1.000	7.000	5.570	5.745	6.000	0.066	1.041	1.084	-1.261	2.642
RM	1.000	7.000	5.759	6.000	6.000	0.067	1.054	1.111	-1.545	3.777
SCT	1.000	7.000	5.733	5.824	6.000	0.054	0.852	0.726	-1.663	5.666
SLR	1.000	7.000	5.483	5.606	6.000	0.067	1.054	1.110	-1.448	3.583
STRAT	1.572	7.000	5.643	5.771	5.428	0.060	0.946	0.895	-1.155	2.068
TURB	1.804	7.000	5.678	5.793	5.196	0.054	0.863	0.745	-1.080	2.271
VA	1.000	7.000	5.792	6.000	6.000	0.061	0.960	0.922	-1.626	4.729
VO	1.000	7.000	5.827	6.000	6.000	0.066	1.043	1.087	-1.842	5.465

SD = Standard deviation; SE = Standard error; VAR = Variance

DEC = Decentralization; ELR = External lateral relations; ILR = Internal lateral relations; INV = Digital business model innovativeness; IS = Information systems; MFE = Employee multifunctionality; OP = Organizational performance; RM = Digitized revenue model; SCT = Self-containment; SLR = Slack resources; STRAT = Strategic posture; TURB = Turbulence; VA = Digitized value architecture; VO = Digitized value offering

We first examined the data for any evidence for CMV in two steps (detailed results can be found in Appendix II-D). First, during the Harman's (1967) single factor analysis, 11 factors with an eigenvalue greater than 1 emerged, which cumulatively accounted for 65.97% of the total variance, and the first factor only captured 30.79% of the total variance. Hence, no single factor emerged in the unrotated factor structure that accounted for most of the variance. Second, we performed the full collinearity test in PLS-SEM by connecting all latent variables to a dummy variable and then examining the collinearity statistics (i.e., inner VIF values). Full VIF ranged from 1.3 to 2.6 and thus were far below the most conservative threshold of 3.3 (Kock, 2015, p. 6; Kock & Lynn, 2012, p. 558). Hence, both results indicate that the data is likely not affected by CMV.

Following the recommendations by Becker et al. (2012, p. 377), a confirmatory factor analysis was conducted at two levels, namely the first-order and the second-order level. We first assessed reflective first-order measurement models for their reliability and validity. Standardized loadings, reliability, and convergent validity of reflective measurement models are shown in Table II-15. After assessing construct measures' indictor reliability, items were retained if the indicators exhibited squared standardized outer loadings above .7. All constructs displayed high and significant indicator reliability, except for two items in the decentralization and turbulence measures. However, we did not remove DEC_3 for two reasons: Theoretical considerations did not warrant a single-item construct, and the lowest acceptable loading threshold for indicator loadings is argued to be at .4 (Hulland, 1999, p. 198). Similar considerations applied to the item TURB_5. Internal consistency reliability (i.e., correlations between different items) of constructs was assessed by means of Cronbach's alpha and composite reliability. Here, all measurement models exceed the recommended threshold of .7 for both metrics (Hair et al., 2012, p. 429), except for the decentralization measure ($\alpha = .53$). We decided not to drop or alter the decentralization construct, since Cronbach's alpha values above .5 still show moderate reliability (Hinton, McMurray, & Brownlow, 2004, p. 364), and the compositive reliability measure indicated high internal consistency. All constructs displayed an average variance extracted (AVE) between .55 and .79, which is well above the threshold of .5 (Hulland, 1999, p. 198). This indicates satisfactory convergent validity of our reflective constructs, where convergent validity denotes that a construct's measure "correlates positively with alternative measures of the same construct" (Hair et al., 2016, p. 112).

Table II-15. Indicator loadings, internal consistency reliability, and convergent validity of first-order reflective constructs.

Construct	Items	SL	SD	SE	t-statistic	CR	α	AVE
DEC	DEC_1 (R)	*Deleted*				0.779	**0.534**	0.649
	DEC_2 (R)	*Deleted*						
	DEC_3	**0.617**	0.100	0.006	6.962**			
	DEC_4	0.958	0.020	0.001	48.67**			
ILR	ILR_1	0.818	0.034	0.002	20.348**	0.861	0.785	0.608
	ILR_2	*Deleted*						
	ILR_3	0.810	0.036	0.002	18.216**			
	ILR_4	0.710	0.060	0.004	11.488**			
	ILR_5	0.776	0.050	0.003	15.537**			
IS	IS_1	0.874	0.026	0.002	32.463**	0.883	0.737	0.791
	IS_1 (R)	*Deleted*						
	IS_3	0.904	0.019	0.001	47.367**			
MFE	MFE_1	0.829	0.040	0.003	31.844**	0.881	0.801	0.711
	MFE_2	0.869	0.018	0.001	25.593**			
	MFE_3	0.831	0.047	0.003	32.31**			
	MFE_4 (R)	*Deleted*						
	MFE_5 (R)	*Deleted*						
OP	OP_1	0.817	0.033	0.002	24.366**	0.923	0.896	0.706
	OP_2	0.836	0.041	0.003	20.753**			
	OP_3	0.840	0.040	0.003	21.088**			
	OP_4	0.876	0.019	0.001	44.794**			
	OP_5	0.830	0.030	0.002	27.275**			
STRAT	SP_1	0.827	0.020	0.001	38.389**	0.884	0.825	0.658
	SP_2	0.776	0.044	0.003	17.334**			
	SP_3	0.887	0.018	0.001	47.163**			
	SP_4 (R)	*Deleted*						
	SP_5	0.747	0.039	0.002	19.785**			
SLR	SR_1	0.829	0.030	0.002	27.806**	0.877	0.813	0.641
	SR_2	0.815	0.033	0.002	24.057**			
	SR_3	0.781	0.046	0.003	16.838**			
	SR_4	0.777	0.043	0.003	18.589**			
TURB	TURB_1	0.724	0.044	0.003	16.453**	0.858	0.791	0.549
	TURB_2	0.756	0.041	0.003	17.442**			
	TURB_3	*Deleted*						
	TURB_4	0.817	0.028	0.002	28.517**			
	TURB_5	0.600	0.061	0.004	10.211**			
	TURB_6	0.788	0.036	0.002	22.551**			

SL = Standardized loading; SD = Standard deviation; SE = Standard error; CR = Composite reliability; α = Cronbach's alpha; AVE = Average variance extracted

DEC = Decentralization; ILR = Internal lateral relations; IS = Information systems; MFE = Employee multifunctionality; OP = Organizational performance; SLR = Slack resources; STRAT = Strategic posture; TURB = Turbulence

(R) Reverse coded item

** Significant at $p = .01$ (2-tailed, $t > 2.57$).

Discriminant validity of reflective measurement models (i.e., the extent a construct is different from other constructs) was assessed by performing a cross-loading analysis as documented in Appendix II-E. The analysis confirmed that indicators loaded highest on their theoretically intended constructs compared to the loadings on other constructs. Furthermore, by applying the Fornell–Larcker criterion, we compared the square root of the average variance of individual constructs with the correlation coefficients with other latent constructs (Hair et al., 2016, p. 116). The results show that constructs share more variance with their associated indicators than with other measures. To substantiate discriminant validity, we assessed the more rigorous heterotrait-monotrait ratio of correlations (HTMT). The HTMT denotes the ratio of the between-trait correlations to the within-trait correlations (Henseler, Ringle, & Sarstedt, 2015, p. 121). All HTMT values are below the most conservative threshold of .85 (Henseler et al., 2015, p. 121). As Table II-16 illustrates, the reflective measurement models meet all requirements for adequate discriminant validity.

Table II-16. Discriminant validity of first-order reflective constructs.

	DEC	ILR	IS	MFE	OP	SLR	STRAT	TURB
DEC	**0.806**	0.486	0.708	0.521	0.678	0.701	0.639	0.408
ILR	0.327**	**0.779**	0.795	0.665	0.548	0.695	0.685	0.743
IS	0.500**	0.605**	**0.889**	0.848	0.692	0.817	0.791	0.747
MFE	0.417**	0.522**	0.652**	**0.843**	0.681	0.759	0.686	0.564
OP	0.508**	0.457**	0.564**	0.577**	**0.840**	0.725	0.836	0.586
SLR	0.488**	0.558**	0.635**	0.614**	0.616**	**0.801**	0.812	0.592
STRAT	0.463**	0.551**	0.624**	0.561**	0.716**	0.664**	**0.811**	0.747
TURB	0.311**	0.588**	0.576**	0.461**	0.495**	0.480**	0.611**	**0.741**

DEC = Decentralization; ILR = Internal lateral relations; IS = Information systems; MFE = Employee multifunctionality; OP = Organizational performance; SLR = Slack resources; STRAT = Strategic posture; TURB = Turbulence

The diagonal values shown in bold represent the square root of each construct's AVE, whereas latent variable correlations are located below this line (i.e., Fornell–Larcker criterion). The HTMT values are located above the diagonal line.

** Significant at $p = .01$ (2-tailed, $t > 2.57$).

To evaluate our formative measurement models, we assessed indicator weights and their significance. Most items displayed significant weights on their respective constructs. Table II-17 shows that a few exceptions are to be noted (i.e., ELR_3, ELR_4, ELR_5, VA_4). Besides considering formative indicators' relative contributions to their constructs by examining their weights, we also considered the outer loadings of formative indicators that exhibit non-significant weights but loadings above .50 to retain *absolutely important* indicators and to avoid unnecessarily omitting content or changing the nature of formative constructs (Cenfetelli & Bassellier, 2009, p. 693; Hair, Hult, Ringle, & Sarstedt, 2014, p. 129). Thus, we decided to keep all items to not unnecessarily change the theoretically-substantiated nature of the formative constructs (Cenfetelli & Bassellier, 2009, p. 693; Hair, Hult, et al., 2014, p. 129). Next, we tested the formative constructs for multicollinearity on the item level (Diamantopoulos &

Winklhofer, 2001, p. 272). The VIF values for all indicators range between 1.21 and 2.54 and thus are well below the critical threshold of 5 (Hair et al., 2016, p. 143), indicating that no excessive multicollinearity is present. This is further substantiated by the CI on the construct levels that are far below the cutoff value of 30, ranging from 10.01 to 18.06 (Belsley, 1984, p. 184; Hair, Black, et al., 2014, p. 221).

Table II-17. Analysis of multicollinearity, significance, and relevance of formative first-order constructs.

Construct	CI	Item	VIF	*Outer weights*				*Outer loadings*			
				W	SD	SE	t-statistic	SL	SD	SE	t-statistic
ELR	15.402	ELR_1	1.256	0.392	0.166	0.010	2.361*	0.719	0.111	0.007	6.460**
		ELR_2	1.530	0.406	0.153	0.009	2.651**	0.809	0.096	0.006	8.430**
		ELR_3	1.819	0.082	0.146	0.009	**0.560**	0.684	0.103	0.007	6.651**
		ELR_4	1.561	0.209	0.172	0.010	**1.210**	0.690	0.099	0.006	6.976**
		ELR_5	1.907	0.260	0.171	0.010	**1.514**	0.733	0.093	0.006	7.852**
RM	10.005	RM_1	1.206	0.282	0.089	0.006	3.156**	0.633	0.084	0.005	7.534**
		RM_2	1.206	0.850	0.061	0.004	13.992**	0.967	0.023	0.001	42.365**
VA	18.059	VA_1	1.812	0.539	0.128	0.008	4.196**	0.886	0.048	0.003	18.512**
		VA_2	1.829	0.339	0.126	0.008	2.683**	0.766	0.071	0.004	10.734**
		VA_3	1.696	0.231	0.112	0.007	2.063*	0.755	0.074	0.005	10.159**
		VA_4	2.541	0.110	0.170	0.011	**0.644**	0.812	0.080	0.005	10.152**
VO	13.705	VO_1	1.846	0.367	0.108	0.007	3.409**	0.851	0.062	0.004	13.740**
		VO_2	1.613	0.302	0.079	0.005	3.836**	0.785	0.064	0.004	12.315**
		VO_3	1.863	0.500	0.092	0.006	5.451**	0.901	0.033	0.002	27.508**

CI = condition index; VIF = Variance inflation factor; SD = Standard deviation; SE = Standard error; W = Weight; SL = Standardized loading

ELR = External lateral relations; RM = Digitized revenue model; VA = Digitized value architecture; VO = Digitized value offering

** Significant at $p = .01$ level (2-tailed, $t > 2.57$).

* Significant at $p = .05$ level (2-tailed, $t > 1.96$).

We assessed the internal validity and reliability of our formative HCMs analogously to the assessment of our first-order formative measurement models. As shown in Table II-18, all first-order constructs have significant weights on their respective higher-order constructs. Furthermore, the VIF values of the individual lower-order constructs ranged from 1.21 to 3.16 and thus are below the threshold of 5. The CI of 12.85 and 18.02 are below the threshold of 30. Hence, multicollinearity among the first-order constituents is not a critical issue.

For self-containment, employee multifunctionality had a stronger beta weight ($\beta = .72$; $p < .01$) than decentralization ($\beta = .45$; $p < .01$). This suggests that task diversity and a broad skill base (i.e., reducing horizontal differentiation) have a stronger contribution for realizing a self-contained context than a flat chain of command within the digital IM (i.e., reducing vertical differentiation). This aligns with previous research emphasizing the criticality of the resource base while simultaneously acknowledging the recurrent need to control cost and outcomes through narrower communication channels to generate explorative settings (Chen et al., 2010,

p. 248; Lyytinen & Rose, 2003, p. 579). Results further suggest that among the factors that form digital business model innovativeness, digitalized value offering is the most important ($\beta = 0.63$; $p < .01$), followed by digitalized revenue model ($\beta = 0.28$; $p < .01$), and digitalized value architecture ($\beta = 0.17$; $p < .1$). The strong weight of the digitalized value offering construct confirms the dominance of the product-centric focus on digital innovation (e.g., Lee & Berente, 2012, p. 1430; Yoo, Henfridsson, et al., 2010, p. 725). This aligns well with research arguing that novel digital products and services constitute the logical apex of digital business model innovation (Fichman et al., 2014, p. 335; Teece, 2010, p. 183), and that the activities for creating, delivering, and appropriating value revolve around the value proposition (Amit & Zott, 2010, p. 5).

When taken together, the results confirm that digital business model innovativeness is a second-order construct formed by digitized value offering, digitized value architecture, and digitized revenue model, and that decentralization and employee multifunctionality form the higher-order construct of self-containment. As proposed by Ringle et al. (2009, p. 301), we assessed the nomological validity of digital business model innovativeness (i.e., whether the second-order formative construct carries the theoretically intended meaning) during the analysis of the direct effect hypothesis (H5), whereas self-containment's contribution to digital business model innovativeness is examined in the subsequent set-theoretic analysis.

Table II-18. Analysis of multicollinearity, significance, and relevance of formative second-order constructs.

Second-order constructs	CI	First-order constructs	VIF	β weight	*t*-statistic
Self-containment	12.847	Decentralization	1.211	0.451	2.884**
		Employee multifunctionality	1.211	0.724	5.774**
Digital Business Model Innovativeness	18.018	Digitized value offering	2.786	0.630	7.403**
		Digitized value architecture	3.155	0.174	1.763*
		Digitized revenue model	2.492	0.282	3.296**

** Significant at $p < .01$ (2-tailed, $t > 2.57$).
* Significant at $p < .1$ (2-tailed, $t > 1.65$).
CI = condition index; VIF = Variance inflation factor

6.2 Set-Theoretic Analysis

Since the confirmatory factory analysis provided good support for validity and reliability of the measurement models, we proceeded with the identification and evaluation of configurational archetypes for effective and ineffective digital IM.

6.2.1 Contrarian Case Analysis

Table II-19 shows the summary of our contrarian case analysis from cross-tabulating the conditions (i.e., independent variables) to the outcome (i.e., dependent variable) of digital business model innovativeness to substantiate the use of fsQCA as analytical technique. The second column contains cases that support the theoretically expected main effects. These cases follow the pattern of "X has a positive relationship with Y in that low X associates with low Y and high X associates with high Y" (Woodside, 2016b, p. 48). Ambiguous relations are those in which a *neutral* value (i.e., a Likert value of 4) of the condition results in high or low digital business model innovativeness, or the outcome exhibits a neutral value albeit high or low values in the condition variable. By contrast, a linear and symmetric relationship would assume that a neutral value of an independent variable would result in a neutral value of the dependent variable. The contrarian effect column includes negative contrarian cases (i.e., negative indicator and positive outcome) as well as positive contrarian cases (i.e., positive indicator and negative outcome) that run counter to theoretically expected main effects (Wu et al., 2014, p. 1655). Examining the data indicates the presence of various ambiguous and contrarian relationships between the conditions and digital business model innovativeness that are separate from the main effect. Table II-19 indicates that particularly external lateral relations exhibit a higher number of ambiguous and contrarian cases, whereas the relationship between self-containment and digital business model innovativeness is more linear. Although the majority of cases follow a more symmetric antecedent-outcome relationship, 11% of ambiguous and 3% of contrarian cases on the average run counter to the main effects. Traditional approaches such as multiple regression analysis ignore this complexity of reality and suffer from "over simplistic theorizing and handling of a data set" (Woodside, 2014, p. 2502). Hence, these results warrant fsQCA as a suitable analytical technique to unravel the complex antecedent conditions and distinct *causal recipes* for digital IM configurations that either exhibit high or low innovativeness.

Table II-19. Results of the cross-tabulation ($N = 251$).

Condition	Main effect	Ambiguous relation	Contrarian effect
External lateral relations	198 (79%)	43 (17%)	10 (4%)
Internal lateral relations	215 (86%)	28 (11%)	8 (3%)
Information systems	221 (88%)	22 (9%)	8 (3%)
Self-containment	228 (91%)	19 (8%)	4 (2%)
Slack resources	219 (87%)	23 (9%)	9 (4%)
Strategic posture	220 (88%)	27 (11%)	4 (2%)
Turbulence	222 (88%)	25 (10%)	4 (2%)
Average	**87%**	**11%**	**3%**

6.2.2 Analysis of Necessity

Table II-20 shows the results of the necessity analysis. Consistency scores of .90 and above indicate that a condition is "almost always necessary" (Ragin, 2000, p. 227). However, we only found consistency scores between .44 and .83, and coverage scores ranged from .46

to .81. The test against the consistency benchmark of .90 exhibited only negative and non-significant *z*-scores for single conditions, and the RoN scores ranged from .62 to .87. We further examined the XY-plots of the fuzzy-set membership of cases in terms of digital business model innovativeness and individual conditions. We saw that most cases fell above diagonal line, indicates that no necessary condition is present. Taking all individual values into consideration, we conclude that no single condition included in our analysis has a consistent superset relation with the presence or absence of digital business model innovativeness, and thus we also conclude that no necessary condition is present. Consequently, all conditions were included for the subsequent identification of sufficient solutions and ideal types (Ragin et al., 2008, p. 43).

Furthermore, we sought to assess the notion of *strategy-structure-environment fit* as hypothesized in section 4.3 by means of necessity analysis. The perspective suggests that the OD needs to co-align with the environment *and* the organizational strategy in order to generate high performance (Priem, 1994, p. 430; Volberda et al., 2012, p. 1051). Akin to the approach of disproving a null hypothesis, we assessed whether the environment *or* the organizational strategy form a necessary condition for the presence or absence of high digital business model innovativeness. More specifically, we assessed whether both conditions joined by a *logical or* (i.e., STRAT+TURB) are functional equivalents or "substitutable necessary conditions" (Ragin, 2006, p. 299). Both the original expression as well as the negated term (i.e., ~STRAT+~TURB) achieve consistency scores of .90 for the presence or the absence of the outcome, respectively. This at a first glance may suggest that the joined expressions may be considered as "almost always necessary" (Ragin, 2000, p. 227), since they match the conventional consistency threshold of .90. However, the analysis indicates only moderate coverage scores, and the expressions therefore do not fully cover all cases of membership in the respective outcome. Also, considering that our data is generally skewed to higher values (see section 6.1), we thus conclude that membership in the group of firms with high innovativeness is not a subset of the combined expressions stated above, and that digital IM's OD indeed needs to co-align with both the environment *and* the organizational strategy in order to yield high innovativeness. The same conclusions hold true for the absence of digital business model innovativeness.

Table II-20. Analysis of necessity results.

Condition	High digital business model innovativeness				Absence of digital business model innovativeness			
	Consistency	*z*-score	Coverage	RoN	Consistency	*z*-score	Coverage	RoN
ELR	0.746	-5.209	0.737	0.785	0.515	-12.149	0.501	0.658
~ELR	0.496	-13.364	0.509	0.679	0.731	-5.445	0.738	0.799
ILR	0.745	-5.230	0.737	0.785	0.536	-11.492	0.522	0.668
~ILR	0.518	-12.659	0.531	0.688	0.731	-5.438	0.738	0.798
IS	0.724	-5.904	0.813	0.868	0.438	-14.539	0.484	0.704
~IS	0.541	-11.904	0.494	0.616	0.831	-2.314	0.747	0.763
SCT	0.764	-4.597	0.758	0.800	0.487	-13.033	0.475	0.648
~SCT	0.471	-14.181	0.482	0.665	0.753	-4.760	0.758	0.810
SLR	0.776	-4.215	0.772	0.810	0.488	-12.994	0.477	0.651
~SLR	0.475	-14.036	0.485	0.665	0.768	-4.288	0.771	0.818
STRAT	0.807	-3.195	0.798	0.826	0.476	-13.367	0.463	0.641
~STRAT	0.457	-14.639	0.469	0.662	0.793	-3.514	0.801	0.840
TURB	0.781	-4.060	0.780	0.817	0.474	-13.418	0.466	0.648
~TURB	0.467	-14.319	0.474	0.658	0.777	-3.989	0.777	0.820
STRAT+TURB	0.897	-0.255	0.737	0.705	0.585	-9.986	0.473	0.545
~STRAT+~TURB	0.566	-11.080	0.747	0.558	0.895	-0.335	0.740	0.719

RoN = Relevance of Necessity

ELR = External lateral relations; ILR = Internal lateral relations; IS = Information systems; SCT = Self-containment; SLR = Slack resources; STRAT = Strategic posture; TURB = Turbulence

~ = Negation (i.e. absence of condition)

+ = Presence of either condition or of both conditions (logical "or")

6.2.3 Sufficiency Analysis: Identification of Digital IM Configurations

Based on the truth table analysis, Table II-21 shows the ideal type configurations of digital IM that exhibit high digital business model innovativeness (i.e., effective configurations), while Table II-22 shows configurations that result in the absence of digital business model innovativeness (i.e., ineffective configurations). The presence of multiple effective and ineffective configurations confirms the existence of causal asymmetry and first-order (or across-type) equifinality (Fiss, 2011, p. 407). The solution tables are based on the *configuration chart* notation or introduced by Ragin and Fiss (2008, p. 205). This chart combines the prime implicants from the parsimonious and intermediate solutions into an easily comprehensible representation of the causal mechanisms. Since the intermediate solution is a subset of the most parsimonious one, both may be combined to demonstrate the relative importance of conditions. Blank cells indicate that the condition's presence or absence does not contribute to generating the outcome of interest. The presence of a condition is indicated by a full circle, while a crossed-out circle indicates the absence of a condition (Fiss, 2011, p. 407). Large circles represent the most decisive *core ingredients* that occur in both the parsimonious and intermediate solution terms; small circles represent causal conditions that occur in the intermediate but not parsimonious solution and thus are *complementary*, *peripheral*, or *contributing* (Ragin & Fiss, 2008, p. 204).

Configurations within the tables are numbered and grouped according to shared core conditions. Groups of configurations sharing core conditions that are surrounded by different sets of complementary conditions are called “neutral permutations” (Fiss, 2011, p. 394), denoting that trade-offs between peripheral conditions may still result in the same outcome. Our results show three neutral permutations (i.e., groups) of effective digital IM and three neutral permutations for ineffective digital IM, which indicates the presence of second-order (or within-type) equifinality (Fiss, 2011, p. 407). We extended the common notation by adding the correlation coefficient for the relationship between the configurations and digital business model innovativeness for an even more detailed interpretation of the results. In the following subsections, we first present the digital IM configurations that are linked to the presence of digital business model innovativeness and then to its absence, followed by a comparison of the findings in light of our configurational hypotheses presented in section 4.3.

6.2.3.1 Digital IM Configurations for the Presence of Digital Business Model Innovativeness

Table II-21 shows three solutions distributed across six single configurations that exhibit digital business model innovativeness, with high individual consistency scores found (≥ .92). To provide an example for how to interpret the solution tables, the digital IM design of Configuration 1a combines—regardless of the application of internal lateral relations—substantial resource commitments (i.e., slack resources) and an extensive use of IS for innovation activities as core conditions in institutional settings with an aggressive strategic posture but irrespective of turbulence. These causal core conditions are surrounded and reinforced by reductions in the division of work and the division of authority within the digital IM unit (i.e., self-containment).

The core conditions of the neutral permutations within Solution 1 (i.e., Configurations 1a, 1b, and 1c) indicate that an aggressive strategic posture combined with high resource commitments and the use of IS in the digital IM are sufficient for achieving digital business model innovativeness. The configurations included in Solution 1 suggest a substitution effect between internal and external lateral relations for firms that exhibit high degrees of strategic aggressiveness. Here, comparing Configuration 1a with Configurations 1b and 1c indicates that internal and external lateral relations may be treated as design substitutes in this institutional context. Specifically, external innovation partnerships allow Configuration 1a to generate high digital business model innovativeness, regardless of whether there is an established collaborative process with other business units or not, as indicated by the *don’t care* situation signaled by the blank space. By contrast, Configurations 1b and 1c show the opposite pattern. Irrespective of the environmental turbulence or bonds with external innovation sources, digital

IM Configuration 1c combines cross-functional business interfaces with a protected internal atmosphere (i.e., self-containment), while leveraging know-how from business units particularly in fairly turbulent environments (1b) allows high digital business model innovativeness to be generated irrespective of any reductions in horizontal and vertical differentiation within the digital IM.

Table II-21. Digital IM configurations resulting in the *presence* of digital business model innovativeness.

	Solution					
	1			2		3
Configuration	**1a**	**1b**	**1c**	**2a**	**2b**	
Digital IM design strategies						
Slack resources	●	●	●		•	⊗
Self-containment	•		•	●	●	●
Internal lateral relations		•	•	•	•	⊗
External lateral relations	•			●	●	⊗
Information systems	●	●	●		•	⊗
Strategic posture	●	●	●	•		●
Turbulence		•		●	●	●
Consistency	0.93	0.94	0.93	0.92	0.95	0.94
Raw coverage	0.50	0.51	0.50	0.52	0.46	0.16
Unique coverage	0.03	0.04	0.01	0.06	0.01	0.02
Correlation	0.36**	0.36**	0.37**	0.38**	0.37**	0.08
Overall solution consistency	0.90					
Overall solution coverage	0.67					

Black circles indicate the presence of a condition, and circles with × indicate its absence. Large circles indicate core conditions; small ones indicate peripheral conditions. Blank spaces indicate "don't care."

*** significant at the α 0.01 level (2-tailed, t > 2.57).*

The core conditions of the two neutral permutations of Solution 2 indicates that in substantially turbulent environments, the reliance on external lateral relations combined with a reduction of horizontal and vertical differentiation (i.e. self-containment) is sufficient to achieve high digital business model innovativeness when combined with a moderate degree of internal lateral relations. The comparison with Configurations 1a-c indicates the presence of a digital IM that integrates the benefits of internal knowledge with external innovation capabilities under high turbulence. This suggests that the combination of internal and external lateral relations particularly works well in complex and rapidly changing digital environments. Furthermore, the comparison of Configurations 2a and 2b indicates that abundant resource commitments combined with the use of IS for digital innovation activities are of lesser importance for a digital IM that is situated in a firm with a fairly strategic stance. This suggests that digital IM in more proactive firms (2a) may be less prudent in resolving "imperfect information" (Mithas et al., 2013, p. 515), for example by diligently using IS to scan for innovation opportunities or investing substantial resource amounts for research before initiating innovation initiatives, as seen in Configuration 2b. Instead, a digital IM following Configuration 2a is willing to take greater risks in that it relies on the proficiency of its internal and external knowledge sources, and thus it aims to initiate new projects more quickly. It is noteworthy that Configuration 2a represents the most dominant causal path (raw/unique coverage = .52/.06) for achieving digital business model innovativeness.

Finally, Configuration 3 suggests that there are trade-offs between the self-containment strategy and the other digital IM design strategies for highly aggressive firms operating under strong turbulence. This contrasts with Configuration 2a, in that it also combines self-containment with a more proactive strategic posture under strong turbulence. However, Configuration 3 is particularly suited for a digital IM operating in organizations with an even more aggressive strategic stance than in the case of Configuration 2a. These specific contextual conditions suggest a highly capable *top-down think tank* under direct authority of the top management board as being most effective, which represents a "select unit of high quality professionals grouped in islands of excellence" (Dror, 1984, p. 219). This to some extent lends credence to the concept of structural ambidexterity, in which separated organizational structures are responsible for either alignment or adaptability (Gibson & Birkinshaw, 2004, p. 221). Interestingly, Configuration 3 is the only solution that jointly combines an aggressive strategic stance and the presence of environmental turbulence as causal core conditions, although most of seminal innovation research proposes that environmental change and strategic differentiation are the primary contingencies for high innovativeness (Tidd, 2001, p. 174). This may also explain the tentative and ambiguous results from Miller and Friesen (1983, p. 231) regarding the relationships between environmental hostility, strategy-making, and innovation. However, comparing the raw coverage score of the other solutions ranging around .5 with Configuration 3, it is evident that it represents the least dominant model for predicting digital business model innovativeness with a raw coverage score of only .16.

The solution table for achieving high digital business model innovativeness indicates high overall consistency (.90). Furthermore, the overall coverage score indicates that the combined results substantively account for 67% of the membership in the digital business model innovativeness set. Except for Configuration 3, correlations between membership in effective configurations and digital business model innovativeness are statistically significant ($p < .01$) and vary around .37. With these taken together, either abundant resource availabilities or enlarged job scopes appear as core design strategies for achieving appropriate information processing capabilities across all effective digital IM configurations. Here, slack resources are more important to aggressive firms, whereas a self-contained digital IM unit is more important in turbulent environments. This suggests that firms in turbulent innovation environments particularly benefit from empowered and multiskilled employees since these firms allow them to quickly sense and seize new trends and opportunities in rapidly changing ecosystems. In comparison, aggressive firms may profit more from high-density workforces and high capital investments dedicated to a broad range of experiments, some of which may result in successful digital business model innovation. We did not find any digital IM configurations that particularly can work well in very stable environments or work for firms with a pronounced defender strategy. However, digital IM Configurations 1a and 1c may work well in both turbulent and stable environments, but only in firms that are strongly inclined to exploiting new strategic trajectories. Furthermore, Configuration 2a may work well for a moderate to aggressive stance, while the digital IM represented in Configuration 2b may generate high innovativeness irrespective of the strategic orientation. Nevertheless, these configurations require a highly turbulent environment that puts high information processing needs on the digital IM to prove effective. This to some extent supports earlier research which has regarded a turbulent environment as crucial antecedent for innovativeness (Gupta et al., 1986, p. 10; Huse et al., 2005, p. 318), and noted that defenders are unlikely to innovate their business in situations of stability (Olson & Slater, 2002, p. 13).

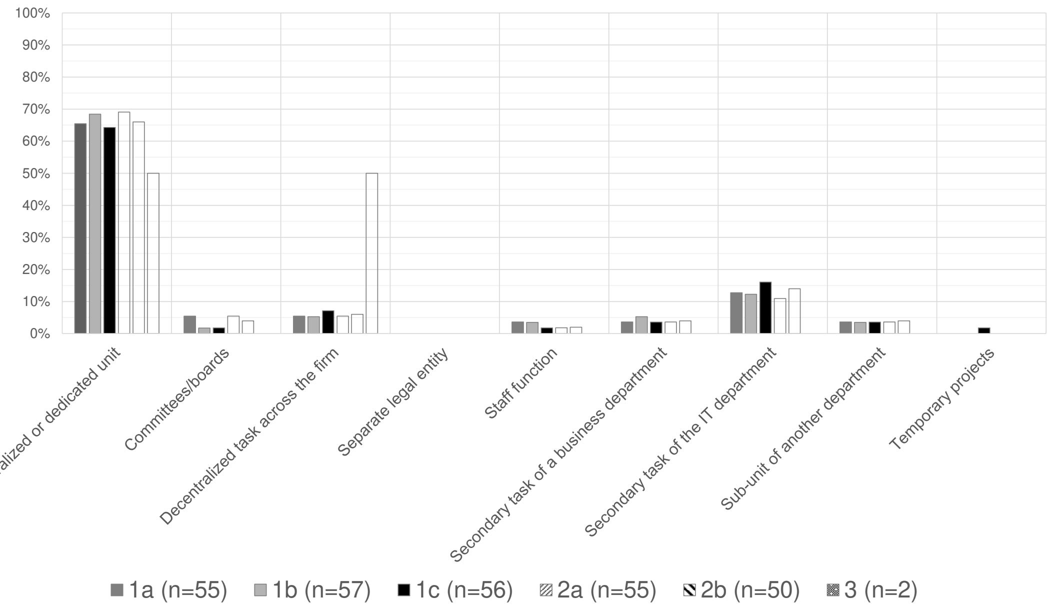

Figure II-10. Mapping of configurational paths for *effective* digital IM to basic meso-level structures.

To investigate the association between the micro-level digital IM design strategies and the basic meso-level structures, Figure II-10 shows that the most dominant structure for effective configurations by far is the centralized or dedicated unit, followed by delegating the digital IM task to the IT department. On the average, 64% of effective configurations use the centralized unit as basic structure, with the sample average being at 44%. This finding contradicts research that has seen a decentralized or contextualized approach to be superior in information processing over more centralized settings (Gibson & Birkinshaw, 2004, p. 209; Wang, 2003, p. 242). Furthermore, virtually no effective configuration builds on dedicated legal entities or temporary matrix organizations (i.e., project settings) as its basic structure. Due to the nature of fuzzy sets, a case may have different degrees of memberships in multiple configurations.

6.2.3.2 Digital IM Configurations for the Absence of Digital Business Model Innovativeness

Table II-22 shows three highly consistent (≥ .92) solutions including seven individual causal configurations resulting in the absence of digital business model innovativeness. Configurations 1a-1c indicate that digital IM's lack of excess resources is a core condition for the absence of digital business model innovativeness in firms that are focused on existing products and services and operating in highly stable environments. The salient path of Configuration 1a (raw/unique coverage = .52/.03) indicates that the causal core effect is reinforced by the non-use of IS for innovation and the absence of external innovation partnerships. Missing information-sharing routines with external parties likewise contribute to low innovation performance in Configuration 1b, reinforced by the presence of internal decentralization and employee multifunctionality (i.e., self-containment). This signals a negative trade-off effect between self-containment and external lateral relations in defensive firms operating in stable environments. Also, Configuration 1b contradicts the typical expectation that greater local decision-making autonomy and a reduction in the division of labor enable a unit to achieve a better sense and absorb innovation-relevant knowledge (Chen et al., 2010, p. 248; Lyytinen & Rose, 2003, p. 582). In turn, Configuration 1c shows that the absence of self-containment and internal lateral relations combine with the non-use of IS to low innovativeness.

Table II-22. Digital IM configurations resulting in the *absence* of digital business model innovativeness.

	Solution						
	1			2		3	
Configuration	**1a**	**1b**	**1c**	**2a**	**2b**	**3a**	**3b**
Digital IM design strategies							
Slack resources	⨂	⨂	⨂		⊗	⨂	⨂
Self-containment		●	⊗	⨂	⨂	⊗	⊗
Internal lateral relations			⊗	⊗	⊗	●	●
External lateral relations	⊗	⊗		⨂	⨂	⬤	⬤
Information systems	⊗		⊗		⊗	●	⊗
Strategic posture	⨂	⨂	⨂	⊗		⨂	⨂
Turbulence	⨂	⨂	⨂	⨂	⨂	⊗	●
Consistency	0.94	0.93	0.94	0.92	0.92	0.95	0.93
Raw coverage	0.52	0.26	0.48	0.49	0.46	0.17	0.20
Unique coverage	0.03	0.01	0.02	0.03	0.01	0.01	0.03
Correlation	−0.52**	−0.16*	−0.44**	−0.40**	−0.42**	0.01	−0.05
Overall solution consistency				0.89			
Overall solution coverage				0.63			

Black circles indicate the presence of a condition, and circles with × indicate its absence. Large circles indicate core conditions; small ones indicate peripheral conditions. Blank spaces indicate "don't care."

*** significant at the α 0.01 level (2-tailed, t > 2.57).*

The causal key ingredients for the absence of innovativeness in Configurations 2a-b involve operating in a highly stable environment while disregarding external sources for digital innovation and employing centralized decision making, as well as high functional specialization within the digital IM unit (i.e., the absence of self-containment). The effect is reinforced in both configurations by not establishing cross-functional relationships between the digital IM and other units. Furthermore, Configuration 2b applies to firms with any type of strategic orientation; it combines the core conditions with the absence of innovation slack and not using IS to support the collection and utilization of innovation-related information. However, for a digital IM in firms with a particularly pronounced passive strategic stance (2a), these conditions do not matter for achieving low digital business model innovativeness. This suggests that defensive firms facing stability have higher probabilities of failing at digital business model innovativeness than firms with a more proactive orientation in the same environment.

The two configurations in Solution 3—mostly irrespective of the turbulence—indicate that for firms that do not aggressively pursue markets, the absence of slack resources and the presence of external lateral relations represent the core conditions for ineffective digital IM. Both digital IM configurations in Solution 3 combine a more centralized local decision-making authority and a systematic division of labor (i.e., absence of self-containment) with exchanges between digital IM and other business units as complementary conditions (i.e., presence of internal lateral relations). The presence of strong external knowledge sources and intrafirm collaboration within the ineffective digital IM Solution 3 contradicts previous research which has indicated positive innovation benefits from using these sources (Chesbrough, 2003, p. 63; van de Vrande et al., 2009, p. 428). This demonstrates that these digital IM configurations not only suffer from a lack of resources for exploration and potentially a strategic unwillingness to transfer digital innovations into business operations but also further from an over-reliance on external knowledge sources. This may result in the inability to drive digital core competencies alone, a high risk of vendor lock-ins, and the not invented here syndrome (Parida, Westerberg, & Frishammar, 2012, p. 295). The effect may be aggravated by the variety of different backgrounds and perspectives through the interorganizational and cross-functional integration that in this case may result in less efficient decision making, increased overheads, and conflict over resources required to innovate (Troy, Hirunyawipada, & Paswan, 2008, p. 133). Furthermore, Solution 3 indicates a trade-off between increasing degrees of turbulence and the use of IS for firms with such a strategic orientation. Specifically, Configuration 3a indicates that in fairly stable environments, the use of IS contributes to the absence of digital business model innovativeness. By contrast, Configuration 3b shows the opposite pattern: In the face of modest turbulence, the absence of dedicated IS for digital innovation activities contributes to the absence of the outcome. This suggests that spending efforts on systems such as for coordinating and communicating digital innovation activities in the absence of a complex and dynamic environment is counterproductive for digital innovation activities. The reason is that since these tools are costly and ineffective when facing information that are not characterized by uncertainty and ambiguity. The finding provides support to previous research, which noted the innovative use of IS for sensing and assimilating opportunities to be of little help when merely facing routine problems (Roberts et al., 2016, p. 50). Although the neutral permutations of Solution 3 are highly consistent, the coverage scores indicate that these configurations only cover a moderate proportion of outcome cases and thus may be far less common in practice.

When these findings are taken together, both the resource scarcity for digital innovation activities and a firm's strategic focus on existing products and services as well as on a stable environment appear to be core and/or complementary conditions across all configurations, which then leads to the absence of digital business model innovativeness. We did not find digital IM configurations resulting in the absence of innovativeness in firms that have an aggressive strategy or firms that operate in highly turbulent environments. However, we noted two exceptions; we identified one digital IM configuration (3b) that results in the absence of innovativeness when turbulence is moderately pronounced, and one other configuration (2b) also applies to more prospector-oriented firms yet situated in highly stable environments. This highlights that particularly exploitative-oriented organizations operating in stable environments face only little information processing needs and thus see only few reasons to apply dedicated design strategies to expand the information processing capabilities of their digital IM. Consequently, this results in the absence of digital business model innovation. By contrast, the use of IS for innovation and the reliance on internal lateral relations are only complementary for not achieving innovativeness. This indicates that the non-application of these two design strategies does not have a major impact on a low information processing capacity, and thus they do not significantly affect digital innovation failure. The overall solution scores indicate that the presented configurations consistently (0.89) account for 63% of membership in the set of firms not exhibiting digital business model innovativeness. Statistically significant ($p < .01$) correlations between memberships in the ineffective solutions and digital business model innovativeness range from −.16 to −.52, where Configuration 1a exhibits the strongest correlation. Correlations of Configurations 3a and 3b were insignificant.

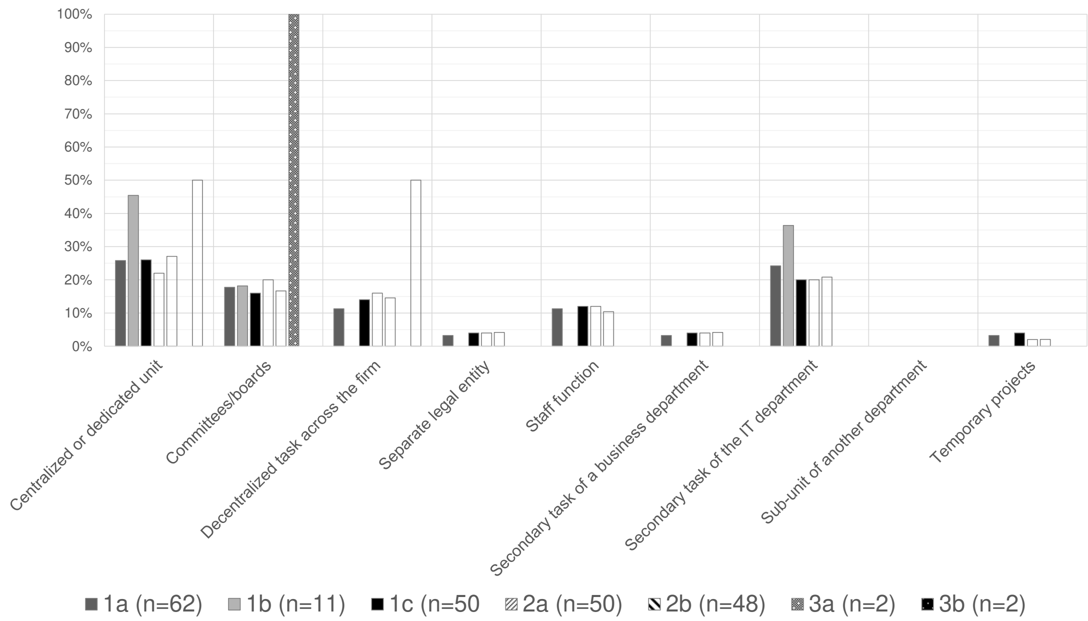

Figure II-11. Mapping of configurational paths for *ineffective* digital IM to basic meso-level structures.

As with the case of effective solutions, Figure II-11 shows that the centralized unit is the most frequent basic structure used by ineffective digital IM configurations. However, the dominance of the centralized approach is far less clear than in Figure II-10, since only 28% of the identified configurations on the average build on a dedicated unit, whereas effective configurations were 64% and the sample average is at 44%. Similar to the effective configurations, delegating the digital IM task to the IT department is also a common approach and even more frequently seen across ineffective configurations. In contrast to effective configurations, we see that committees, staff organizations, and decentralization play more important roles in digital IM ineffectiveness. We also found a small portion of ineffective configurations building on dedicated legal entities for digital IM, yet no ineffective configuration that is embedded as a sub-unit in another department (e.g., a digital task force).

6.2.3.3 Comparison of Results and Evaluation of Configurational Hypotheses

Comparing results in Table II-21 and Table II-22 offers further insights into the complex nature of digital IM. The results indicate that the presence or absence of digital business model innovativeness is largely irrespective of the implementation of internal lateral relations, since this design strategy only appears as a peripheral condition across configurations and does not even exert any causal effect in some variants. This is contrary to previous research on the role of collaborative, synchronized processes and cross-functional integration as a foundation for effective internal information flows (Flynn et al., 2010, p. 62; Galbraith, 1973, p. 19).

The results also confirm the findings from our contrarian case analysis in section 6.2.1, in that causal effects are to some extent symmetric. For instance, Configurations 2a and 2b in Table II-22 represent the exact causal negation of Configurations 2a and 2b in Table II-21. While this suggests causal symmetry for Solution 2 in both tables, it further indicates that digital innovation success (failure) for firms with a more defensive strategic orientation in highly turbulent (stable) environments only peripherally depends on digital IM's use of IS, slack resources, and internal lateral relations. Furthermore, comparing low performing Configurations 1a-c from Table II-22 with the high performing Configurations 1a-c in Table II-21 indicates certain similarities in that both share slack resources and strategic posture as core conditions. Nevertheless, we see substantial indicators of causal complexity at hand. In particular, a stable environment represents a core condition for Configurations 1a-c (Table II-22) for not exhibiting digital business model innovativeness, whereas the environment only plays a peripheral or no role in Configurations 1a-c (Table II-21) for exhibiting high digital business model innovativeness. Contrary to their high performing counterparts, either the use or non-use of IS for digital innovation activities only plays a minor role for Configurations 1a-c in Table II-22.

The results also confirm the findings from our necessity analysis in section 6.2.2, since no condition is present or absent across all configurations. However, either strategic posture, turbulence, or both occur as core conditions across all configurations. This supports the finding of the necessity analysis that these contingencies serve as almost "substitutable necessary conditions" (Ragin, 2006, p. 299) or close to functional equivalents for the presence or absence of digital business model innovativeness (STRAT+TURB and ~STRAT+~TURB, respectively). In terms of high performance, this indicates that firms either need to have the proactive exploration of new opportunities ingrained into their strategic core, or they are otherwise pressured by the environment to resolve the information processing needs and are thus to some extent forced to adapt to changing external requirements (Daft & Lengel, 1986, p. 556; Miller & Friesen, 1982, p. 6). A stable environment particularly seems to be a highly relevant condition for not exhibiting digital business model innovativeness.

When these findings are taken together, our first configurational hypothesis (H1) is supported, since there is no universal digital IM solution that yields high innovativeness under any turbulence situation. Indeed, varying degrees of turbulence that put forward different degrees of uncertainty and equivocality—and thus varying information processing needs (Daft & Lengel, 1986, pp. 556–557)—are part of the solution tables. Throughout the analysis, different patterns of digital IM design strategies were identified that fit a specific environmental context. Therefore, the identification of multiple equally effective digital IM configurations demonstrated the presence of first-order and second-order equifinality, which provides support for our second hypothesis (H2). Results further showed that the effectiveness of the OD for digital IM depends on a firm's strategic posture, and that no single configuration proves effective across all strategic orientations. Nevertheless, most of the identified effective configurations work best for a digital IM situated in firms with an aggressive strategic stance. While this implies that most of the identified digital IM configurations are not suitable for other strategic orientations, however, we also found a configuration (2b) that would work well in more defensive firms. Hence, the results thus support our third configurational hypothesis (H3), in that the effectiveness of a design strategy configuration depends on a firm's strategic posture. Since the institutional and environmental contingencies proved to jointly represent crucial variables that needs to be considered during design choices for digital IM (hypotheses H1 and H3), we see strong support for the configurational *strategy-structure-environment fit* perspective (Priem, 1994, p. 430; Volberda et al., 2012, p. 1051) for achieving digital business model innovativeness. Finally, the results provided evidence for causal asymmetry. In contrast to statements from previous research (Galbraith, 1973, p. 19; Goodhue et al., 1992, p. 298), results show that design strategies do not necessarily support each other synergistically. Supporting our fourth hypothesis (H4), individual design strategies may either contribute to the presence or absence of digital business innovativeness; this depends on both their combination with other strategies as well as the pattern of internal and external contingencies. To this end, the configurational analysis revealed the trade-off, substitution, and complementarity effects among the different design strategies; these typically "remain in a black box in the more standard statistical approaches" (Fiss, 2011, p. 407). These conclusions apply to all five digital IM design strategies under investigation. This highlights that the conjunction of digital IM design strategies and not their independent effects constitute consistent paths or *causal recipes* to digital business model innovativeness. To this end, the findings underscore the ability of fsQCA to unravel the complex internal relationships between design strategies and their sufficiency within digital IM configurations; such effects would remain hidden in standard statistical analyses.

6.2.4 Assessing Robustness of Results

Table II-23 summarizes the findings from our robustness checks, while the detailed analyses may be found in Appendix II-G. As explained in section 5.5.3, we originally used the 10th, 50th (i.e., the median), and 90th percentiles as thresholds during calibration. In our robustness tests, we changed the threshold levels for inclusion/exclusion in the set by using two alternative calibrations. We then tested the results of the sufficiency analysis against our original calibration. We did not change the threshold for the crossover point, since the original one seemed most reasonable to us, and a change would lead to cases shifting from one to another row in the truth table. Alternative 1 considered the thresholds for non-membership and full membership to be further away from the median (5th and 95th percentiles, respectively), while Alternative 2 kept those thresholds closer to the median (15th and 85th percentiles, respectively). All resulting configurations appear across both alternative calibrations, with coverage and consistency scores close to the original results. In both alternative calibrations, self-containment is no longer a relevant condition in Configuration 2b. Both alternatives yielded three new prime implicants that resemble variants of Configuration 3, yet with rather low unique coverage scores (< .01). Since those new configurations only cover very few of the observed data and thus represent “rare birds” (Woodside, 2016a, p. 69), these configurations only have limited predictive power for digital business model innovativeness in practice. We therefore do not regard these new configurations as legitimate additions to our original results. In short, the overall solution coverage and consistency scores across alternatives were close to the results based on the original calibration.

Table II-23. Overview of robustness tests (configurations for achieving digital business model innovativeness).

Changes applied	Changes compared to original results	Overall coverage	Overall consistency
Original results based on: 10th, 50th, 90th percentiles used for calibration; two cases as frequency threshold (218 or 87% out of 251 cases retained); minimum raw consistency threshold: 0.92; minimum PRI consistency threshold: 0.65		0.67	0.90
Calibration			
Alternative 1: 5th, 50th, 95th percentiles	Self-containment is no longer a relevant condition in Configuration 2b Three new variants of Configuration 3 appear: ~ELR*~ILR*~IS*SCT*SLR*STRAT*~TURB ~ELR*~ILR*~IS*~SCT*SLR*STRAT*TURB ~ELR*~ILR*IS*SCT*~SLR*STRAT*~TURB	0.73	0.92
Alternative 2: 15th, 50th, 85th percentiles	Same results as for Alternative 1	0.67	0.88
Minimum frequency thresholds			
3 cases (180 or 71% out of 251 cases retained)	Configuration 3 no longer appears	0.65	0.90
4 cases (156 or 62% out of 251 cases retained)	TURB added as condition in Configuration 1a ~TURB added as condition in Configuration 1c ~SLR added as condition in Configuration 2a Term "~ILR*~IS*SCT*~SLR" negated in Configuration 3 Configurations 1b and 2b no longer appear	0.56	0.92
Minimum consistency thresholds			
Raw: 0.94 / PRI: 0.75	~ILR added as condition in Configuration 1a ~ELR added as condition in Configuration 1c IS added as condition in Configuration 2a Configurations 1b and 3 no longer appear	0.55	0.94
Raw: 0.91 / PRI: 0.50	Turbulence is no longer a relevant condition in Configuration 2b A new form of Configuration 2b in which SCT is not a relevant condition appears in addition to Configuration 2b Four new variants of Configuration 3 appear: ~ELR*~ILR*~IS*SCT*SLR*STRAT*~TURB ~ELR*~ILR*~IS*~SCT*SLR*STRAT*TURB ~ELR*~ILR*IS*SCT*~SLR*STRAT*~TURB ~ELR*ILR*IS*~SCT*~SLR*~STRAT*TURB	0.72	0.88
TURB = Turbulence; SLR = Slack resources; SCT = Self-containment; ILR = Internal lateral relations; ELR = External lateral relations; IS = Information systems; STRAT = Strategic posture ~ = Negation (i.e. absence of condition) * = logical *AND*			

Regarding minimum frequency, we subsequently applied more stricter thresholds. We did not apply lower thresholds than our original value of two cases, since a threshold of one observation would seem unreasonably small and would no longer comply with common guidelines (Ragin, 2009, p. 107). We first applied a threshold of three instead of two best-fitting cases, which still retaining a reasonable number of observations (180 out of 251 observed cases, or 71%; original was 218 out of 251 observed cases, or 87%). Configuration 3 no longer results from the Boolean minimization procedure while the other configurations remain unchanged. We then applied an even more strict frequency threshold of four cases per truth table row. In total, this resulted in retaining 156 of total cases (or 62%). This yielded slightly modified Configurations 1a, 1c, 2a, while Configurations 1b and 2b are no longer part of the results. Configuration 3 was more substantially changed by negating parts of the solution term. Since our original minimum frequency threshold of two cases retained more than the recommended minimum value of 80% of empirical observations (Ragin, 2009, p. 107) and displays higher overall coverage consistency scores, we deem this threshold as the most appropriate choice.

We performed separate analyses with adjusted minimum raw and PRI consistency thresholds guided by examining gaps in consistencies in the truth table rows. We experimented with thresholds that were stricter and lower compared to our original choice. Here, to not violate any methodological standards, we paid caution to certain lower bounds for inspecting consistency gaps in the truth table. Since our truth table rows displayed rather high raw consistency scores, the tests were primarily guided by the PRI consistency scores. For our first test, we chose a stricter alternative PRI consistency threshold of .75 (raw consistency at .94) compared to our original PRI consistency threshold of .65 (raw consistency at .92). Resulting configurations were similar to our original solutions. Single conditions were added to Configurations 1a, 1c, and 2a, while Configurations 1b and 3 no longer appeared. For the second test, we selected a lower PRI consistency threshold of .5 (raw consistency at .91). A PRI consistency value of .5 is generally considered to be the lowest acceptable threshold, since truth table rows below this value indicate significant inconsistency (Greckhamer et al., 2018, p. 8). Here, turbulence was no longer a relevant condition in Configuration 2b, and an additional variant of Configuration 2b appeared in which self-containment was not considered relevant. Furthermore, the test yielded four new variants of Configuration 3.

Taken together, three original configurations (i.e., 1a, 1c, 2a) remained widely unchanged throughout all six tests and thus proved most robust. Configuration 1b no longer appeared in two tests but appeared without changes in the others. Configuration 2b did not change in two tests but was changed or accompanied by new similar configurations in three tests and no longer appeared in one test. Configuration 3 was unchanged in three tests but was accompanied by similar new configurations in three tests. It was changed in one experiment and was no longer present in two tests. We conclude that our original calibration and frequency threshold choices are well positioned on a *middle ground*, and that solutions 1a, 1c, and 2a represent robust configurations for achieving high digital business model innovativeness. While Configurations 1b and 2b also still represent quite robust configurations, Configuration 3 may have more fine-nuanced manifestations in practice that has yet need to be examined more in detail.

6.2.5 Predictive Validity

As described in section 5.5.7, we randomly split the data into two equally-sized subsamples and then computed the configurations for each subsample. As recommended when assessing fsQCA results' predictive validity (Ali et al., 2016, p. 5322; Woodside, 2013, p. 468), we calculated the complex term as most conservative solution from both split-samples, since the complex term considers only the empirical evidence at hand without incorporating empty truth table rows and represents a subset of all the other solution terms (Schneider & Wagemann, 2012, p. 162). The complex solutions contained multiple prime implicants (i.e., models or configurations). All prime implicants from the first subsample (i.e., modeling sample) then were tested against the second subsample (i.e., holdout sample) by comparing consistency and coverage scores. Successively, the roles of the subsamples were reversed and again compared. Here, we computed each prime implicant that was yielded from the analysis of the modeling sample using the holdout sample and the fsQCA software, namely with the *fuzzyand(x,...)* function (Pappas et al., 2017, p. 10). We performed predictive tests for all complex prime implicants from the modeling sample and vice versa. The configurations generated from the modeling sample should yield high raw consistency and similar coverage scores for predicting the outcome in the holdout sample. Table II-24 indicates that the configurations are consistent indicators for the presence of digital business model innovativeness across both subsamples. Results showed that consistency and coverage of solutions are consistent across both samples, and that the first (second) subsample has good predictive abilities for the second (first) subsample. The table further points out the terms that are present in the original solution (in bold); some of these have a subset relationship with the original configurations presented in section 6.2.3 since they add single conditions to the causal term.

Furthermore, we performed an XY-plot of the modeled variables against the outcome variable of the holdout sample in order to assess whether the model (i.e., prime implicant) is a sufficient antecedent (i.e. subset; model membership score ≤ outcome membership score) of the outcome in both split-samples (Schneider & Wagemann, 2012, pp. 57, 128). As an example for consistency across subsample, Figure II-12 demonstrates how the third prime implicant resulting from the first subsample is causally relevant in predicting digital business model innovativeness in the second subsample, since most cases fall above the diagonal line of the .5 value, and indicating high consistency (.93) and high coverage (.43) scores as sufficient solution. In conclusion, while the coverage and consistency scores of the ideal type configurations in section 6.2.3 indicated good fit validity, these results also provide good support for predictive validity (Woodside, 2016a, p. 62).

Table II-24. Results of predictive validity tests: complex solutions for the presence of digital business model innovativeness.

Complex solutions and prime implicants	Modeling sample			Holdout sample	
	Raw COV	**Unique COV**	**CON**	**Raw COV**	**CON**
Subsample 1 as modeling sample, Subsample 2 as holdout sample					
01. **ILR*IS*SCT*SLR*STRAT***~TURB	0.248	0.016	0.883	0.234	0.945
02. **ILR*IS*SLR*STRAT*TURB***~SCT	0.260	0.014	0.906	0.212	0.945
03. **ELR*IS*SCT*SLR*STRAT***TURB	0.512	0.234	0.932	0.443	0.961
04. ~ELR*~ILR*~IS*SCT*SLR*STRAT*~TURB	0.205	0.025	0.931	0.151	0.933
05. ELR*ILR*~IS*~SCT*~SLR*STRAT*TURB	0.197	0.019	0.912	0.177	0.855
Overall solution consistency	0.895				
Overall solution coverage	0.623				
Subsample 2 as modeling sample, Subsample 1 as holdout sample					
06. **ILR*IS*SCT*SLR*STRAT***~ELR	0.208	0.005	0.975	0.264	0.941
07. ELR*ILR*IS*SLR*~STRAT*TURB	0.219	0.012	0.940	0.249	0.918
08. **ILR*IS*SLR*STRAT*TURB***~ELR	0.210	0.008	0.946	0.268	0.942
09. **ELR*ILR*IS*SCT*STRAT*TURB**	0.468	0.032	0.968	0.491	0.929
10**. ELR*ILR*SCT *STRAT*TURB***SLR	0.468	0.035	0.944	0.514	0.922
11. ~ELR*ILR*IS*SCT*~SLR*~STRAT*~TURB	0.148	0.005	0.877	0.166	0.910
12. **~ELR*~ILR*~IS*SCT*~SLR*STRAT*TURB**	0.158	0.021	0.926	0.171	0.951
13. ~ILR***ELR*IS*SCT*SLR*STRAT***~TURB	0.194	0.017	0.963	0.211	0.927
Overall solution consistency	0.908				
Overall solution coverage	0.627				

COV = coverage; CON = Consistency; TURB = Turbulence; SLR = Slack resources; SCT = Self-containment; ILR = Internal lateral relations; ELR = External lateral relations; IS = Information systems; STRAT = Strategic posture; INV = Digital business model innovativeness; OP = Organizational performance

~ = Negation (i.e. absence of condition); * = logical "and"; Terms that appear in the original results printed in bold

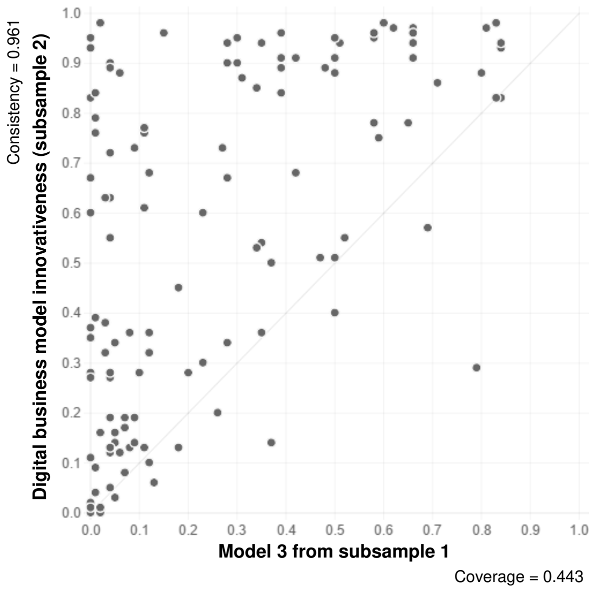

Figure II-12. Test of model 3 (i.e., prime implicant 3) from subsample 1 using data from subsample 2.

6.3 Analysis of Direct Effects, Nomological Validity, and Utility

After having identified ideal types of effective and ineffective digital IM, we firstly examined the hypothesized direct relationship between digital business model innovativeness and organizational performance (*H5*). Secondly, we performed the MANOVA to compare the relationship between the identified digital IM configurations and organizational performance to evaluate their nomological validity and utility.

6.3.1 Effect of Digital Business Model Innovativeness on Performance

Table II-25 shows the assessment results of the nomological network presented in section 4.3. The findings from the PLS-SEM analysis indicate that the model explains almost 50% (R^2 = .49) of the variance of the organizational performance construct, which supports the model's satisfactory in-sample predictive validity (Sarstedt, Ringle, Henseler, & Hair, 2014, p. 156) and aligns well with previous innovation and performance research (e.g. Camisón & Villar-López, 2014, p. 2897). The blindfolding procedure with an omission distance of 7 resulted in a Q^2 value well above zero (.32), which provides support for out-of-sample predictive power (Hair et al., 2016, p. 202). The q^2 value of .42 further substantiates the large predictive relevance of digital business model innovativeness for organizational performance (Hair et al., 2016, p. 209). As expected, the respective values of the digital business model innovativeness construct were considerably smaller, since we only included two control variables and no other antecedents (e.g., design strategies) in the model. An analysis of the standardized root mean square residual (SRMR) yielded a value of .05, which is well below the traditional threshold of .08 (Hu & Bentler, 1999, p. 27), thus suggesting an overall good fit of the path model.

Table II-25. Path coefficients, significance levels, and effect sizes.

Structural path	β	*t*-value	95% BCa	f²
(H5) Digital business model innovativeness → Organizational performance	0.688	13.741**	(0.574, 0.773)	0.914**
(c_1) Unit age → Digital business model innovativeness	0.075	1.030	(−0.059, 0.220)	0.006
(c_2) IT firm → Digital business model innovativeness	0.132	2.665**	(0.024, 0.220)	0.018
(c_3) Firm age → Organizational performance	−0.087	2.007*	(−0.171, −0.002)	0.015
(c_4) Firm size → Organizational performance	0.012	0.259	(−0.076, 0.101)	0.000

Standardized root mean square residual (SRMR) composite model = 0.052
$R^2_{OP} = 0.494$** / $Q^2_{OP} = 0.317$ / $q^2_{OP} = 0.423$
$R^2_{INV} = 0.024$ / $Q^2_{INV} = 0.013$

** Significant at the α 0.01 level (2-tailed, t > 2.57).
* Significant at the α 0.05 level (2-tailed, t > 1.96).
BCa = Bias-corrected and accelerated bootstrap confidence interval

The path coefficient estimate for the relationship between digital business model innovativeness and organizational performance was positive and significant (β = .69; p < .01). This supports our direct effect hypothesis (H5), and it indicates that organizational performance increases along growth in innovativeness. The corresponding f^2 value of .91 indicates that digital business model innovativeness has a large effect on the level of explained variance in organizational performance (Hair et al., 2016, p. 201). This result aligns with earlier research, which has suggested that innovativeness and organizational performance should be strong and significantly related (Ali et al., 2016, p. 5321; Camisón & Villar-López, 2014, p. 2897; Hernández-Perlines et al., 2016, p. 5385). This further provides support for nomological validity of the formative measure at the second-order construct level, since digital business model innovativeness proved to carry the intended meaning in line with theoretical expectations (Ringle et al., 2009, p. 301). Consistent with earlier research that postulates innovation advantages for firms situated in "fast-clockspeed contexts" (Mendelson & Pillai, 1998, p. 431), results confirm (β = .13; p < .01) that organizations with their primary industry of operation located in the IT domain perform better at digital business model innovation (c_2). Data analysis also indicates a significant and negative yet minor relationship (β = −.09; p < .05) between firm age and organizational performance (c_3). While this contradicts some research that sees performance advantages for older firms (e.g. Chen et al., 2014, p. 336), it lends credence to other findings that have indicated the overall performance deteriorating with firm age (e.g. Coad, Segarra, & Teruel, 2013, p. 180). The 95% bias-corrected and accelerated confidence intervals (BCa) also indicate significant path weights, since confidence intervals of respective paths do not contain zero. Counter to prior research (Jansen et al., 2006, p. 1667; Lubatkin et al., 2006,

p. 664), the relationships between unit age and innovativeness (c_1) as well as between firm size and overall performance (c_4) were insignificant.

6.3.2 Effect of Digital IM Design Configurations on Performance

Subsequently, to evaluate the nomological validity and utility of our fsQCA results, we assessed whether firms that specifically employ one of the effective (ineffective) digital IM configurations perform better (worse) at organizational performance using the MANOVA procedure. This required us to group observations according to the six configurations for effective digital IM and the seven configurations for ineffective digital IM as identified in section 6.2.3. The case was coded with a value of 1 if it exhibited at least one membership in the ineffective digital IM sets, and it was given a value of 2 if it exhibited at least one membership in the effective digital IM sets. A case was considered *more in than out* a configurational set if it displayed a set membership score of above .5 (Ragin, 2008, p. 30). Cases with no *more in* membership scores (i.e., $\leq .5$) for any of the configurations were coded as 0. No case was assigned to more than one group. Next, we tested for the assumptions required to carry out the MANOVA (Hair, Black, et al., 2014, p. 684). Details of the assumption tests and detailed MANOVA results may be found in Appendix II-H. Table II-26 shows that our sample fulfils the requirement of having at least two cases per group, based on the analysis of two dependent variables. The dependent variables were significantly correlated with each other, and there was no multicollinearity ($r = .70$, $p < .01$) (Hair, Black, et al., 2014, p. 196). There was an overall approximate linear relationship between organizational performance and digital business model innovativeness across all three groups, as assessed by scatterplot. While these results indicated that our sample complies to some assumptions, it violated others. The residuals of organizational performance and innovativeness were not normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$) and by visual inspection of normal Q-Q plots. There were several univariate outliers in the data, as assessed by inspection of a boxplot. Furthermore, the presence of multivariate outliers was assessed by comparing Mahalanobis distance values against a chi-square (χ^2) distribution with two degrees of freedom and an alpha level of $p < .01$ (Agresti, 2002, p. 654; Hair, Black, et al., 2014, p. 64). Three out of 251 cases exceeded the threshold value of 13.82 and thus were identified as multivariate outliers. There was no homogeneity of variances, as assessed by Levene's test of homogeneity of variance ($p > .05$); there were also no homogeneity of variance-covariances matrices, as assessed by Box's test of equality of covariance matrices ($p = .00$).

Table II-26. One-way multivariate analysis of variance (MANOVA): between-subjects factors.

Group / Factor	Number of cases
0: No membership in any digital IM configuration	77
1: Membership in configurations for ineffective digital IM	78
2: Membership in configurations for effective digital IM	96

Since the original data did not meet all the assumptions that are required to generate valid results from the MANOVA procedure, we took measures to address the issues and performed the analyses simultaneously on adjusted data. Research has indicated that analyses of variance are highly sensitive to outliers (Scariano & Davenport, 1987, p. 128). Hence, we winsorized the sample by setting the values of the smallest and largest 10% of the transformed observations equal to the values next to these bounds (Wilcox, 2003, p. 64). As a result, six remaining outliers in the effective configurations group were removed from the subsequent analyses. The dependent variables again exhibited a significant correlation close to the original value, thus indicating that multicollinearity is not an issue in the adjusted data as well. The adjusted sample neither exhibited univariate nor multivariate outliers across all factors and dependent variables, but the Shapiro-Wilk test still indicated non-normality. Literature has indicated that MANOVA tests are quite robust to violations of normality (Blanca, Alarcón, Arnau, Bono, & Bendayan, 2017, p. 554; Johnson & Wichern, 2018, p. 312). Since the adjusted data fulfilled major assumptions, we decided to re-run the analysis. The MANOVA, the follow-up ANOVAs, and the post hoc analysis on the adjusted data resulted in essentially the same results compared to the analysis on the original data; all results were statistically significant at $p < .01$. We therefore conclude that the assumption violations of the original data do not materially affect the results and their interpretation (Hair, Black, et al., 2014, p. 68). Hence, we report the findings from the original data as follows, but we employed Pillai's Trace instead of Wilks' Lambda for our subsequent analyses as suggested by literature when violating assumptions (Hair, Black, et al., 2014, p. 69).

In line with our findings from the set-theoretic analysis in section 6.2.3, the results show that the firms which have at least a *more in than out* fuzzy membership in one of the six configurations for effective digital IM exhibited higher digital business model innovativeness (M = 6.36, SD = 0.51) than the firms with membership in the seven ineffective configurations for digital IM (M = 5.05, SD = 1.05) or the firms with no membership in any of the identified configurational sets (M = 5.85, SD = 0.79).[15] Additionally, the firms with a membership in one of the identified configurations effective digital IM exhibited higher organizational performance (M = 6.29, SD = 0.54) than those that are member of the ineffective group (M = 4.71,

[15] Data are expressed as mean (M) and standard deviation (SD).

SD = 1.06) and those who are not member in any of the identified configurations (M = 5.54, SD = 0.79). Figure II-13 shows the differences across all three configurational groups.

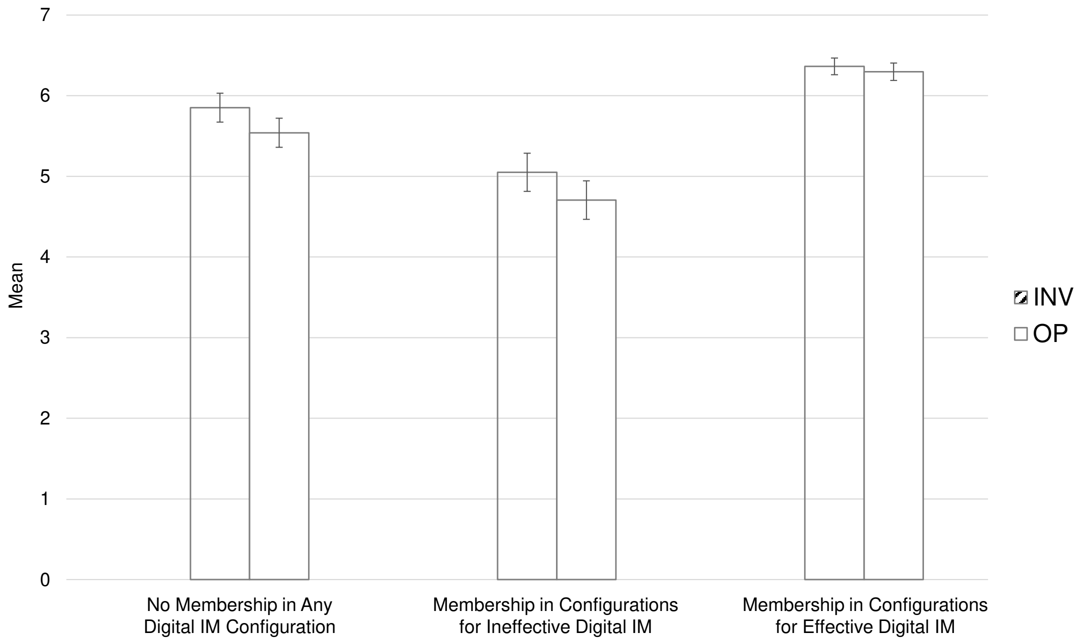

Figure II-13. Mean values and 95% confidence intervals across configurational groups for digital business model innovativeness (INV) and organizational performance (OP).

There was a statistically significant difference between the configurational groups on the combined dependent variables, $F(4, 496) = 34.60$, $p < .01$; Pillai's Trace = .44; partial $\eta^2 = .22$. Follow-up univariate one-way ANOVAs showed that both digital business model innovativeness of $F(2, 248) = 58.61$, $p < .01$; partial $\eta^2 = .32$, and organizational performance of $F(2, 248) = 83.66$, $p < .01$; partial $\eta^2 = .40$ were statistically significantly different between firms from the configurational groups, using a Bonferroni adjusted α level of .025.

For *digital business model innovativeness*, a Games-Howell post hoc analysis confirmed that firms with membership in the configurations for effective digital IM had statistically significantly higher mean scores than firms from either the group of firms with non-membership (0.51, 95% CI[0.27, 0.76], $p < .01$) or the group with membership in one of the ineffective configurations (1.31, 95% CI[1.00, 1.62], $p < .01$). The mean increase from firms with membership in the ineffective configurations to firms with no membership in one of the identified configurations (0.80, 95% CI[0.45, 1.16]) was statistically significant ($p < .01$). Thus, these results further corroborate our findings from our configurational analyses in section 6.2.3. For *organizational performance*, our post hoc analysis showed that the mean increase from firms with membership in one of the ineffective configurations to the group of firms with non-membership in any of the identified configurations (0.83, 95% CI[0.48, 1.19]) was statistically significant ($p < .01$), as well as the increase from firms with no configurational memberships to firms with membership in effective digital IM configurations (0.76, 95% CI[0.51, 1.01], p <

.01). The test further confirmed that the statistically significant ($p < .01$) and substantial mean increases in organizational performance from the group of firms with membership in ineffective digital IM configurations to firms with membership in effective digital IM configurations (1.59, 95% CI[1.28, 1.91]). Overall, both the results from the PLS-SEM analysis as well as from the MANOVA provide strong support for our fifth hypotheses (*H5*), in that our effective configurations not only yield higher innovativeness, but are also related to higher organizational performance.

7 Discussion

7.1 Configurational Propositions for Digital Innovation Management

To discuss and theoretically integrate our results, we derived a contingency framework for digital IM that provides propositions on how to design effective digital IM in various situations and may guide future research. Grounded in extant research, the following discussion provides first cues on the interplay and mechanisms among the variables which fsQCA is not able to provide (De Meur et al., 2009, p. 160). During the development of the research model (see section 4.3), we argued for the configurational *strategy-structure-environment fit* (Priem, 1994, p. 430; Volberda et al., 2012, p. 1051) to represent the key in achieving high digital business model innovativeness, and our results provided strong support for this assumption. Hence, as shown in Table II-27, we included the institutional context (i.e., strategic posture, see section 4.2.4) and the information processing needs (i.e., turbulence, see section 4.2.2) as primary contingencies that may guide organizations in the design of effective structures for their digital IM.

The first contingency is the strategic posture, and it differentiates between how firms enact their environments. Defenders typically see only a few needs to adjust their business models; they tend to focus on exploitation of existing capabilities and aim to become experts in their current area of operations and improving existing business models. By contrast, prospectors continuously aim to explore new opportunities outside of their traditional domains, and they embrace environmental trends by proactively pursuing product innovation and more fundamental reconfigurations of their business models (Miles & Snow, 1978, p. 29). Although Miles and Snow (1978, p. 29) defined two more strategic types—namely analyzers and reactors—we did not include them in our contingency framework. The reason is that prospector and defender types are most well sketched out theoretically by scholars, and they are commonly used as the two *strategic extremes* in business research (Meier, O'Toole, Boyne, Walker, & Andrews, 2010, p. 165). Analyzers and reactors may be regarded as positioned in between the defender and prospector types.

The second included contingency is the information processing needs as proxied by the turbulence prevailing in the digital innovation environment. High turbulence is characterized by (a) heterogeneous technologies, products, and customers' needs; (b) fast and unpredictable change; and (c) scarcity of resources and high degrees of competition (Shortell, 1977, p. 276). This turbulence specifically results from prevailing generativity, convergence, and the exponential rates of development (Yoo, Lyytinen, Boland, et al., 2010, pp. 13–14) that puts pressure on the digital IM unit. Consequently, this culminates in fast shifts in technologies and customer preferences, increasing complexity and uncertainty, as well as increasing market competition due to both a high number of new entrants and the competition around the resources and capabilities that are required to carry out digital innovation.

The question arises as to which meso-level structure represent the appropriate plenum for hosting the presented configurations (Burton & Obel, 2004, p. 46). Since the vast majority (> 60%) of investigated cases that match one of the identified effective configurations employed a centralized or dedicated unit for their digital IM, the propositions most likely apply to this type of structure. It is worth noting that a centralized approach to IM may take several forms in practice. For example, it may be anchored on par with other areas of top management (e.g., sales, finance, operations) or as a part of a functional area (e.g., within the R&D division) (Gaubinger et al., 2015, p. 239). Our propositions are certainly not appropriate for situations in which the digital IM is delegated to a separate legal entity, nor are they carried out in temporary projects, since none or only few of the innovative cases under investigation applied these structures. Including the insights from the examination of ineffective configurations further suggests that innovation committees or staff functions are most likely not suitable basic structures for carrying out effective digital IM. Since our results are rather ambiguous for firms that aim for a decentralized digital IM or delegating the digital IM task to the IT department, these basic structures need to be considered with caution. Delegating the digital IM task to a business unit and forming specialized sub-units or task forces in existing departments seem to have no major relevance in practice.

The framework parsimoniously summarizes and categorizes the identified configurations from the sufficiency analysis presented in section 6.2.3. *Key design strategies* are the most important digital IM features for which our results suggest a strong causal relationship with digital business model innovativeness; meanwhile, the empirical evidence indicates a weaker causal relationship for *complementary design strategies* (Fiss, 2011, p. 394). The combination of key design strategies represents the significant foundation for effective digital IM for a specific contingency profile and is connected to the complementary design strategies that reinforce the main features. Although the complementary design strategies may eventually not be necessary for achieving digital business model innovativeness, their neglection may result in lower performance compared to the configurations that include the complementary design strategies (Fiss, 2011, p. 398; Ragin & Fiss, 2008, p. 204). Building on our empirical result indicating equifinality and following the gestalt understanding (Gresov & Drazin, 1997, p. 403), the framework contains multiple propositions within the respective combinations of contingencies, inasmuch as backed by extant theory and our empirical evidence. Equifinal alternatives and mandatory combinations are indicated by the terms of logical *or* and logical *and.*

Table II-27. Contingency framework for the OD of effective digital innovation management.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Digital innovation context: information processing needs</td></tr>
<tr><td>Low</td><td>High</td></tr>
<tr><td rowspan="4">Institutional context: strategic posture</td><td rowspan="2">Prospector</td><td>P1</td><td>P3</td></tr>
<tr><td>Key design strategies:
• Slack resources and information systems
Complementary design strategies:
• Self-containment and
• Internal or external lateral relations
Associated configurations[1]: 1a, 1c</td><td>Key design strategies:
• Slack resources and information systems or
• Self-containment and external lateral relations
Complementary design strategies:
• Internal lateral relations
Associated configurations[2]: 1b, 2a</td></tr>
<tr><td rowspan="2">Defender</td><td rowspan="2">No configurations found.</td><td>P2</td></tr>
<tr><td>Key design strategies:
• Self-containment and external lateral relations
Complementary design strategies:
• Slack resources and
• Internal lateral relations and
• Information systems
Associated configuration[1]: 2b</td></tr>
<tr><td colspan="4">1: These digital IM configurations are more versatile in that they are also suited for prospector firms operating in highly turbulent environments.
2: Although Solution 3 also matches this contingency profile, we decided to not include the solution in this framework since it displayed only low empirical coverage scores.</td></tr>
</table>

7.1.1 Design for Digital IM with Low Information Processing Needs in Prospector Firms

Prospector firms with a digital IM that faces low information processing needs from the innovation environment may simultaneously aim to minimize risk while seizing apparent opportunities for digital business model innovation. These firms often have an opportunistic perspective on digital technology, build on prior strengths, and seek to rapidly exploit new opportunities by involving quick yet careful decisions (Hirschheim & Sabherwal, 2001, p. 89).

Our results suggest that the *combination of slack resources and information systems* is the key micro-level design for a digital IM embedded in such firms. Viewing both design strategies separately, this finding provides support to extant research which contends that high-quality IS information is required for designing and testing new products (Cook & Eining, 1993, p. 53; Pavitt, 1990, p. 22), and that excess budgets and resources may spur the generation of new ideas and technologies (Troilo et al., 2014, p. 262). However, our results in combination contradict previous research arguing that IS information best supports innovation performance in situations of constrained budgets, in which innovation managers are more alerted to effective utilization of resources and thus make greater use of IS for their decision processes (Yang, Wang, & Cheng, 2009, p. 530). The combination further contradicts the common focus on IS to support performance efficiency and standardization, with the objective to reduce slack via IS (e.g. Brynjolfsson & Hitt, 2000, p. 28). We also contend that slack most likely not results from the IS use within the identified configuration, since the notion that IS may cause slack resources (i.e., the productivity paradox) due to superimposing technology onto processes was rebutted by earlier research (Dehning, Dow, & Stratopoulos, 2004, p. 60).

While slack may nurture innovation, it is often seen as one primary source of inefficiencies (King & Kraemer, 1984, p. 469). However, planned slack in combination with IS allows tasks to be automated in the workflow "as a means to free up human cognitive resources" (Raman & McClelland, 2019, p. 6), and the surplus cognitive resources may consequently be used more efficiently toward IS-enabled innovation activities. IS may not only foster individual activities such as environmental scanning to acquire external information about digital trends (Belfo & Trigo, 2013, p. 541), but it may further help to coordinate the *overlapping slack* between actors in the digital IM unit and thus bring together complementary capabilities and perspectives (Agrawal, Catalini, Goldfarb, & Luo, 2018, p. 1070). The combination may encourage experimentation with novel digital technologies in form of pilot projects whose success is uncertain (Swanson, 1994, p. 1081), since the digital IM unit has a large source of funding for digital innovation activities and piloting of new technologies available (Yang et al., 2009, p. 534). The combination of IS and amassing internal resources may also grant greater autonomy and control to the digital IM unit (Ang & Cummings, 1997, p. 238), since excess budgets may be spend on explorative initiatives that were substantiated through the insights acquired through the use of IS. Thus, we propose our first proposition (P):

> **P1a.** *For aggressive firms that operate in digital innovation environments with low information processing needs in their digital IM, slack resources and the use of information systems are sufficient key digital IM design strategies to achieve digital business model innovativeness.*

The core OD may be complemented by *combining a self-containment strategy with either internal or external lateral relations*. This underscores the presence of second-order equifinality in our results (Fiss, 2011, p. 407), since organizations may choose among alternative complementary designs for their digital IM core. First, the research suggests that the *combination of self-containment and internal lateral relations* may reduce unresponsiveness and inefficiencies in the intra-organizational communication (i.e., red tape) (Diefenbach & Sillince, 2011,

p. 1520). The combined strategies may bring together key members of the organization in interlocking functional teams that make decisions in a self-directed fashion that are superior to “rigidly divided functional silos” (Baker, 2012, p. 234). Here, non-hierarchical information flows between the digital IM and other business units joined with a combination of local decision-making autonomy and knowledgeable managers within the unit may increase the effectiveness of digital innovation activities. Notably, our finding that internal lateral relations only play a peripheral role for digital business model innovativeness runs counter to prior research on internal collaboration in innovation settings (Flynn et al., 2010, p. 62; Gassmann et al., 2012, p. 122). This may result from what Christensen et al. (2018) note as a “natural-but-ultimately-pathological devotion” (p. 1062) of many organizational members to existing operations, capabilities, customers, and markets that may constrain breakthrough digital innovations within the digital business models.

Second, our results suggest that firms may *substitute internal with external lateral relations within the combination with self-containment*. Literature has argued that combining high levels of unit-level authority with external integration may enhance responsiveness and operational efficiency of the arrangement, and may well foster the involvement of the partner (Sheu, Rebecca Yen, & Chae, 2006, p. 27). Our results concur with the arguments by both Wang et al. (2015, p. 1932), in that we found unit-level decentralization and external collaboration of lower importance in more stable environments (i.e., low information processing needs) and also by Hirschheim and Sabherwal (2001, p. 89) in that firms in stable contexts often pursue a selective sourcing approach. Taken together, we propose the following:

> **P1b.** *The combination of self-containment with either internal or external lateral relations complements the aforementioned digital IM configurations to achieve digital business model innovativeness.*

7.1.2 Design for Digital IM with High Information Processing Needs in Defender Firms

Our results indicate an appropriate digital IM design for defensive firms with less emphasis on exploration, but that has yet need to deal with high information processing needs in their digital IM. Firms in this category typical focus on efficiency gains through process improvements (Hirschheim & Sabherwal, 2001, p. 89). A defender firm aims to address its “entrepreneurial problems” (Miles et al., 1978, p. 550) by the sealing of a niche in its industry by offering high quality digital products and services at a competitive pricing (Hess et al., 2016, p. 128). In doing so, a defender tends to ignore outside trends and strives to achieve continued viability (Miles et al., 1978, p. 551). In case of high information processing needs in the digital IM, a defender may be forced to differentiate its offerings with novel (digital) attributes to address unmet needs (Olson & Slater, 2002, p. 13). A defender's engagement in digital business model innovation that is stipulated by high information processing needs may be viewed as its effort to re-establish stability, either through cautious and incremental adaptions or as a response to sudden market shifts and disruption (Hirschheim & Sabherwal, 2001, p. 94).

Comparing the most effective design for a defender's digital IM facing high information processing needs with the design of the previously described digital IM that faces low information processing needs in prospector firms, the roles of key and complementary design strategies are reversed: Here, the *combination of self-containment and external lateral relations* represent the most effective core OD. This aligns well with previous research which stresses that external innovation partnerships may be more important and effective in turbulent environments (Lichtenthaler, 2009, p. 327; Wang et al., 2015, p. 1934) since they allow firms to achieve a time to market that would otherwise not be possible for such firms (Chesbrough & Crowther, 2006, p. 232). This further supports previous research which has argued that the sourcing of external innovation capabilities is more likely for a defender business strategy (Hirschheim & Sabherwal, 2001, p. 90).

However, examining the result from the analysis of ineffective digital IM configurations substantiates that in this contingency profile, the reliance on external lateral relations *without* pursuing a self-containment strategy in the digital IM unit may combine to low digital business model innovativeness (see Configuration 3b in Table II-22). Extant literature has suggested that IM is more successful if the unit empowered to identify new digital business opportunities is able to join partnerships independently on the basis of the types of innovations that the unit aims to develop (van der Duin & Ortt, 2008, p. 533). An independent unit with adequate skills that does not interfere with the firm's basic routines and that streamlines the inflow of information from external innovation partners is often seen as a prerequisite for successful innovation (Chiaroni, Chiesa, & Frattini, 2011, p. 36). Here, combining both design strategies may foster mutual partnerships that allows for co-innovation on eye level (Arnold, Erner, Möckel, & Schläffer, 2010, p. 51). A well-skilled and independent digital IM unit may be able to judge the impact of external partners on the focal firm's innovation performance and thus may avoid a biased or wrong evaluation of external technologies (Herzog & Leker, 2010, p. 327). In their study on open innovation practices, Chesbrough and Crowther (2006) identified companies with successful internal autonomous units dedicated to external innovation partnerships that are almost "run like a venture capital firm" (p. 234). Chesbrough and Crowther (2006, p. 234) further noted that building successful external innovation partnerships requires *internal innovation champions* that promote and control external information flows related to innovation.

Here, our results concur with previous research which has argued that it is important to defensive firms that the innovation unit autonomously and coherently integrates new products and processes into existing strategies (Burton, Lauridsen, & Obel, 2004, p. 69; Elenkov & Manev, 2005, p. 382). Previous research has confirmed that a focal unit's information capability grounded on the efficient information dissemination and rapid decision making is key to success for technology-based collaborations (Wang et al., 2015, p. 1934). To this end, a less bureaucratic digital IM and multiskilled employees may serve as bedrock for successful innovation partnerships. Here, the unpretentiousness of the digital IM unit may signal a sense of reliability and mutual trust to external partners, spur fast and efficient transfer of tacit knowledge, and may subsequently reduce risk and cost in digital innovation (du Plessis, 2007, p. 24). In sum, our results and the literature suggest that a digital IM unit combining external lateral relations and self-containment may champion digital change and related innovation partnerships, promote risk-taking, match potential partners to digital innovation problems, avoid over- and under-funding of innovation projects involving external actors, create a sense of urgency for the partnerships, mitigate the not invented here syndrome, ensure fit of external initiatives with the digital strategy, and serve as gatekeeper for internal interfaces (Chesbrough & Crowther, 2006, p. 233; Chiaroni et al., 2011, p. 35; Herzog & Leker, 2010, p. 328). Thus, we propose the following:

> **P2a.** *For defensive firms operating in digital innovation environments with high information processing needs in their digital IM, self-containment and external lateral relations are sufficient key digital IM design strategies to achieve digital business model innovativeness*

In contrast to the effective OD for a prospector's digital IM that faces low information processing needs, both slack and the use of IS are only part of the complementary combination for a defender's digital IM design that faces high information processing needs. Although slack is generally acknowledged to represent a good innovation buffer in most situations (Flynn & Flynn, 1999, p. 1024), the finding that slack resources are not a key design strategy for a digital IM in defensive firms supports previous research which has argued that aggressive market behavior may serve as a crucial catalyst to "transform slack into good performance" (Carnes, Xu, Sirmon, & Karadag, 2019, p. 73). According to our empirical results, defender firms need to *add internal lateral relations to the combined use of IS and slack resources* to mitigate this strategic drawback and to achieve maximum information processing utilization in their digital IM. We may assume that internal lateral relations add additional information flows that foster the IS-enabled use of slack resources for digital innovation activities in firms that are generally not inclined toward exploration (Agrawal et al., 2018, p. 1070; Baker, 2012, p. 234). Furthermore, the internal relations to other units—whether formal or informal relations—may act as a means of *organizational control* (Ouchi, 1977, p. 98) to ensure managerial discipline and to avoid improper spending of IS-enabled slack resources for digital innovation projects. This control may be particularly important in defender firms that traditionally face simultaneous demands for innovativeness and efficiency when confronted with high information processing needs (Yang et al., 2009, p. 534). Thus, we propose the following:

> **P2b.** *The combined use of slack resources, internal lateral relations, and information systems complements these digital IM configurations to achieve digital business model innovativeness.*

Since no alternative core and complementary designs for a digital IM with high information processing needs in defensive firms emerged during our analysis, we note the absence of first-order and second-order equifinality. Although the aforementioned OD may enhance the innovativeness of more defensive firms, these organizations may be more vulnerable to business model disruptions since they rest on a more reactive strategy; such a strategy holds the risk of major failure in events that constitute major shocks to established businesses that are primarily geared to exploitation (Kilkki et al., 2018, p. 277). In the case of an extreme and unforeseen shock, mere incremental changes to the core business may be no longer sufficient, and rapid *redomaining* (Arthur, 2009, p. 73) through radical and prompt business model changes may not be accomplishable for most organizations in a timely manner. Nevertheless, the aforementioned OD may equip the digital IM in more defensive firms with the appropriate foresight to timely address increasing information processing needs and thus guide strategic action related to sustained digital innovation.

Notably, our results did not suggest a single effective digital IM configuration that works well for firms with a defender stance and a digital IM operating in stable environments. This finding aligns with previous research which has indicated that defenders mostly engage in innovation when pressurized by turbulence (O'Regan & Ghobadian, 2005, p. 92); the finding also aligns with OIPT which suggests that increasing uncertainty and equivocality represent the origin for building appropriate organizational structures for advanced information processing (Daft & Macintosh, 1981, p. 219; Qu et al., 2011, p. 105). It confirms that a firm in such a specific situation sees little need "to break away from the existing path and create a new digital path" (Henfridsson et al., 2009, p. 4). For breaking out of existing path dependencies, this suggests that these firms either need to thoroughly engage in entrepreneurial and managerial learning to modify the scope of their strategy, or to experience a sudden an sharp increase in their information processing needs (e.g., unforeseen technology-push and market-pull) in order to move from exploitation to exploration (Zhang, Macpherson, & Jones, 2006, p. 312).

7.1.3 Design for Digital IM with High Information Processing Needs in Prospector Firms

Our results suggest effective designs for a digital IM embedded in prospector firms that face high information processing needs. Firms in these situation pursue first-to-market approaches by taking a competitive view on digital technology and focus on flexible business model changes to quickly explore new digital innovation opportunities (Hirschheim & Sabherwal, 2001, p. 89). Our results indicate that the configurational propositions from the previous two sections are more versatile in that they also apply to prospector firms and a digital IM with high information processing needs. Here, either the *combination of slack resources with the use of information systems* or the *combination of self-containment and external lateral relations* constitute the key OD. The former is similar to the digital IM core OD in prospector firms with low information processing needs (P1, see section 7.1.1), whereas the latter is similar to the digital IM core OD in defender firms with high information processing needs (P2, see section 7.1.2). In our work, we found that self-containment is a mandatory key design strategy for prospectors with low information processing needs but only a substitutable design strategy in situations with high information processing needs; notably, this finding runs counter to previous research which has argued that less centralized units are better suited in case of turbulent and complex environments than formalized units (Olson, Slater, & Hult, 2005, p. 49). Here, the variety of perspectives, opinions, and ideas of the digital IM team that need to be considered when applying self-containment may jeopardize rapid decision making in times where quick changes in strategic trajectories are required (Groysberg, Polzer, & Elfenbein, 2010, p. 735).

Compared to prospector firms with a digital IM facing low information processing needs, a prospector's digital IM facing high information processing needs is surprisingly more versatile, since firms may choose among various alternatives to achieve digital business model innovativeness. Although the alternatives represent the two core designs from the two previously described contingency profiles, prospector firms in turbulent environments are nonetheless more efficient in terms of required resources since they only need to *add internal lateral relations* to their core digital IM design to achieve full performance. Prospectors' operating under turbulence often display an effective connection to the internal resource base (i.e., internal lateral relations) which allows for a broader range of possible actions compared to other strategy-environment profiles (Strong, McGuinness, & Morgan, 2003, p. 1417).

Our findings run counter the understanding of *the more the better* or the thought that a higher need for information processing requires the application of more design strategies, and our results demonstrate the multifaceted organizational complexity in the coalignment among different design strategies that fit differently in different contingency situations (Galbraith, 1977, p. 81; Randolph & Dess, 1984, p. 115). Besides this point, based on our results, this contingency profile allows us to apply any of the previously presented configuration to achieve innovativeness. Additionally, by changing only few parts of their digital IM's OD, prospectors may easily adapt to changing information processing requirements, thus altogether making the digital IM most efficient and adaptive in this contingency situation.

Extant literature and the OIPT offers theoretical explanations to this versatility. Environmental turbulence is found to be “positively related to innovative, risk-taking and proactive behavior” (Strong et al., 2003, p. 1413), particularly in prospector firms. Here, prospectors’ *exploratory mode* allows for quick adaptions of an organization (Burton et al., 2004, pp. 71–72), which may be fostered by high information processing needs. Here, higher information processing needs in the digital IM may spur the entrepreneurial orientation, and this may result in a heightened awareness for digital innovation opportunities. Against the backdrop of our results, this may suggest that the overall strategic aggressiveness in prospector firms combined with the external pressure to quickly engage in digital innovation may have a positive effect on the information processing capabilities of the digital IM, and the lack of information processing requirements (quadrant P1) needs to be compensated through additional design strategies in prospector firms operating in stability (Carnes et al., 2019, p. 77). Furthermore, previous research has shown that managers situated in more proactive firms are more likely to interpret changing and coercive external information as opportunities for innovation (Aragón-Correa, Matías-Reche, & Senise-Barrio, 2004, p. 965), which may substitute the effect of certain design strategies.

Taking these ideas together, although prospector firms with a digital IM facing high information processing needs may decide among different key OD configurations (i.e., first-order equifinality), we cannot assume a second-order equifinality for the best-fit configurations in this specific situation, since evidence only supports internal lateral relations as effective and efficient complementary strategy. By including the second-best-fit propositions from the previous sections, the relatively broad range of available *causal pathways* to digital business model innovativeness suggests that equifinality is most present in this contingency situation, since firms matching this environment-strategy profile may choose from all of the presented designs. Nevertheless, the two equifinal combinations of key and complementary design strategies as shown in the upper right quadrant of Table II-27 may particularly promise the best fit and thus the highest digital business model innovativeness for prospector firms and a digital IM with high information processing needs, and it may be more efficient since they only require internal lateral relations for highest performance. Thus, we propose the following:

> **P3a.** *For aggressive firms operating in digital innovation environments with high information processing needs in their digital IM, self-containment and external lateral relations are sufficient key digital IM design strategies to achieve digital business model innovativeness.*

P3b. *These firms may substitute self-containment and external lateral relations with slack resources and the use of information systems.*

P3c. *The use of internal lateral relations complements the aforementioned digital IM configurations to achieve digital business model innovativeness.*

7.2 Contributions to Research and Practice

This study developed a more detailed understanding on the different design strategies that in conjunction result in effective or ineffective digital IM. We demonstrated that individual design strategies exert different effects on digital business model innovativeness depending on their combination. In addition, we showed that the effect is dependent upon the information processing needs from the digital innovation environment as well as on a firm's strategic posture. The results further indicate a situation of equifinality (Ragin, 2008, p. 15), since multiple combinations of digital IM design strategies result in the presence or absence of digital business model innovativeness. Our empirical results strongly confirm our configurational hypotheses (H1–H4), a direct and significant effect of digital business model innovativeness on overall organizational performance (H5), and the positive relationship between effective digital IM OD and organizational performance. Overall, our study makes three significant contributions to the body of digital IM research. These contributions are directly related to our research questions as stated in Chapter 1:

1. This paper provides a conceptualization of digital business model innovation and an examination of its building blocks.
2. This paper develops and tests a configurational theory on digital IM's OD using a multimethod approach.
3. This paper provides insights on the relationship between digital business model innovativeness and organizational performance.

First, we expand the digital innovation literature by providing a more detailed and thorough *conceptualization of digital business model innovation*. We synthesized the extant research on digital innovation and business model innovation, and we conceptualized digital business model innovation as the creation or change of ways for offering, creating, delivering, or capturing value that are new to the organization and that result from the use of digital technology (Chapter 3). As previous research has put forward that business model innovation entails paradigmatic changes in a firm's business logic to achieve a competitive edge (Amit & Zott, 2012, p. 44; Teece, 2010, p. 186), our conceptualization acknowledges that digital technologies are becoming an inherent driver of that change in many organizations (Breidbach & Maglio, 2015, pp. 2–3). However, previous research has mostly focused on the supply side and treated digital business model innovation as almost synonymous to digital product innovations (Fichman et al., 2014, p. 335). We posit that traditional conceptualizations of business model innovation as well as the product-centric perspective on digital innovation are insufficient to explain how digital technologies not only act as an enabler but also as a trigger of business model innovation (Lusch & Nambisan, 2015, p. 157). Furthermore, the focus on novel digital product and process innovations alone is not enough, since firms need to appropriate new innovations in reconfigured business models to seize economic rents (Amit & Zott, 2010, p. 2). To this end, our efforts go beyond a narrow focus as we disseminated the dimensions of digital business model innovation and their characteristics. This contribution is significant and important, since the digitalization of business models constitutes the apex of digital enterprise transformations (Bharadwaj et al., 2013, p. 472; Hess et al., 2016, p. 124). Moreover, an improved understanding of digital business model innovation may direct future research.

Second, we promoted *digital IM as the key function for sensing and seizing digital technologies for new or reconfigured digital business models*. Essentially, conventional approaches to IM may prove insufficient for the management of digital innovation and business models due to the fundamentally different logic (see section 2.2.2) of digital innovations (Nambisan et al., 2017, p. 225; Yoo, 2013b, p. 232). We argued that the organizational structure of a digital IM is the key determinant to ensure effective information flows and that it allows for timely and appropriate reactions to changes. Thereby, we employed Galbraith's (1973, 1974) OIPT as theoretical perspective for analyzing the causal mechanisms between design strategies for effective digital IM. We hypothesized that digital business model innovativeness results from a fit of the digital IM structures with a firm's strategic intent and the information processing needs resulting from the environmental dynamics caused by digital innovation.

By applying fsQCA, we uncovered multiple, equally effective *causal recipes* for digital IM. Our results support the fit as gestalt perspective on digital IM, in that multiple equifinal configurations (i.e., gestalts) of design strategies were found that combine to digital business model innovativeness. Since configurations are differently suited for different contingency profiles, our results confirm that a configuration "rationale for an individual organization may not be rational for large numbers of organizations" (Greenwood & Hinings, 1996, p. 1027). In contrast to previous research which has examined the effect of organizational structure on innovation performance (Cosh, Fu, & Hughes, 2012, p. 304; de Visser et al., 2010, p. 293; Gentile-Lüdecke, Torres de Oliveira, & Paul, 2019, p. 5), our study demonstrated that the presence of digital business innovativeness depends on the combined effects of design strategies, not on their individual, linear, and additive net effects. Our results resolve the somewhat conflicting and non-significant findings about choices in organizational structure (e.g., formalization, centralization) and their relationship to innovativeness in these previous studies (e.g., Cosh et al., 2012, p. 313; Gentile-Lüdecke et al., 2019, p. 13). Here, we discovered that individual design strategies are not necessarily supporting each other, and we found signs of causal asymmetry and complexity, since results indicated various complementarity, trade-off, and substitution effects across contingency profiles. Depending on the institutional and external context, design strategies combine differently in a digital IM to produce digital business model innovativeness. The notion of causal complexity was further substantiated by comparing the high performing digital IM configurations with the low performing organizations. Here, we found that the low performing configurations do not represent the causal opposite of high performing designs but are rather unique patterns that combine to the absence of innovativeness. We deem the identification of different configurations as useful and important because they represent "ways of abstracting and directing key theoretical ideas" (Greenwood & Hinings, 1988, p. 296) and thus may fertilize future research.

The OIPT perspective provided better insights than traditional market-level perspectives such as the technological networks theory (Hidalgo & Albors, 2008, p. 125), the diffusion of innovation theory (Bass, 1969, p. 216) and the disruptive innovation theory (Christensen et al., 2018, p. 1069). Our model also acknowledges the environment as the source for innovation, yet it provides richer explanations on the firm- and unit-level structures required to generate innovativeness. Firm-level innovation research often focuses on the core innovation competencies and capabilities, which builds on work such as the resource-based view of the firm (Barney, 1992, p. 44) or dynamic capabilities theory (Teece & Pisano, 1994, p. 538). These theories argue that innovation management should integrate and reconfigure internal and external competencies to achieve competitive advantage (Xu et al., 2007, p. 15). While we generally concur with the arguments of the resource-based view and dynamic capabilities perspectives, they typically do not offer detailed explanations of effective organizational structures for reconfiguring the resource base. Here, our research provides the blueprints for a digital IM that is able to sense and seize digital business opportunities and to reconfigure the dimensions of a business model accordingly, and thus our work may serve as starting point to alter the resource base in a digital way (Fichman et al., 2014, p. 330; Frishammar & Åke Hörte, 2005, p. 254; Nylén & Holmström, 2015, p. 58). In line with the OIPT (Galbraith, 1977, p. 209), our research model incorporates external linkages for innovation and thus concurs with arguments from research paradigms such as open innovation (Chesbrough, 2003, p. 43), and it also acknowledges that digital innovation is not solely firm-centric (Pon et al., 2015, p. 30; Tilson, Lyytinen, & Sorensen, 2010, p. 3). Our findings align with previous research that found a greater effect for external innovation linkages in face of high information processing needs (Lichtenthaler, 2009, p. 327). However, we also extend the knowledge from open innovation research. Given an aggressive strategic stance, we found equifinal options to substitute external linkages with other design strategies.

There are only few existing theories of organizational structure, and the available theories agree that the most critical variables are strategic choice, environment, and technology (Child, 1972, p. 16). Positioned in the broader context of general systems theory (Von Bertalanffy, 1968, p. 30), the information processing view on digital IM may be viewed as focus on the structure subsystem that interacts with other subsystems, such as of tasks and control (Suchan & Dulek, 1998, p. 103). The general system view of IM (Drucker, 1985, p. 29) focuses on the integration on various capabilities to generate novel solutions and subsequent market advantages. Nevertheless, general systems theory focuses on the interrelatedness and change among all parts of an organization, whereas OIPT allows us to focus on the specific context of the digital IM unit. Others employ transaction cost theory (Williamson, 1994, p. 87) to the strategy-structure-environment fit by focusing on the *economic transaction* as unit of analysis. Here, *bureaucratic costs* of structures are viewed as transactions that incur when a firm pursues economic benefits (i.e., strategy) (Jones & Hill, 1988, p. 172). Bureaucratic costs may be mitigated by either changing strategy (e.g., integration or diversification) or structure (i.e., by internalizing the transaction or by obtaining it through the market). While this theoretical perspective may offer explanations on why organizations either obtain digital innovations at the market or internalize digital IM, however, it does not provide answers on the OD of effective digital IM (Roberts & Greenwood, 1997, p. 349). Specifically, there is only scant research devoted to the structures of digital IM (Nambisan et al., 2017, p. 231). Hinings et al. (2018, p. 53) proposed to apply institutional theory (Selznick, 1948) to study digital IM structures. Since institutional theory explains how organizations become more similar over time through deliberate imitation (Knott, 2003, p. 930), it may offer insights on how and why an increasing number of firms adopt emergent practices such as crowd-based platforms to carry out digital IM (Hinings et al., 2018, p. 54). However, it does not provide answers on effective structures of a corporate digital IM or the causal mechanisms between individual design strategies under varying contingency profiles. Taking these ideas together, we posit that the OIPT provided a suitable theoretical lens to address our research questions and that it represents a significant contribution to theory and practice.

Comparing our results to common typologies of organizational structures such as the dichotomy of organic vs. mechanistic organizations by Burns and Stalker (1961), we note some important differences. Our results only provide limited support to the common hypothesis that "the more dynamic the environment, the more organic" (Mintzberg, 1979, p. 270), since self-containment, resembling the core of organic structures, was found to be not necessarily required in face of high information processing needs. In examining Mintzberg's (1979, p. 301) set of structural archetypes (e.g., machine bureaucracy, divisional form, adhocracy), we see that these archetypes are mostly suited for designing the overall firm but not for designing effective digital IM structures. Here, Mintzberg (1979) put great emphasis on overarching decision-making systems and the “superstructure of the organization” (p. 104), while OIPT was found particularly useful to examine unit-level structures against the background of a unit’s specific task requirements (Daft & Macintosh, 1981, p. 208). Thus, our research delves deeper than merely focusing on the common organizational meso-level structures for innovation management such as central executive support functions, upper management areas, or decentralized support units (Gaubinger et al., 2015, p. 240). By examining dedicated digital IM design strategies in conjunction with basic meso-level structures, we were able to generate richer insights on the causal mechanisms that combine to digital business model innovativeness. While our five design strategies based on Galbraith’s (1977, p. 49) seminal work are akin to Mintzberg’s (1979) nine “design parameters” (p. 67), we contend that OIPT offered the better foundation that allows us to acknowledge the role of IS and external sources for innovation activities not included in Mintzberg’s work. The extant body of literature only offers few typologies focused on innovation management. For example, based on four types of ambidexterity, Prange and Schlegelmilch (2010, pp. 48–49) proposed nine innovation archetypes such as the *visionary innovator* or the *consolidating innovator* that are dependent upon different contingencies (e.g., leadership, culture, and vision). However, they primarily focus on the overall innovativeness of a firm and less on the unit-level IM function. To best of our knowledge, our study is among the first that provides a theoretically framed and empirically-tested typology of contextualized and effective digital IM that eventually contributes to the bottom line. Our study therefore contributes to research and theory by providing an empirically-tested, context-specific middle-range theory (Pinder & Moore, 1980, p. 19) of effective digital IM building on OIPT that predicts the complex interplay among various micro-level design strategies. The theoretical framing as well as the configurational typology thus filled an important yet empty position between the traditional grand theories applied to IM (cf. Xu et al., 2007, p. 14), the organizational typologies of superstructures not focused on the specific task set of digital IM (e.g., Burns & Stalker, 1961; Mintzberg, 1979), the frameworks from standard-setting bodies (e.g., ISO, 2019), and the more detailed guidelines for IM aimed at practitioners (e.g., Gaubinger et al., 2015).

By employing fsQCA, our study also makes a methodological contribution by responding to calls to apply configurational analysis to uncover rigorous patterns in institutional arrangements of digital IM (Hinings et al., 2018, p. 58; Nambisan et al., 2017, p. 232). Despite the increasing attention of the method in behavioral research, there is a general lack of analytical rigor and compliance with best practice in the scientific community when applying fsQCA (Greckhamer et al., 2018, p. 2; Liu et al., 2017, p. 82). We do not merely apply the method’s core (i.e., identification of ideal types), but we further consider the complete range of key steps that are often missing in other studies (cf. Pappas, Kourouthanassis, Giannakos, & Chrissikopoulos, 2016, pp. 797–798). This includes the analysis of contrarian cases, assessment of necessary conditions, and testing the robustness and predictive validity of our results (Woodside, 2014, p. 2502). Furthermore, we extend the traditional approach by providing the correlation of individual configurations with the outcome of interest as additional indicator for the strength of the configuration-outcome relationship. Moreover, we combined fsQCA in a multimethod setting by examining the meso-level design structures associated with individual configurations, and by validating the nomological validity and utility of our set-theoretic results using PLS-SEM and MANOVA. By taking these ideas together and by combining several data analysis techniques, we further add to the relatively scarce body of multimethod research in the IS discipline (Mingers, 2003, p. 246).

Finally, we demonstrated the *effect that digital business model innovativeness exerts on organizational performance*. This aspect of our study was fueled by previous research (Ali et al., 2016, p. 5321; Gunday et al., 2011, p. 672; Hernández-Perlines et al., 2016, p. 5385) which has found innovativeness to be positively related with organizational performance. Spurred by ongoing discussions in research (Fichman et al., 2014, p. 335; Sambamurthy et al., 2003, p. 239) and practice (Anand et al., 2015) about digital innovations' contribution to the corporate bottom line, the unique notion of digital business model innovation has raised the issue of revisiting their relationship. Our results provided support for a significant and substantial positive effect of digital business model innovativeness on organizational performance. Furthermore, we demonstrated that the effective (ineffective) configurations from our set-theoretic analysis are not only associated with high digital business model innovativeness, but also with high (low) firm performance. To this end, these results may somewhat resolve the issue of evaluating relevance and performance of digital transformations (Heavin & Power, 2018, p. 43), and they provides evidence for how firms successfully utilize digital innovations for their business (Armbruster et al., 2008, pp. 654–655).

Our results also have a twofold *contribution to practice*, since the discussion of digital business model innovation may support a shared understanding of digitalization's core across organizations, and the findings support managers to configure their digital IM structures according to their idiosyncratic strategy-environment profile. To this end, this study provides one novel building block for addressing the practical challenge of business model changes that are associated with the phenomenon of digitalization (Hess et al., 2016, p. 124). On the one hand, innovation managers may employ techniques such as profile deviation analysis to assess their digital IM against the identified configurations of top-performing organizations that operate in a similar context (Kabadayi, Eyuboglu, & Thomas, 2007, p. 197). On the other hand, our configurational propositions may provide first clues for designing or redesigning digital IM structures that fit a given context. Based on the results from the set-theoretic analysis presented in section 6.2 and the configurational contingency framework discussed in section 7.1, Figure II-14 shows a condensed framework that allows firms to scrutinize their digital IM structures against the speed and complexity of digital innovation prevailing in their industry. The analysis demonstrated that both external partnerships (i.e., external lateral relations) as well as self-organization (i.e., self-containment) represent key mechanisms that allow digital business model innovations to thrive in fast-changing and complex innovation environments, despite a firm's strategic orientation. The excess resource commitments (i.e., slack resources) such as time and budget buffers dedicated to experimentation, and also applying the tools supporting innovation activities (i.e., IS) proved to represent the key approaches in industry's which suffer from less digitalization pressure. Firms should apply both combinations to their digital IM to seize its full potential, yet they should place different emphasis (in terms of resource investments) on the pairings according to the perceived speed and complexity in their digital innovation ecosystem. Channeling information flows (e.g., ideas) across the organization to the digital IM by establishing collaborative structures and processes with internal business units (i.e., internal lateral relations) may enhance the creation of digital business model innovation, although our results only indicate a supportive role of tight internal bonds.

It should be noted that the simplified framework abstracts from a firm's strategic posture, yet the proposed decision model is quite compatible to any strategic stance due to the identified situation of equifinality. However, for highest innovation performance, managers should refer to the detailed framework including the strategic orientation as presented in section 7.1. Furthermore, the model does not apply to very defensive firms operating in stable industries that are not yet affected by significant degrees of digitalization. As a managerial implication, digital innovation managers need to be aware about the strategic posture of their firm and the complexity and speed of digital innovation they are engaging in when designing appropriate digital IM structures. Nevertheless, for other firms, the framework also provides guidance to digital innovation managers on how to shift their strategic focus and resource commitments in light of changing speed and complexity.

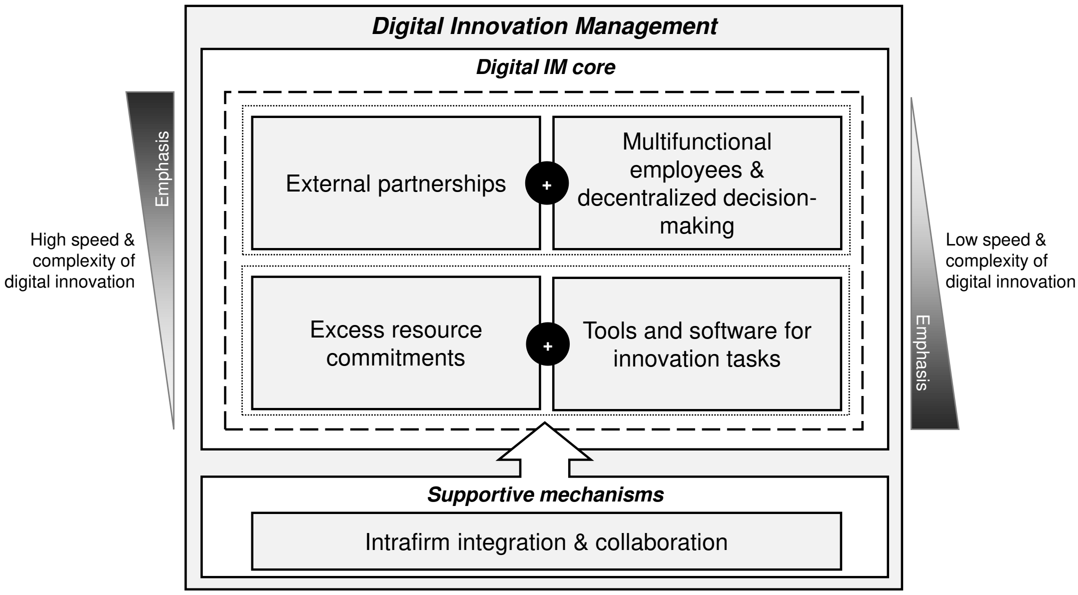

Figure II-14. Condensed framework for guiding digital innovation managers in practice.

7.3 Limitations and Directions for Future Research

We acknowledge that our study has limitations that must be considered. In this section, we discuss the four limitations and associated implications for future research associated with (a) our taken theoretical assumptions, (b) the data sample, (c) the scope and capabilities of fsQCA, and (d) the cross-sectional nature of our study.

First, our research is primed by our underlying *theoretical assumptions* and consequently, it is sensitive to the *variables* selected and specified for inclusion in the analysis. Our research is based on the understanding that information processing capabilities are critical to effective innovation management (Lievens & Moenaert, 2000, p. 47), and that appropriate organizational structures represent the key variable for information processing in innovation management (Kießling et al., 2012, p. 7; Russell & Russell, 1992, p. 642; Tidd, 2001, p. 179; Utterback, 1971, pp. 81–82). Such innovation management must align with the strategy and the environment to achieve digital business model innovativeness (Resca et al., 2013, p. 72). Since the concepts of structure, strategy, and environment are rather broad (Fiss, 2011, p. 412), we only included a representative set of variables on the expense of other possible variables, partly owing to the limited number of variables fsQCA can handle (Marx, 2010, p. 155; Marx & Dusa, 2011, p. 114). Nevertheless, we posit that our variable selection represents the key ingredients that are important to OIPT and the strategy-environment domain in the context of digital IM. Yet, we acknowledge that other theories and frameworks may also provide valuable insights on digital IM. Others have proposed to apply ecogenesis (Resca et al., 2013, p. 80), solution-problem pairing, and technology affordances to study digital IM (Nambisan et al., 2017, p. 231). Furthermore, while we included external lateral relations to acknowledge the role of external sources for digital innovation, our investigation of effective digital IM focused on a focal firm and its digital IM as the unit of analysis. Since our unit of analysis was a focal firm's digital IM, we did not consider network effects among various actors that are prevalent in the more recent open digital innovation platform ecosystems paradigm (Parker et al., 2017, p. 257). Others may take an ecosystem perspective to examine the coordination of innovation partners in exchange networks in more detail (Adner & Kapoor, 2010, p. 309). This approach would place a greater emphasis on the distributed nature of digital innovation (Pon et al., 2015, p. 30; Tilson, Lyytinen, & Sorensen, 2010, p. 3). For example, the resource dependence theory would allow power asymmetries to be examined in the exchange of innovation resources among different network actors (Nienhüser, 2008, p. 10; Pfeffer & Salancik, 2003, p. 53). Our research focused on the micro-level design of the digital IM structures since we were particularly interested in effective information processing for digital IM specific task characteristics, and this information processing may vary considerably across business units (Daft & Macintosh, 1981, p. 208; Gibson & Birkinshaw, 2004, p. 211). Nevertheless, firm-level attributes may also be crucial for a holistic understanding of digital IM performance. For example, future research may include additional variables such as the formalization of structures surrounding the digital IM, a firm's overall technological capabilities, or the role of a visionary top management (Prange & Schlegelmilch, 2010, p. 49; Terziovski, 2010, p. 895). Taking these ideas together, we advise researchers to investigate the phenomenon from other theoretical lenses and apply different measures to chart an even more comprehensive picture of digital IM.

Similarly, due to the principle of conjunctural causation, *omitting or including conditions* may result in substantially different sufficient solutions that lead to digital business model innovativeness (Ragin, 2008, p. 208). According to the recommendation by Berg-Schlosser et al. (2009), researchers can have a "close dialogue with the cases" (p. 14) and go back-and-forth between the data and the analysis in small *N* qualitative settings to dynamically adjust the set of conditions throughout the research process. However, we only had weaker knowledge about our cases due to the quantitative nature of our study. Nevertheless, applying the knowledge of conceptual relationships to other nomological variables may to some extent substitute the lack of intimate relations with the observed cases and their sensitivity to the selected conditions (Greckhamer et al., 2013, p. 54) if variables behave in a way consistent with the a-priori expectations (Peter, 1981, p. 135). Hence, we regard the assessment of our direct effect hypotheses using the PLS-SEM and the MANOVA test (see section 5.6) for testing the relationship of effective and ineffective digital IM configurations with digital business model innovativeness and organizational performance (see section 6.3) as support for the nomological validity and robustness of our variable selection.

Second, in terms of *data*, we saw that responses in our sample were more peaked than the normal distribution and skewed to higher mean values. We assume that non-normality of the data results from our qualifying strategy, since we only allowed respondents whose organizations at least *to some extent* engage in digital innovation and transformation. Nevertheless, fsQCA, PLS-SEM, and MANOVA are considered to perform well in case of non-normal data (Hair, Black, et al., 2014, p. 68; Reinartz et al., 2009, p. 338; Schneider & Wagemann, 2012, p. 248). Furthermore, our taken a-priori and a-posteriori measures allowed us to eliminate the negative influence of any satisficing behavior as much as possible, and the instrument and measurement validation indicated good reliability and validity. We also considered the non-normal nature during the necessity analysis and compared our original MANOVA results to those based on adjusted data to avoid any flawed inferences. However, performing the configurational analysis on additional samples in future research may further validate the reliability and robustness of our findings.

Moreover, although it is advised to use theoretical and substantive knowledge about the cases to define *calibration* thresholds (Greckhamer et al., 2018, p. 7), we lacked such external standards, partly owing to the quantitative nature of our research. We thus used relative sample properties for defining breakpoints. While various researchers followed the same approach for calibrating data (e.g., Ali et al., 2016, p. 5321; Greckhamer, 2016, p. 800; Torres et al., 2017, p. 56), future research may employ contextual knowledge to calibrate set memberships in a more fine-nuanced manner. However, testing different calibration approaches demonstrated that our results and thus threshold choices are quite robust (see section 5.5.6). Furthermore, our truth table naturally contained possible configurations that were not covered by empirical instances (i.e., logical remainders). In our analysis, we included 42 empirically observed configurations out of 128 mathematically possible configurations (i.e., 7 conditions = 2^7 combinations). To this end, our results are to some extent limited by the sample size. However, fsQCA's algorithm accounts for this limited diversity by placing different emphasis on causally core and causally peripheral conditions, while being grounded on the empirical evidence at hand (Fiss, 2011, p. 403). Nevertheless, future research may uncover further empirical instances of yet unobserved configurations and differentiate theoretically and empirically impossible remainders "that cannot exist in social reality as we know it" (Schneider & Wagemann, 2012, p. 156) because they run counter to fundamental principles of organizing.

Although we analyzed cross-industry data, the identified digital IM configurations may only *apply to firms in the United States*. Furthermore, firms from the IT industry represent the most dominant group (26%) in our sample. Future research may expand the study to include firms from other markets such as the European Union or Asia and compare those findings to our results. Follow-up research may also place particular emphasis on firms that are not embedded in fast-clockspeed industries such as IT (Mendelson & Pillai, 1998, p. 431), although we only found a minor influence of operating in the IT industry on digital business model innovativeness (see section 6.3). Likewise, our results primarily hold true for a *centralized digital IM approach*, since most effective configurations were found to build on this meso-level design. Since a centralized IM represents one of the most common corporate structures (Kaschny & Nolden, 2018, p. 147), we contend that our results are highly relevant for the practice of digital IM. Surprisingly, no effective configuration was found that resides in a separate legal entity, most likely owing to the limited presence of this structural type in our sample. Since there is a growing number of dedicated legal entities such as research centers, innovation labs, incubators, and joint ventures that take over the risk-intensive tasks of creating large-scale digital innovations (Li et al., 2016, p. 9; Prange & Schlegelmilch, 2010, p. 49), it may be fruitful to particularly focus on effective digital IM structures that are embedded in separate legal entities, as these are purported to have the "highest possible commitment intensity" (Gaubinger et al., 2015, p. 245) among all basic structures. Our results also do not apply in situations where digital IM is not viewed as a temporary task and thus is not carried out on a more permanent basis, since almost no effective configuration builds on a temporary project structure. We also found only a few effective cases of a decentralized digital IM as part of all organizational units and divisions. Similarly, future research may investigate an ambidextrous digital IM either with structurally independent units focusing on emerging digital business models (i.e., *dual structures*), or contextually empowering employees to make their own judgments as to how to divide time and efforts between daily business and digital IM activities (Gibson & Birkinshaw, 2004, p. 210). Regarding the former, future research may investigate how effective digital IM may be embedded in concepts such as *bimodal IT* or *two-speed IT*, which aim to separate the tasks of exploiting efficient IT services from exploratory digital innovation activities within the IT unit (Horlach, Drews, & Schirmer, 2016, p. 1420). By contrast, it may also be worth investigating why particularly ineffective digital IM configurations build on executive support structures such as innovation committees or staff functions. Here, the nonexistent authority and decision-making competence of the digital IM in combination with the task complexity may represent major obstacles for effective digital IM (Gaubinger et al., 2015, p. 238).

Third, the study's results are limited by the overall *scope and capabilities of fsQCA*. The set-theoretic analysis was criticized because it does not explain *how causal combinations lead to a certain outcome* (Goldthorpe, 1997, p. 5). In essence, the results of fsQCA serve as a "predictive tool" (Berg-Schlosser et al., 2009, p. 11), which provides conjectures on the behavior of not yet observed cases. Hence, following Gregor's taxonomy of theory types (Gregor, 2006, p. 620), this subscribes to the notion of a *theory for predicting* (i.e., type III theory). This rests on the goal of configurational analyses to predict outcomes from a set of certain conditions (*what will be?*) without explaining the underlying causal connections between the conditions in any detail (Berg-Schlosser et al., 2009, p. 12). It is important to note that configurational analysis does not strive to explain the mechanisms behind and between the causal variables (Schneider & Wagemann, 2007, p. 28). The discussion and integration of our configurational propositions (see section 7.1) firstly provide justificatory yet theoretical causal explanations on *how and why* the identified conjunctions of digital IM design strategies may contribute to digital business model innovativeness in different contingency settings. However, dedicated empirical investigations may be required to unravel the supportive mechanisms between combinations of key and complementary design strategies across different levels of digital IM's information processing needs and firms' strategic aggressiveness more thoroughly. Here, the more in-depth analysis of underlying processes among design strategies must be carved out by moving beyond the initial observations and theoretical justifications (De Meur et al., 2009, p. 160). Thus, the observed regularities demand for further investigations such as *thick* case studies involving close dialogues and comparing cases that belong to different digital IM configurations in order to develop a *theory for explanation* (i.e., type II theory) (Gregor, 2006, p. 620) for the connections and deep structures at work (Ragin, 2008, p. 120). Furthermore, our paper does not provide detailed prescriptions on the principles, methods, tools, and techniques that organizations should apply to carry out effective digital IM in practice (*how to do?*). Based on our results, follow-up research may take a design-oriented approach (Gregor & Jones, 2007, p. 316; Hevner, March, Park, & Ram, 2004, p. 80) to derive and evaluate a *theory for design and action* (i.e., type V theory) (Gregor, 2006, p. 620) including recommendations (e.g., design principles) for effective and contextualized digital IM.

Finally, our study is likewise limited by is cross-sectional nature. While the results provide insights on which digital IM configurations may result in innovativeness and performance, they do not provide explanations on *whether and how a digital IM may move between different configurations*, denoting so-called "organizational tracks" (Greenwood & Hinings, 1988, p. 303). One obvious reason for a design change in the digital IM is a lack of fit with the strategy and information processing needs that may shift over time. Because of the interdependencies among various structural elements that combine to effective configurations, Miller (1982) argued that organizations must perform comprehensive "quantum leaps" (p. 141) instead of continuous adaptions to re-establish harmony among structural elements. Miller's point is that once a structure is no longer aligned with strategy and the environment, the evolutionary and incremental changes to single attributes are too costly and would destroy complementarities between structural elements. Instead, he argued that the cost of having a strategy-structure-environment misfit must be traded off until they exceed the cost for redesigning structures. After this time span of "adaptive lag" (Miller, 1982, p. 139), organizations should radically transform many organizational elements simultaneously to avoid structural disharmonies. Applying Miller's arguments to our findings, piecewise and incremental adjustments to individual design strategies may cause costly imbalances and affect digital IM's performance, since we found complementarity effects among the design strategies. Since the conjunction of designs strategies results in effective digital IM, the gradual and piecemeal changes to an OD pattern may result in a severe loss of innovativeness. Nevertheless, Greenwood and Hinings (1996) noted that successful incremental structural change may occur “within the parameters of an existing archetypal template” (p. 1026) while more radical change involves the shift from “one template-in-use to another” (p. 1026). Considering the relationship of key and complementary design strategies, we thus may assume that the move between second-order equifinal digital IM configurations (i.e., neutral permutations) may be less problematic to organizations, while those transforming from one first-order equifinal configuration to another may be considered more revolutionary in terms of upheaval and may require a structural quantum leap to avoid inefficiencies (Miller, 1982, p. 141). For example, a digital IM based on Configuration 1a in Table II-21 (see section 6.2.3) may converge to the second-order equifinal Configurations 1b or 1c quite easily and incrementally since they share the same key design strategies and only requires adjustments in the pattern of complementary design strategies. By contrast, moving from 1a to the first-order equifinal Configuration 2a may be considered more radical, since this transformation requires the roles of key and complementary design strategies to be reversed. Here, following the previous argumentation, a quantum change may be more efficient and effective than a gradual transition.

However, the ability to perform quantum leaps may be constrained by structural inertia, that is, organizations often fail to adapt their structures accordingly in face of changing internal and external pressures (Hannan & Freeman, 1984, p. 149). Organizations often fail to adapt because they are imprinted by their idiosyncratic “mimetic, normative, and coercive processes” (Greenwood & Hinings, 1996, p. 1027), aside from a frequent lack of resource commitments. These processes are part of their environmental and institutional context that may restrain structural change and learning, a process unfolding over time referred to as path dependence (Sydow, Schreyögg, & Koch, 2009, p. 691). As Hannan and Freeman (1984) already noted, “Other things being equal, the faster the speed with which new organizations can be built, the greater is the (relative) inertia of a set of existing structures” (p. 152). Furthermore, the prevalent coherence among design strategies may reinforce the pervasive interpretive scheme in the guiding configurational pattern and thus adds to the inertia (Greenwood & Hinings, 1988, p. 303). Nevertheless, in times of fast-changing, converging, and generative digital technologies and markets (see section 2.2.2), a continuous monitoring and timely re-alignment of the digital IM configuration are key to sustained digital business model innovation.

The inner mechanisms of the re-aligning process may be worth being investigated. We might understand these mechanisms as a thick socio-technical process (Emery & Trist, 1969, p. 284) that includes technical, methodological, organizational, and cognitive dimensions (Gond, Grubnic, Herzig, & Moon, 2012, p. 206). Organizations need to establish a learning process that is aimed at increasing the degree of fit; this can be done by assessing the current digital IM structure against the strategic background and the information processing needs that result from the digital innovation context (Sinkula, 1994, p. 36). Follow-up research may provide valuable insights not only on the alignment process and its inner mechanisms, but also on the variables determining the responsiveness of a digital IM configuration to design changes. To investigate the moves, paths, and barriers across and between digital IM configurations, detailed longitudinal and qualitative comparative case studies as well as historical analyses may be required, since organizational change commonly does not become completely visible in "less than three years" (Greenwood & Hinings, 1996, p. 1047).

8 Conclusion

This paper illuminated and addressed the prevalent phenomenon of digital business model innovation and its management. More specifically, the paper focused on digital IM's OD that effectively allows firms to create or change the ways how they offers, creates, delivers, and captures values by means of digital technologies. This conclusion briefly summarizes the answers to the three research questions as stated in the introduction (see Chapter 1).

By addressing the first research question (RQ1), the paper shed light on the nature and dimensions of digital business model innovation (see Chapter 3). We conceptualized digital business model innovation as changes in the individual business model components (i.e., value proposition, creation, delivery, and capture) that result from the use of digital technology. The continuum ranges from augmenting traditional products with computing capacity and connectivity (e.g., smart products) to creating genuinely new digital products and services. Additionally, value propositions become increasingly personalized, co-created in complex networks, and they continuously adapt to changing customer preferences throughout their entire lifecycle. Digitalization also affects internal processes to become more autonomous and context-aware along the entire supply chain. Properties of digital technologies such as zero or low marginal cost of reproduction significantly impact revenue and cost models, leading to associated opportunities for firms. Nevertheless, it was discussed that the notion of *what and how to digitalize the business model* represents a key challenge for many organizations, and that dedicated digital IM may serve as key for addressing this question.

Digital IM was framed as an organizational activity that builds on the processing of substantial amounts of information from the environments to (re)design business model components that cater changing customer preferences using digital technologies. Hence, the paper subsequently put forward an understanding of digital IM that was fertilized by Galbraith's (1973, 1974) OIPT. The proposed research model conceptualized complexity, dynamism, and hostility that result from the nature and logic of digital innovation as the primary sources of environmental uncertainty and equivocality (i.e., information processing needs); these needs must be resolved by organizations in order to stay competitive in digital innovation environments. Here, digital IM was positioned as the key function for gathering required information in sufficient richness by sensing and evaluating environmental changes, as well as by subsequently reconfiguring the business model to address changing competitive requirements (i.e., information processing capabilities). As proposed by OIPT, several strategies may be applied to digital IM's OD to adjust its overall information processing capabilities, namely the strategies of slack resources, self-containment, internal and external lateral relations, and IS. In building on a *fit as gestalt* understanding, the model hypothesized that digital IM's effectiveness—in terms of digital business model innovativeness—in a specific context results from a strategy-structure-environment coalignment, and that multiple, yet disparate, equally effective configurations may exist. The model further hypothesized that digital business model innovativeness directly contributes to overall organizational performance. Consequently, we empirically tested the research model in a quantitative survey study (see Chapter 6). We unraveled multiple "causal recipes" (Ragin, 2013, p. 172) of digital IM that exhibit high and low degrees of digital business model innovativeness (RQ2) by employing a combination of fsQCA and PLS-SEM for the data analysis. The results suggest that it is the conjunction of digital IM design strategies that contributes to innovativeness, not the independent effects of OD elements. The findings not only support the strategy-structure-environment fit perspective, but they also indicate the presence of causal complexity and causal asymmetry manifested in trade-off, substitution, and complementarity effects between strategies. Furthermore, we empirically demonstrated the subsequent direct effect of digital business model innovativeness on organizational performance by applying PLS-SEM, and finally—in an effort of nomological validation—we related individual configurational groups to organizational performance by employing MANOVA (RQ3). Finally, in Chapter 7, we derived configurational propositions from our results and provided thrusts for future research.

Ultimately, digital IM remains an important yet complex phenomenon. Although this paper substantially contributed to a better understanding about digital IM's OD strategies that may spur or impede a firm's digital business model innovativeness and ultimately organizational performance, future investigations may add to these findings by providing even more fine-grained insights into the inner mechanics of digital IM.

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Appendices II

Appendix II-A. Measurement Items

Variable code is provided in brackets. All scales are seven-point Likert scales (1= strongly disagree, 7 = strongly agree) if not indicated otherwise. Reverse coded items are indicated with [R].

Code	Measure	Source
[INV] Outcome: Digital Business Model Innovativeness [Second-order measure, formative-formative hierarchical component model] *Please indicate your agreement with each of the following statements with respect to your firm. Over the past 3 years, …*		
Digitalized value offering [formative measure]		(Spieth & Schneider, 2016, p. 686)
VO_1	… our firm has met existing (as yet unfulfilled) customer demands or has stimulated new customer demands by offering new digital products or services.	
VO_2	… our firm's products and services have become more digital.	
VO_3	… introducing new digital products and services has enabled us to differentiate from our competitors.	
Digitalized value architecture (i.e. *value creation and delivery*) [formative measure]		
VA_1	… we have explored new forms of digital value creation chains and networks (e.g. multi-sided digital platforms) to realize our offerings.	
VA_2	… our firm's internal value creation activities have increasingly relied on digital technologies.	
VA_3	… our firm has increasingly relied on digital distribution channels.	
VA_4	… our firm's core competencies and resources used to create products and services have increasingly focused on digital technologies (e.g. an increasing number of data analysts and user experience experts).	
Digitalized revenue model [formative measure]		
RM_1	… digital technologies have become a major cost driver in our firm.	
RM_2	… our firm has developed new ways to generate revenues by using digital technologies.	
[OP] Nomological variable: Organizational performance [reflective measure]		

Please indicate your level of agreement with the following statements about your firm: *Over the past three years…*		
FP_1	… our financial performance has been outstanding.	(Powell & Dent-Micallef, 1997, p. 402)
FP_2	… our financial performance has exceeded those of our competitors.	
FP_3	… our sales growth has been outstanding.	
FP_4	… we have been more profitable than our competitors.	
FP_5	… our sales growth has exceeded those of our competitors.	
[TURB] Information Processing Needs: Turbulence [reflective measure] *Please indicate your agreement with each of the following statements with respect to your firm's environment.*		
TURB_1	The technologies in our principal industry are changing rapidly.	(Jaworski & Kohli, 1993, pp. 68–69)
TURB_2	Technological changes open up big opportunities in our principal industry.	
TURB_3	It is very difficult to forecast where the technologies in our principal industry will be in the next one to two years.	
TURB_4	The technological developments in our principal industry are substantial.	
TURB_5	Competition around new technological developments in our principal industry is cut-throat.	self-developed
TURB_6	The needed diversity in technologies to cater for different customer preferences has dramatically increased in our principal industry.	self-developed
[SLR] Design strategy: Slack resources [reflective measure] *Please indicate your level of agreement with the following statements about the* ***digital innovation unit****:*		
SR_1	The unit has many resources (e.g. financial, staff) at its discretion to fund and initiate new digital initiatives.	(De Luca & Atuahene-Gima, 2007, p. 110)
SR_2	The unit has access to many resources (e.g. financial, staff) available in the short run to fund and initiate digital initiatives.	
SR_3	The unit has access to uncommitted resources (e.g. financial, staff) that can be used to fund and initiate digital initiatives at short notice.	
SR_4	The unit has no problems obtaining resources (e.g. financial, staff) at short notice to support new digital initiatives.	
[SCT] Design strategy: Self-containment [Second-order measure, reflective-formative hierarchical component model] *Please indicate your level of agreement with the following statements about the* ***digital innovation unit****:*		

Employee multifunctionality ***(i.e. reducing horizontal differentiation: reducing functional specialization and division of labor)*** **[reflective measure]**		(Huang et al., 2010, p. 527)
MFE_1	Employees in this unit receive training to perform multiple tasks.	
MFE_2	Employees in the unit learn how to perform a variety of tasks.	
MFE_3	Employees are cross-trained, so that they can fill in for others if necessary.	
MFE_4	In this unit, employees learn only how to do one job. [R]	
MFE_5	In this unit, employees are encouraged to learn specific skills in depth rather than to develop a broad skills base. [R]	
Decentralization ***(i.e. reducing vertical differentiation: decentralization of decision-making authority)*** **[reflective measure]** Please indicate your level of agreement with the following statements about the **digital innovation unit**:		
DEC_1	Employees in the unit must even refer small matters to someone higher up for a final answer. [R]	
DEC_2	There can be little action taken in the innovation unit until a supervisor approves a decision. [R]	
DEC_3	Employees in the unit can do almost anything they want without consulting a supervisor.	
DEC_4	The unit is a good place for a person who likes to make their own decisions.	
[ILR] Design strategy: Internal lateral relations [reflective measure] *Please indicate your level of agreement with the following statements:* *Throughout innovation cycles, the* ***digital innovation unit*** *and* ***other departments and business units****...*		
ILR_1	… often interact formally (e.g. exchange reports and forms according to documented rules).	(Brettel et al., 2011, p. 266)
ILR_3	… exchange large amounts of information (e.g. market and competitive analyses).	
ILR_5	… share collective goals, to a large extent.	
ILR_4	… often exchange resources (e.g. financial, staff) or work results (e.g. templates, prototypes).	
ILR_2	… often interact informally (e.g. irregular or unscheduled meetings).	
[ELR] Design strategy: External lateral relations [formative measure] *Please indicate the average frequency in which the* ***digital innovation unit*** *draws from the following sources throughout innovation cycles.* *1 = Never, 2 = Very rarely, 3 = Rarely, 4 = Occasionally, 5 = Often, 6 = Very often, 7 = Always.*		

ELR_1	**Customer involvement**: Directly involving customers in digital innovation processes, for example, by active market research to check their needs, online innovation contests, crowdsourcing, or by developing digital products and services based on individual customers' specifications and designs.	(Laursen & Salter, 2006, p. 140; van de Vrande et al., 2009, p. 425)
ELR_2	**Alliances and partnerships**: Collaboration with external partners such as technology suppliers, competitors, and universities to support innovation processes via arrangements such as formal partnerships, alliances, networks, or joint ventures.	
ELR_3	**Equity investments**: Investments in new or established enterprises (e.g. startups) to gain access to their knowledge or to obtain other synergies.	
ELR_4	**Contracting**: Buying or outsourcing services relating to digital innovation from other organizations, such as research institutes, consultants, commercial engineers, or suppliers.	
ELR_5	**Intellectual property licensing**: Buying or using intellectual property of other organizations relating to digital technologies, such as patents, copyrights, or software licenses.	
[IS] Design strategy: Information systems [reflective measure] *Please indicate your level of agreement with the following statements about the **digital innovation unit:***		
IS_1	The use of information systems such as for project and resource management, knowledge management, market intelligence, cooperative work, and others have improved the unit's ability to develop new digital products, services, processes, and business models.	(Wang et al., 2012, p. 357)
IS_2	The use of information systems such as for project and resource management, knowledge management, market intelligence, cooperative work, and others have reduced the unit's ability to develop new digital products, services, processes, and business models. [R]	
IS_3	The use of information systems such as for project and resource management, knowledge management, market intelligence, cooperative work, and others provided support for digital innovation.	
[STRAT] Institutional context: Strategic posture [reflective measure] *Please indicate your level of agreement with the following statements about your **firm**:*		
SP_1	Our firm generally strongly emphasizes technological innovation and leadership.	(Covin & Slevin, 1989, p. 86)

SP_2	Our firm generally seeks to initiate actions, which competitors then respond to.	
SP_3	Our firm generally tries to be the first to introduce new products or services, administrative techniques, operating techniques, and so on.	
SP_4	Our firm generally typically seeks to avoid competitive clashes, preferring a live-and-let-live stance (rather than a competitive stance). [R]	
SP_5	Our firm generally has a strong proclivity for high-risk projects with chances of very high returns.	
Control variables		
SIZE	Please indicate the approximate number of employees working for your entire firm: [Radio button; 1 choice] Screened out: 1 – 49 1: 50 – 249 2: 250 – 499 3: 500 – 4,999 4: 5,000 – 50,000 5: 50,000+ (Coding: 50-499: 0; 500-50,000+: 1)	(Chengalur-Smith, Duchessi, & Gil-Garcia, 2012, p. 63; Padilla-Meléndez & Del Aguila-Obra, 2006, p. 101; Torrisi et al., 2016, p. 1377)
AGE_U	Kindly estimate the number of years the digital innovation unit has existed in this form: [Numerical input]	(Jansen et al., 2006, p. 1667)
AGE_F	Please estimate the number of years since your firm has been in existence (founded/purchased/acquired): [Numerical input]	
STR_U	*Which of the following settings best describes the digital innovation unit in your firm?* [Radio button; 1 choice] Centralized or dedicated unit/department Committees/boards Decentralized task across the firm Dedicated/Separate legal entity (e.g. a subsidiary or startup) Staff function Secondary task of a business department Secondary task of the IT department Sub-unit of another department (e.g. a digital task force) Temporary projects (no organizational department/unit) Other: [Text input]	(Böhl et al., 2016, p. 7; Kiessling et al., 2011, p. 6)
IND	*Please indicate your firm's primary industry of operation:* [Radio button; 1 choice]	(US Census Bureau, 2017b, p. 26)

	11 - Agriculture, Forestry, Fishing and Hunting 21 - Mining, Quarrying, Oil and Gas Extraction 22 - Utilities 23 - Construction 31-33 - Manufacturing 42 - Wholesale Trade 44-45 - Retail Trade 48-49 - Transportation and Warehousing 51 – Media and Telecommunication (e.g. offline Publishing and Broadcasting, Motion Pictures, Telecommunication Carriers) 5112, 518, 54151 - Information Technology (IT) 52 - Finance and Insurance 53 - Real Estate and Rental and Leasing 54 - Professional, Scientific, and Technical Services 55 - Management of Companies and Enterprises 56 - Administrative and Support Services, Waste Management and Remediation Services 61 - Educational Services 62 - Health Care and Social Assistance 71 - Arts, Entertainment, and Recreation 72 - Accommodation and Food Services 81 - Other Services (except Public Administration) 92 - Public Administration	
Respondent demographics: Job role *Please indicate your primary role in your firm:* [Radio button; 1 choice]		
ROL	*[Following roles qualified for the survey]* IT executive (chief information officer, chief digital officer, chief technology officer, vice president of IS/IT, …) Business executive (chief executive officer, chief financial officer, chief operating officer, …) Innovation manager (new product development manager, IT/digital innovation manager, R&D manager, business development manager, …) *[Following roles were screened out]* IT (middle) manager Business (middle) manager Other: [Text input]	(Benlian et al., 2011, p. 111)
Attention check		

AT_1	*Please select the option strongly disagree. This is just to screen out random clicking. Do not click on other scale items.*	(Oppenheimer et al., 2009, p. 871)
Screening heuristics		
SCR_1	*Overall, to what extent does your firm engage in the enhancement, transformation, and/or the creation of products, processes, and business models via digital technologies?* 1=Not at all, 2=Very little, 3=To some extent, 4=To a great extent, 5 =To a very great extent (Survey is aborted if respondent selects options 1 or 2)	Chapter 3
SCR_2	*How aware are you of your firm's structures and mechanisms to come up with ideas for changed or new digital or digitally enhanced products, processes, and business models?* 1=Not at all, 2=Very little, 3=To some extent, 4=To a great extent, 5 =To a very great extent (Survey is aborted if respondent selects options 1 or 2)	Section 4.2

Appendix II-B. Sample Statistics

Screen-out statistics.

In-survey targeting- screen outs	**735**
Job role (not a senior or innovation manager)	203
No digital innovation engagement (SCR_1)	442
Not aware of digital innovation structures (SCR_2)	69
Firm size (<50 employees)	21
Quality checks- screen outs	**95**
GeoIP (≠ US)	30
RelevantID[16]	38
Speeders	27
Total No. of respondents qualified after in-survey targeting	**263**
Satisficing behavior- screen outs	**12**
Final sample size	**251**

[16] Filters duplicate responses from the same machine (http://www.imperium.com/services/relevantid/)

Sample demographics (*N*=251).

Industry	*N*	Small/ Medium	Large	Ø age (years)	IM structure
Accommodation and Food Services	5	40%	60%	26	1 (40%)
Administrative and Support Services, Waste Management, and Remediation Services	6	33%	67%	20	2 (33%)
Agriculture, Forestry, Fishing, and Hunting	2	100%	0%	15	3 (100%)
Arts, Entertainment, and Recreation	5	80%	20%	13	1 (40%)
Construction	23	48%	52%	16	1 (44%)
Educational Services	16	56%	44%	48	1; 2 (44% each)
Finance and Insurance	22	23%	77%	31	1 (55%)
Health Care and Social Assistance	20	15%	85%	63	7 (35%)
Information Technology (IT)	65	32%	68%	18	1 (47%)
Management of Companies and Enterprises	1	100%	0%	84	1 (100%)
Manufacturing	25	32%	68%	34	1 (52%)
Media and Telecommunication (e.g. offline Publishing and Broadcasting, Motion Pictures, Telecommunication Carriers)	4	0%	100%	38	6 (50%)
Professional, Scientific, and Technical Services	17	47%	53%	24	1 (47%)
Public Administration	3	33%	67%	143	3 (66%)
Real Estate and Rental and Leasing	2	100%	0%	30	1 (50%)
Retail Trade	8	38%	63%	22	1 (62%)
Transportation and Warehousing	9	33%	67%	68	1 (55%)
Utilities	1	0%	100%	38	1 (1%)
Wholesale Trade	4	75%	25%	43	1; 3; 4; 5 (25% each)
Other Services (except Public Administration)	13	62%	38%	27	1 (38%)

N=251

Small/Medium = 50 – 499 employees; Large ≥ 500 employees

1: Centralized or dedicated unit/department; 2: Committees/boards, 3: Decentralized task across the firm; 4: Dedicated/Separate legal entity (e.g. a subsidiary or startup); 5: Staff function; 6: Secondary task of a business department; 7: Secondary task of the IT department.

***Not included**: Sub-unit of another department (e.g. a digital task force); Temporary projects (no organizational department/unit)*

Appendix II-C. Fuzzy-set Calibration of Variables

Variable valibration.

	ELR	ILR	INV	IS	SCT	SLR	STRAT	TURB
Mean	5.24	5.62	5.80	5.71	5.73	5.48	5.64	5.68
Mode	5.66	7.00	7.00	6.00	6.00	6.00	6.00	7.00
Median	5.39	5.70	6.01	6.00	5.82	5.61	5.77	5.79
Percentiles	**Original calibration.**							
10	4.0	4.5	4.8	4.6	4.9	4.4	4.4	4.6
50	5.4	5.7	6.0	6.0	5.8	5.6	5.8	5.8
90	6.3	6.7	6.8	7.0	6.7	6.7	6.7	6.7
Percentiles	**Calibration alternative 1 (robustness test).**							
5	3.4	4.1	4.1	4.1	4.2	3.7	3.9	4.3
50	5.4	5.7	6.0	6.0	5.8	5.6	5.8	5.8
95	6.5	7.0	6.9	7.0	6.8	6.8	6.8	6.8
Percentiles	**Calibration alternative 2 (robustness test).**							
15	4.3	4.8	5.1	5.0	5.0	4.6	4.8	4.8
50	5.4	5.7	6.0	6.0	5.8	5.6	5.8	5.8
85	6.2	6.5	6.6	6.6	6.6	6.5	6.6	6.5
DEC= Decentralization; ILR= Internal lateral relations; INV= Digital Business Model Innovativeness; IS= Information systems; SCT= Self-containment; SLR= Slack resources; STRAT= Strategic posture; TURB= Turbulence								

Appendix II-D. Assessment of Common Method Variance

Harman's (1967) single factor analysis.

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.939	31.96	31.96	16.318	30.788	30.788
2	3.667	6.919	38.879			
3	2.88	5.435	44.314			
4	2.14	4.037	48.351			
5	1.907	3.598	51.949			
6	1.49	2.81	54.759			
7	1.466	2.766	57.525			
8	1.237	2.333	59.858			
9	1.167	2.202	62.06			
10	1.068	2.015	64.076			
11	1.006	1.897	65.973			
12	0.951	1.795	67.768			
13	0.888	1.675	69.443			
14	0.847	1.597	71.04			
15	0.803	1.516	72.556			
16	0.758	Jan 43	73.986			
17	0.739	1.393	75.38			
18	0.681	1.284	76.664			
19	0.67	1.264	77.928			
20	0.623	1.176	79.105			
21	0.599	Jan 13	80.235			
22	0.579	1.092	81.327			
23	0.554	1.044	82.371			
24	0.539	1.018	83.389			
25	0.526	0.993	84.382			
26	0.514	0.97	85.352			
27	0.497	0.938	86.29			
28	0.459	0.867	87.156			
29	0.452	0.853	88.009			

30	0.427	0.806	88.814			
31	0.42	0.793	89.607			
32	0.39	0.737	90.344			
33	0.382	0.721	91.065			
34	0.367	0.693	91.758			
35	0.354	0.667	92.425			
36	0.329	0.622	93.046			
37	0.325	0.612	93.659			
38	0.298	0.562	94.221			
39	0.288	0.543	94.764			
40	0.273	0.515	95.278			
41	0.269	0.507	95.785			
42	0.252	0.476	96.261			
43	0.241	0.455	96.716			
44	0.231	0.435	97.151			
45	0.218	0.411	97.562			
46	0.207	0.39	97.952			
47	0.197	0.371	98.323			
48	0.169	0.32	98.642			
49	0.163	0.308	98.95			
50	0.156	0.293	99.244			
51	0.149	0.282	99.526			
52	0.131	0.246	99.772			
53	0.121	0.228	100.000			

Full Collinearity Test (Kock, 2015, p. 6; Kock & Lynn, 2012, p. 558).

Stage 1		Stage 2	
Latent variable	**Full collinearity VIFs**	**Latent variable**	**Full collinearity VIFs**
DEC	1.291	ELR	1.791
ELR	1.862	ILR	1.687
ILR	1.720	INV	1.656
IS	2.532	IS	2.321
MFE	1.999	OP	2.361
OP	2.514	SCT	1.734
RM	1.808	SLR	2.202
SLR	2.327	STRAT	2.583
STRAT	2.612	TURB	2.005
TURB	2.053		
VA	2.141		
VO	1.930		

Appendix II-E. Discriminant Validity Analysis Results

Cross loadings of reflective constructs.

	DEC	ILR	IS	MFE	OP	STRAT	SLR	TURB
DEC_3	**0.617**	0.186	0.227	0.095	0.274	0.226	0.285	0.119
DEC_4	**0.958**	0.319	0.509	0.459	0.501	0.465	0.473	0.325
ILR_1	0.221	**0.818**	0.489	0.426	0.384	0.430	0.450	0.480
ILR_3	0.197	**0.810**	0.508	0.402	0.346	0.426	0.467	0.525
ILR_4	0.364	**0.710**	0.422	0.394	0.342	0.448	0.381	0.372
ILR_5	0.266	**0.776**	0.461	0.407	0.353	0.420	0.436	0.443
IS_1	0.415	0.560	**0.874**	0.540	0.453	0.487	0.540	0.491
IS_3	0.472	0.520	**0.904**	0.616	0.545	0.615	0.588	0.532
MFE_1	0.350	0.436	0.573	**0.829**	0.467	0.463	0.510	0.433
MFE_2	0.332	0.420	0.542	**0.869**	0.500	0.491	0.530	0.417
MFE_3	0.388	0.480	0.544	**0.831**	0.496	0.462	0.516	0.303
OP_1	0.393	0.371	0.461	0.470	**0.816**	0.534	0.506	0.414
OP_2	0.444	0.409	0.492	0.472	**0.838**	0.649	0.555	0.395
OP_3	0.410	0.452	0.490	0.550	**0.842**	0.662	0.545	0.485
OP_4	0.441	0.393	0.466	0.468	**0.875**	0.607	0.523	0.419
OP_5	0.444	0.305	0.466	0.469	**0.829**	0.569	0.469	0.370
SP_1	0.329	0.466	0.522	0.475	0.605	**0.827**	0.483	0.558
SP_2	0.357	0.415	0.469	0.419	0.563	**0.776**	0.522	0.464
SP_3	0.398	0.496	0.581	0.504	0.624	**0.887**	0.628	0.557
SP_5	0.429	0.402	0.440	0.415	0.527	**0.747**	0.522	0.384
SR_1	0.412	0.480	0.569	0.537	0.485	0.524	**0.829**	0.396
SR_2	0.324	0.457	0.528	0.497	0.503	0.548	**0.815**	0.426
SR_3	0.418	0.436	0.444	0.438	0.480	0.529	**0.781**	0.388
SR_4	0.417	0.410	0.488	0.495	0.509	0.525	**0.777**	0.319
TURB_1	0.135	0.408	0.305	0.325	0.326	0.377	0.337	**0.724**
TURB_2	0.217	0.490	0.493	0.398	0.341	0.458	0.334	**0.756**
TURB_4	0.255	0.484	0.495	0.365	0.396	0.513	0.365	**0.817**
TURB_5	0.218	0.381	0.352	0.169	0.330	0.405	0.306	**0.600**
TURB_6	0.303	0.417	0.465	0.422	0.424	0.492	0.419	**0.788**

Pearson correlations of reflective constructs.

N= 251		DEC	ILR	IS	MFE	OP	SLR	STRAT	TURB
DEC	Correlation	1	.327**	.500**	.417**	.508**	.488**	.463**	.311**
ILR	Correlation	.327**	1	.605**	.522**	.457**	.558**	.551**	.588**
IS	Correlation	.500**	.605**	1	.652**	.564**	.635**	.624**	.576**
MFE	Correlation	.417**	.522**	.652**	1	.577**	.614**	.561**	.461**
OP	Correlation	.508**	.457**	.564**	.577**	1	.616**	.716**	.495**
SLR	Correlation	.488**	.558**	.635**	.614**	.616**	1	.664**	.480**
STRAT	Correlation	.463**	.551**	.624**	.561**	.716**	.664**	1	.611**
TURB	Correlation	.311**	.588**	.576**	.461**	.495**	.480**	.611**	1

**Correlation is significant at the α 0.01 level (2-tailed).

DEC= Decentralization; ILR= Internal lateral relations; IS= Information systems; MFE= Employee multifunctionality; OP= Organizational performance; SLR= Slack resources; STRAT= Strategic posture; TURB= Turbulence

Appendix II-F. Truth Table Analysis (Effective Digital IM)

Truth table (effective digital IM).

ELR	ILR	IS	SCT	SLR	STRAT	TURB	n	INV	RAW	PRI
1	1	1	1	1	1	1	52	**1**	**0.95**	**0.91**
0	1	1	1	1	1	1	3	**1**	**0.96**	**0.87**
1	0	1	1	1	1	1	4	**1**	**0.96**	**0.87**
1	1	1	1	0	1	1	5	**1**	**0.96**	**0.86**
1	1	1	1	1	0	1	3	**1**	**0.94**	**0.78**
0	1	1	1	1	1	0	5	**1**	**0.96**	**0.77**
1	0	1	1	1	1	0	3	**1**	**0.95**	**0.76**
1	1	1	0	1	1	1	3	**1**	**0.93**	**0.73**
1	1	0	1	1	1	1	3	**1**	**0.92**	**0.73**
1	1	1	1	1	1	0	5	**1**	**0.92**	**0.69**
0	0	0	1	0	1	1	2	**1**	**0.94**	**0.68**
0	1	1	0	1	1	1	4	**1**	**0.93**	**0.67**
1	1	0	1	0	1	1	4	**1**	**0.93**	**0.67**
0	0	0	1	1	1	0	2	0	0.92	0.63
0	0	1	1	0	1	0	2	0	0.94	0.62
1	1	1	0	1	0	1	3	0	0.94	0.61
0	0	0	0	1	1	1	2	0	0.92	0.61
1	1	1	1	1	0	0	3	0	0.91	0.59
0	1	1	0	0	0	1	4	0	0.91	0.52
1	1	1	0	0	1	0	2	0	0.92	0.50
1	0	0	0	0	1	1	2	0	0.89	0.47
1	1	0	1	1	0	0	2	0	0.88	0.43
1	1	0	0	0	1	1	3	0	0.88	0.42
1	0	0	1	1	0	0	2	0	0.87	0.41
0	0	1	0	0	0	1	2	0	0.87	0.39
0	0	0	1	0	0	1	2	0	0.87	0.39
1	0	1	0	1	0	0	2	0	0.89	0.38
0	0	0	1	1	0	0	2	0	0.86	0.38
0	1	1	1	0	0	0	2	0	0.89	0.34
0	0	0	0	0	1	0	2	0	0.80	0.34
0	0	1	0	1	0	0	2	0	0.87	0.33
0	0	0	0	0	0	1	7	0	0.78	0.32
0	0	1	1	0	0	0	2	0	0.85	0.31
1	1	0	0	0	0	1	2	0	0.84	0.31
1	1	1	0	0	0	0	2	0	0.88	0.29
0	0	0	0	1	0	0	5	0	0.78	0.24
0	1	0	1	0	0	0	2	0	0.82	0.22
0	0	0	1	0	0	0	5	0	0.74	0.21
0	0	1	0	0	0	0	4	0	0.78	0.16
0	1	0	0	0	0	0	5	0	0.75	0.15
1	0	0	0	0	0	0	5	0	0.73	0.14
0	0	0	0	0	0	0	42	0	0.48	0.08

DEC= Decentralization; ILR= Internal lateral relations; INV= Digital Business Model Innovativeness; IS= Information systems; SCT= Self-containment; SLR= Slack resources; STRAT= Strategic posture; TURB= Turbulence

Results of truth table analysis.

```
*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.915318
                                        raw       unique
                                      coverage    coverage   consistency
                                     ----------  ----------  ----------
ELR*IS*SCT*SLR*STRAT                 0.503758    0.0290409   0.928333
ILR*IS*SCT*SLR*STRAT                 0.502336    0.00885296  0.934697
ELR*ILR*SCT*STRAT*TURB               0.522334    0.0565957   0.922777
ILR*IS*SLR*STRAT*TURB                0.509766    0.0354909   0.937764
ELR*ILR*IS*SCT*SLR*TURB              0.463446    0.0105919   0.947174
~ELR*~ILR*~IS*SCT*~SLR*STRAT*TURB    0.164444    0.015888    0.937708
solution coverage: 0.665484
solution consistency: 0.896593


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.915318
                      raw       unique
                    coverage    coverage   consistency
                   ----------  ----------  ----------
IS*SLR*STRAT       0.589917    0.0856052   0.907026
ELR*SCT*TURB       0.578535    0.0263219   0.89584
SCT*STRAT*TURB     0.603434    0.0233181   0.909352
solution coverage: 0.715361
solution consistency: 0.87078


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.915318
Assumptions:
                                        raw       unique
                                      coverage    coverage   consistency
                                     ----------  ----------  ----------
ELR*IS*SCT*SLR*STRAT                 0.503758    0.0290409   0.928333
ILR*IS*SCT*SLR*STRAT                 0.502336    0.00885296  0.934697
ELR*ILR*SCT*STRAT*TURB               0.522334    0.0565957   0.922777
ILR*IS*SLR*STRAT*TURB                0.509766    0.0354909   0.937764
ELR*ILR*IS*SCT*SLR*TURB              0.463446    0.0105919   0.947174
~ELR*~ILR*~IS*SCT*~SLR*STRAT*TURB    0.164444    0.015888    0.937708
solution coverage: 0.665484
solution consistency: 0.896593
```

Appendix II-G. Robustness Analysis

Alternative calibration 1 applied to all variables.

```
*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV_a1 = f(ELR_a1, ILR_a1, IS_a1, SCT_a1, SLR_a1, STRAT_a1, TURB_a1)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.945282
                                                            raw       unique
                                                          coverage   coverage   consistency
                                                         ---------- ---------- ----------
ELR_a1*IS_a1*SCT_a1*SLR_a1*STRAT_a1                      0.559874   0.0189411  0.946584
ILR_a1*IS_a1*SCT_a1*SLR_a1*STRAT_a1                      0.557687   0.00573057 0.9515
ELR_a1*ILR_a1*IS_a1*SLR_a1*TURB_a1                       0.53861    0.0137232  0.951893
ELR_a1*ILR_a1*SCT_a1*STRAT_a1*TURB_a1                    0.566886   0.0448796  0.941516
ILR_a1*IS_a1*SLR_a1*STRAT_a1*TURB_a1                     0.551353   0.00490111 0.954944
~ELR_a1*~ILR_a1*IS_a1*SCT_a1*~SLR_a1*STRAT_a1*~TURB_a1   0.230318   0.00564015 0.962259
~ELR_a1*~ILR_a1*~IS_a1*SCT_a1*SLR_a1*STRAT_a1*~TURB_a1   0.25514    0.0130144  0.949597
~ELR_a1*~ILR_a1*~IS_a1*SCT_a1*~SLR_a1*STRAT_a1*TURB_a1   0.226367   0.00853562 0.956844
~ELR_a1*~ILR_a1*~IS_a1*~SCT_a1*SLR_a1*STRAT_a1*TURB_a1   0.22691    0.00868624 0.954879
solution coverage: 0.732727
solution consistency: 0.915114


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV_a1 = f(ELR_a1, ILR_a1, IS_a1, SCT_a1, SLR_a1, STRAT_a1, TURB_a1)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.945282
                       raw       unique
                     coverage   coverage   consistency
                    ---------- ---------- ----------
SCT_a1*STRAT_a1     0.724629   0.127732   0.8823
SLR_a1*TURB_a1      0.679915   0.0830183  0.893127
solution coverage: 0.807648
solution consistency: 0.856128


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV_a1 = f(ELR_a1, ILR_a1, IS_a1, SCT_a1, SLR_a1, STRAT_a1, TURB_a1)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.945282
Assumptions:
                                                            raw       unique
                                                          coverage   coverage   consistency
                                                         ---------- ---------- ----------
ELR_a1*IS_a1*SCT_a1*SLR_a1*STRAT_a1                      0.559874   0.0189411  0.946584
ILR_a1*IS_a1*SCT_a1*SLR_a1*STRAT_a1                      0.557687   0.00573057 0.9515
ELR_a1*ILR_a1*IS_a1*SLR_a1*TURB_a1                       0.53861    0.0137232  0.951893
ELR_a1*ILR_a1*SCT_a1*STRAT_a1*TURB_a1                    0.566886   0.0448796  0.941516
ILR_a1*IS_a1*SLR_a1*STRAT_a1*TURB_a1                     0.551353   0.00490111 0.954944
~ELR_a1*~ILR_a1*IS_a1*SCT_a1*~SLR_a1*STRAT_a1*~TURB_a1   0.230318   0.00564015 0.962259
~ELR_a1*~ILR_a1*~IS_a1*SCT_a1*SLR_a1*STRAT_a1*~TURB_a1   0.25514    0.0130144  0.949597
~ELR_a1*~ILR_a1*~IS_a1*SCT_a1*~SLR_a1*STRAT_a1*TURB_a1   0.226367   0.00853562 0.956844
~ELR_a1*~ILR_a1*~IS_a1*~SCT_a1*SLR_a1*STRAT_a1*TURB_a1   0.22691    0.00868624 0.954879
solution coverage: 0.732727
solution consistency: 0.915114
```

Alternative calibration 2 applied to all variables.

```
*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV_a2 = f(ELR_a2, ILR_a2, IS_a2, SCT_a2, SLR_a2, STRAT_a2, TURB_a2)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.874939
                                                              raw       unique
                                                            coverage    coverage   consistency
                                                           ----------  ----------  ----------
ELR_a2*IS_a2*SCT_a2*SLR_a2*STRAT_a2                        0.465719    0.0246506   0.913765
ILR_a2*IS_a2*SCT_a2*SLR_a2*STRAT_a2                        0.464535    0.00836408  0.923742
ELR_a2*ILR_a2*IS_a2*SLR_a2*TURB_a2                         0.460353    0.019411    0.920191
ELR_a2*ILR_a2*SCT_a2*STRAT_a2*TURB_a2                      0.48947     0.0581232   0.909932
ILR_a2*IS_a2*SLR_a2*STRAT_a2*TURB_a2                       0.470848    0.00694388  0.926698
~ELR_a2*~ILR_a2*IS_a2*SCT_a2*~SLR_a2*STRAT_a2*~TURB_a2     0.109255    0.00519204  0.922206
~ELR_a2*~ILR_a2*~IS_a2*SCT_a2*SLR_a2*STRAT_a2*~TURB_a2     0.128224    0.0115677   0.894037
~ELR_a2*~ILR_a2*~IS_a2*SCT_a2*~SLR_a2*STRAT_a2*TURB_a2     0.111969    0.00964242  0.910199
~ELR_a2*~ILR_a2*~IS_a2*~SCT_a2*SLR_a2*STRAT_a2*TURB_a2     0.118077    0.012625    0.891776
solution coverage: 0.671446
solution consistency: 0.877275


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV_a2 = f(ELR_a2, ILR_a2, IS_a2, SCT_a2, SLR_a2, STRAT_a2, TURB_a2)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.874939
                       raw       unique
                     coverage    coverage   consistency
                    ----------  ----------  ----------
SCT_a2*STRAT_a2     0.650678    0.13067     0.846961
SLR_a2*TURB_a2      0.629057    0.109049    0.851256
solution coverage: 0.759727
solution consistency: 0.814209


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV_a2 = f(ELR_a2, ILR_a2, IS_a2, SCT_a2, SLR_a2, STRAT_a2, TURB_a2)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.874939
Assumptions:
                                                              raw       unique
                                                            coverage    coverage   consistency
                                                           ----------  ----------  ----------
ELR_a2*IS_a2*SCT_a2*SLR_a2*STRAT_a2                        0.465719    0.0246506   0.913765
ILR_a2*IS_a2*SCT_a2*SLR_a2*STRAT_a2                        0.464535    0.00836408  0.923742
ELR_a2*ILR_a2*IS_a2*SLR_a2*TURB_a2                         0.460353    0.019411    0.920191
ELR_a2*ILR_a2*SCT_a2*STRAT_a2*TURB_a2                      0.48947     0.0581232   0.909932
ILR_a2*IS_a2*SLR_a2*STRAT_a2*TURB_a2                       0.470848    0.00694388  0.926698
~ELR_a2*~ILR_a2*IS_a2*SCT_a2*~SLR_a2*STRAT_a2*~TURB_a2     0.109255    0.00519204  0.922206
~ELR_a2*~ILR_a2*~IS_a2*SCT_a2*SLR_a2*STRAT_a2*~TURB_a2     0.128224    0.0115677   0.894037
~ELR_a2*~ILR_a2*~IS_a2*SCT_a2*~SLR_a2*STRAT_a2*TURB_a2     0.111969    0.00964242  0.910199
~ELR_a2*~ILR_a2*~IS_a2*~SCT_a2*SLR_a2*STRAT_a2*TURB_a2     0.118077    0.012625    0.891776
solution coverage: 0.671446
solution consistency: 0.877275
```

Frequency threshold set to 3 cases.

```
*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 3
consistency cutoff: 0.915318
                              raw       unique
                            coverage    coverage   consistency
                           ----------  ----------  ----------
ELR*IS*SCT*SLR*STRAT        0.503758    0.0316967   0.928333
ILR*IS*SCT*SLR*STRAT        0.502336    0.0088529   0.934697
ELR*ILR*SCT*STRAT*TURB      0.522334    0.06948     0.922777
ILR*IS*SLR*STRAT*TURB       0.509766    0.0354909   0.937764
ELR*ILR*IS*SCT*SLR*TURB     0.463446    0.0105919   0.947174
solution coverage: 0.649596
solution consistency: 0.897751


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 3
consistency cutoff: 0.915318
                raw       unique
              coverage    coverage   consistency
             ----------  ----------  ----------
SCT*TURB      0.645169    0.0959603   0.877353
SLR*STRAT     0.682873    0.133664    0.850297
solution coverage: 0.778834
solution consistency: 0.8291


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 3
consistency cutoff: 0.915318
Assumptions:
                              raw       unique
                            coverage    coverage   consistency
                           ----------  ----------  ----------
ELR*IS*SCT*SLR*STRAT        0.503758    0.0316967   0.928333
ILR*IS*SCT*SLR*STRAT        0.502336    0.0088529   0.934697
ELR*ILR*SCT*STRAT*TURB      0.522334    0.06948     0.922777
ILR*IS*SLR*STRAT*TURB       0.509766    0.0354909   0.937764
ELR*ILR*IS*SCT*SLR*TURB     0.463446    0.0105919   0.947174
solution coverage: 0.649596
solution consistency: 0.897751
```

Frequency threshold set to 4 cases.

```
*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 4
consistency cutoff: 0.915318
                                       raw       unique
                                     coverage    coverage   consistency
                                    ----------  ----------  ----------
ILR*IS*SCT*SLR*STRAT*~TURB          0.240904    0.025816    0.913661
ELR*ILR*SCT*~SLR*STRAT*TURB         0.237916    0.0356017   0.929297
ELR*IS*SCT*SLR*STRAT*TURB           0.476409    0.213642    0.945858
~ELR*ILR*IS*~SCT*SLR*STRAT*TURB     0.178419    0.0216108   0.931496
solution coverage: 0.563832
solution consistency: 0.915169


*********************
*TRUTH TABLE ANALYSIS*
*********************
Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 4
consistency cutoff: 0.915318
             raw       unique
           coverage    coverage   consistency
          ----------  ----------  ----------
STRAT     0.807369    0.807369    0.797596
solution coverage: 0.807369
solution consistency: 0.797596


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 4
consistency cutoff: 0.915318
Assumptions:
                                       raw       unique
                                     coverage    coverage   consistency
                                    ----------  ----------  ----------
ILR*IS*SCT*SLR*STRAT*~TURB          0.240904    0.025816    0.913661
ELR*ILR*SCT*~SLR*STRAT*TURB         0.237916    0.0356017   0.929297
ELR*IS*SCT*SLR*STRAT*TURB           0.476409    0.213642    0.945858
~ELR*ILR*IS*~SCT*SLR*STRAT*TURB     0.178419    0.0216108   0.931496
solution coverage: 0.563832
solution consistency: 0.915169
```

Adjusted consistency thresholds (Raw: 0.94 / PRI: 0.75)

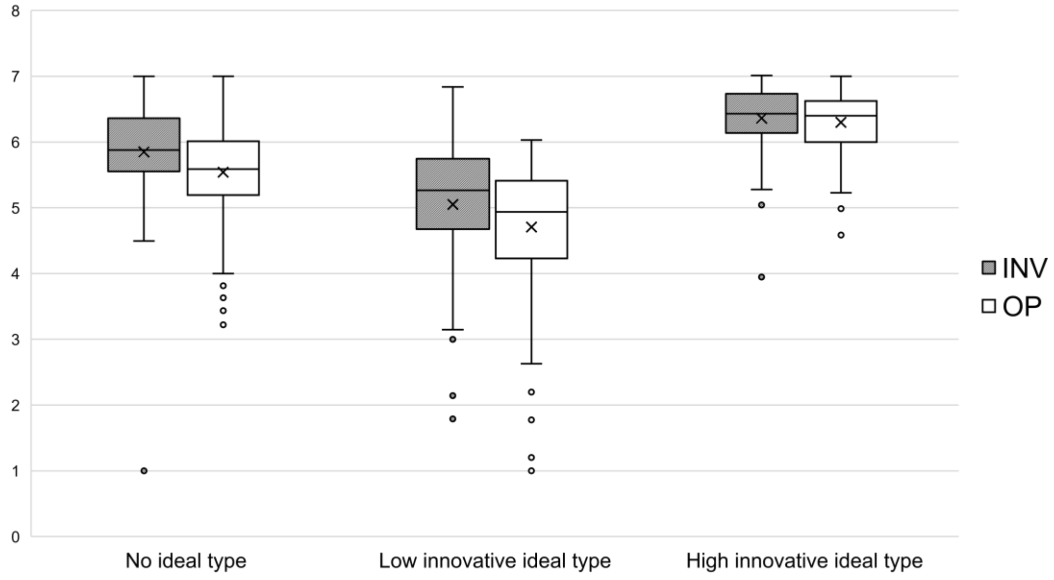
```
*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.944192
                               raw       unique
                              coverage    coverage   consistency
                             ----------  ----------  ----------
ELR*~ILR*IS*SCT*SLR*STRAT     0.250263    0.0292308   0.941759
~ELR*ILR*IS*SCT*SLR*STRAT     0.234557    0.0237449   0.956424
ELR*ILR*IS*SCT*SLR*TURB       0.463446    0.010592    0.947174
ELR*ILR*IS*SCT*STRAT*TURB     0.479808    0.0269542   0.948587
solution coverage: 0.552687
solution consistency: 0.938096


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.944192
                          raw       unique
                         coverage    coverage   consistency
                        ----------  ----------  ----------
IS*SCT*TURB              0.5715      0.356444    0.927995
~ELR*ILR*SLR*~TURB       0.242493    0.0284245   0.85516
ELR*~ILR*STRAT*~TURB     0.262262    0.0393642   0.870177
solution coverage: 0.675934
solution consistency: 0.876724


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.944192
Assumptions:
                               raw       unique
                              coverage    coverage   consistency
                             ----------  ----------  ----------
ELR*~ILR*IS*SCT*SLR*STRAT     0.250263    0.0292308   0.941759
~ELR*ILR*IS*SCT*SLR*STRAT     0.234557    0.0237449   0.956424
ELR*ILR*IS*SCT*SLR*TURB       0.463446    0.010592    0.947174
ELR*ILR*IS*SCT*STRAT*TURB     0.479808    0.0269542   0.948587
solution coverage: 0.552687
solution consistency: 0.938096
```

Adjusted consistency thresholds (Raw: 0.91 / PRI: 0.50)

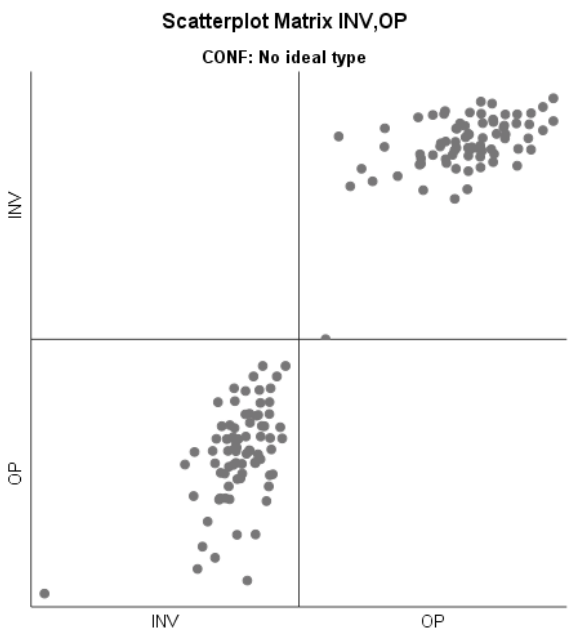
```
*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.910472
                                        raw       unique
                                      coverage    coverage   consistency
                                     ----------  ----------  ----------
ELR*ILR*IS*SCT*SLR                   0.484788    0.0021342   0.927978
ELR*IS*SCT*SLR*STRAT                 0.503758    0.0216898   0.928333
ILR*IS*SCT*SLR*STRAT                 0.502336    0.00695592  0.934697
ELR*ILR*IS*SLR*TURB                  0.495696    0.0037151   0.932908
ELR*ILR*SCT*STRAT*TURB               0.522334    0.0528334   0.922777
ILR*IS*SLR*STRAT*TURB                0.509766    0.00624454  0.937764
~ELR*~ILR*IS*SCT*~SLR*STRAT*~TURB    0.162784    0.0052011   0.937625
~ELR*~ILR*~IS*SCT*SLR*STRAT*~TURB    0.183146    0.0105605   0.924286
~ELR*ILR*IS*~SCT*~SLR*~STRAT*TURB    0.169471    0.0154296   0.91413
~ELR*~ILR*~IS*SCT*~SLR*STRAT*TURB    0.164444    0.00878978  0.937708
~ELR*~ILR*~IS*~SCT*SLR*STRAT*TURB    0.169961    0.0126472   0.920462
solution coverage: 0.717527
solution consistency: 0.880225


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.910472
                  raw       unique
                coverage    coverage   consistency
               ----------  ----------  ----------
SCT*STRAT      0.679395    0.0370719   0.856589
ILR*IS*SLR     0.569365    0.00592828  0.894117
ILR*IS*TURB    0.589996    0.0223696   0.910467
SLR*STRAT      0.682873    0.0373089   0.850297
solution coverage: 0.806104
solution consistency: 0.810525


*********************
*TRUTH TABLE ANALYSIS*
*********************

Model: INV = f(ELR, ILR, IS, SCT, SLR, STRAT, TURB)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.910472
Assumptions:
                                        raw       unique
                                      coverage    coverage   consistency
                                     ----------  ----------  ----------
ELR*ILR*IS*SCT*SLR                   0.484788    0.0021342   0.927978
ELR*IS*SCT*SLR*STRAT                 0.503758    0.0216898   0.928333
ILR*IS*SCT*SLR*STRAT                 0.502336    0.00695592  0.934697
ELR*ILR*IS*SLR*TURB                  0.495696    0.0037151   0.932908
ELR*ILR*SCT*STRAT*TURB               0.522334    0.0528334   0.922777
ILR*IS*SLR*STRAT*TURB                0.509766    0.00624454  0.937764
~ELR*~ILR*IS*SCT*~SLR*STRAT*~TURB    0.162784    0.0052011   0.937625
~ELR*~ILR*~IS*SCT*SLR*STRAT*~TURB    0.183146    0.0105605   0.924286
~ELR*ILR*IS*~SCT*~SLR*~STRAT*TURB    0.169471    0.0154296   0.91413
~ELR*~ILR*~IS*SCT*~SLR*STRAT*TURB    0.164444    0.00878978  0.937708
~ELR*~ILR*~IS*~SCT*SLR*STRAT*TURB    0.169961    0.0126472   0.920462
solution coverage: 0.717527
solution consistency: 0.880225
```

Appendix II-H. MANOVA results

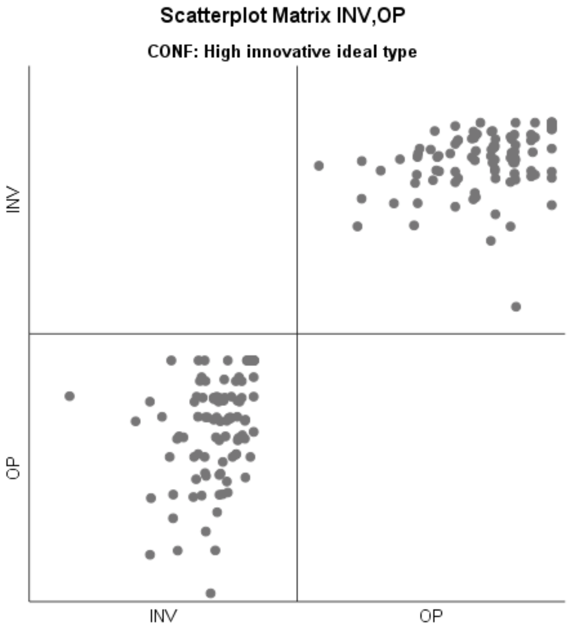
Boxplot for assessing univariate outliers.



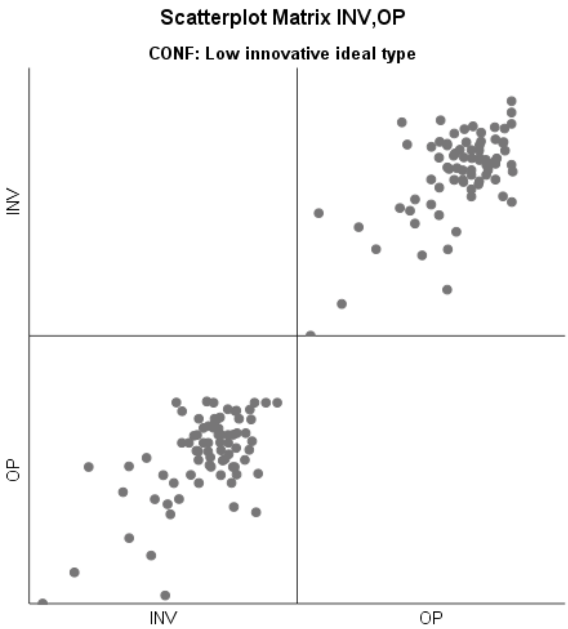
Scatterplot matrix for assessing linear relationship between each pair of dependent variables: companies not exhibiting one of the identified configurations.



Scatterplot matrix for assessing linear relationship between each pair of dependent variables: companies with membership in the high innovative configurations.



Scatterplot matrix for assessing linear relationship between each pair of dependent variables: companies with membership in the low innovative configurations.



Box's test of equality of covariance matrices[a].

Box's M	67.176
F	11.064
df1	6
df2	1225315
Sig.	.000
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups. a: Design: Intercept + ISCONF	

Levene's test of equality of error variances[a].

		Levene Statistic	df1	df2	Sig.
INV	Based on Mean	9.907	2	248	0.000
	Based on Median	7.799	2	248	0.001
	Based on Median and with adjusted df	7.799	2	184.989	0.001
	Based on trimmed mean	8.676	2	248	0.000
OP	Based on Mean	9.431	2	248	0.000
	Based on Median	8.151	2	248	0.000
	Based on Median and with adjusted df	8.151	2	180.205	0.000
	Based on trimmed mean	8.480	2	248	0.000
Tests the null hypothesis that the error variance of the dependent variable is equal across groups. a: Design: Intercept + ISCONF					

Descriptive statistics.

		Mean	Std. Deviation	N
INV	No ideal type	5.851	0.789	77
	Low innovative ideal type	5.050	1.053	78
	High innovative ideal type	6.363	0.512	96
	Total	5.798	0.963	251
OP	No ideal type	5.540	0.796	77
	Low innovative ideal type	4.706	1.060	78
	High innovative ideal type	6.297	0.535	96
	Total	5.570	1.041	251

Multivariate tests[a].

Effect		Value	F	Hypo-thesis df	Error df	Sig.	Partial η^2
Intercept	Pillai's Trace	0.985	7948.198[b]	2.000	247.000	0.000	0.985
	Wilks' Lambda	0.015	7948.198[b]	2.000	247.000	0.000	0.985
	Hotelling's Trace	64.358	7948.198[b]	2.000	247.000	0.000	0.985
	Roy's Largest Root	64.358	7948.198[b]	2.000	247.000	0.000	0.985
CONF	Pillai's Trace	0.436	34.603	4.000	496.000	0.000	0.218
	Wilks' Lambda	0.566	40.659[b]	4.000	494.000	0.000	0.248
	Hotelling's Trace	0.763	46.907	4.000	492.000	0.000	0.276
	Roy's Largest Root	0.757	93.901[c]	2.000	248.000	0.000	0.431

a: Design: Intercept + ISCONF

b: Exact statistic

c: The statistic is an upper bound on F that yields a lower bound on the significance level.

Results of univariate one-way ANOVAs: tests of between-subjects effects.

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial η^2
Corrected Model	INV	74.471[a]	2	37.235	58.603	0.000	0.321
	OP	109.144[b]	2	54.572	83.663	0.000	0.403
Intercept	INV	8228.002	1	8228.002	12949.665	0.000	0.981
	OP	7554.967	1	7554.967	11582.363	0.000	0.979
CONF	INV	74.471	2	37.235	58.603	0.000	0.321
	OP	109.144	2	54.572	83.663	0.000	0.403
Error	INV	157.575	248	0.635			
	OP	161.766	248	0.652			
Total	INV	8669.736	251				
	OP	8059.297	251				
Corrected Total	INV	232.046	250				
	OP	270.910	250				

a: R Squared = .321 (Adjusted R Squared = .315)

b: R Squared = .403 (Adjusted R Squared = .398)

Multiple comparisons: Games-Howell post hoc tests.

Dependent Variable	(I) CONF	(J) CONF	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
INV	*No ideal type*	*Low innovative ideal type*	*0.801**	*0.149*	*0.000*	*0.447*	*1.155*
		High innovative ideal type	-0.512*	0.104	0.000	-0.758	-0.265
	Low innovative ideal type	No ideal type	-0.801*	0.149	0.000	-1.155	-0.447
		High innovative ideal type	-1.313*	0.130	0.000	-1.622	-1.003
	High innovative ideal type	*No ideal type*	*0.512**	*0.104*	*0.000*	*0.265*	*0.758*
		Low innovative ideal type	*1.313**	*0.130*	*0.000*	*1.003*	*1.622*
OP	*No ideal type*	*Low innovative ideal type*	*0.834**	*0.150*	*0.000*	*0.478*	*1.191*
		High innovative ideal type	-0.757*	0.106	0.000	-1.009	-0.506
	Low innovative ideal type	No ideal type	-0.834*	0.150	0.000	-1.191	-0.478
		High innovative ideal type	-1.592*	0.132	0.000	-1.905	-1.279
	High innovative ideal type	*No ideal type*	*0.757**	*0.106*	*0.000*	*0.506*	*1.009*
		Low innovative ideal type	*1.592**	*0.132*	*0.000*	*1.279*	*1.905*

Based on observed means. The error term is Mean Square(Error) = .652

* The mean difference is significant at the .05 level.

III

BALANCING ALIGNMENT, AGILITY, AND EFFICIENCY – TOWARD SUSTAINABLE IT PROJECT PORTFOLIO MANAGEMENT

Abstract

Today's digital technologies dominate over products, services, and operations while the lifecycle of technologies becomes shorter and evolves at an unprecedented rate. Hence, our era of digital enterprise transformations puts significant pressure on contemporary organizations; this phenomenon in turn forces organizations to proactively respond to changing strategic trajectories and work on a multiplicity of projects to capitalize on emerging opportunities. Despite a general acknowledgement that these developments require tremendous efforts from organizations, the organizations often encounter difficulties such as failing to achieve the desired project throughput, struggling with projects that run late, and missing short-term alignment to strategic changes. Many companies today employ institutionalized IT project portfolio management (IT PPM) for tasks such as project evaluation and selection. However, traditional approaches often establish a long-term horizon, which contradicts the necessity to react at short notice. This calls for the refinement of IT PPM towards an aligned yet more flexible approach that is able to adapt to changes as needed. Firms often find themselves incapable of adjusting their operations swiftly; moreover, associated issues are often not solely rooted in formalized processes but in the organizational culture and history or power structures. Thus, this study takes a critical-dialogic stance and applies activity theory (AT) to investigate a revelatory case by uncovering the processes at work that hamper a flexible approach to IT PPM. Subsequently, the study derives recommendations to overcome the identified issues. To increase validity of the findings, the study conducted a focus group that would help to refine the study's recommendations and to evaluate the results in a series of structured expert interviews. The research here contributes to the current body of knowledge by providing a new analytical view on IT PPM and by suggesting recommendations for a significant problem in practice.

Keywords: *IT PPM, agility, alignment, efficiency, sustainability, revelatory case*

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Table of Contents

List of Figures

List of Tables

1 Introduction

Emerging digital technologies are fundamentally and rapidly reshaping customers' needs, and they hold a multitude of opportunities for companies to realize new innovative products and services (Fichman, Dos Santos, & Zheng, 2014, p. 332). Companies need to proactively explore new competencies and incorporate those technological developments into their business operations to improve their competitive edge (Yoo, Henfridsson, & Lyytinen, 2010, p. 730). At the same time, organizations need to exploit their existing IT capabilities so as to effectively support their chosen business strategy, business processes, and operations (Henderson & Venkatraman, 1990, p. 25). These opposing demands amplify the need for organizations to maintain an increasingly large inventory of heterogeneous IT projects, and many companies utilize IT project portfolio management (IT PPM) to select, prioritize, and monitor the organizational set of often interdependent initiatives that compete for scarce resources and vary considerably in size, objectives, and complexity (Archer & Ghasemzadeh, 1999, p. 208). IT PPM drives value creation in a number of ways, namely by aligning IT project efforts with business objectives, providing transparency about initiatives, improving planning and coordination across projects, maximizing benefits of IT investments, and ensuring cost-effective project operations (Maizlish & Handler, 2005, p. 180; Pellegrinelli, 1997, p. 142).

However, evolving technologies that disrupt companies' traditional operating models and the dynamic nature of business demands cause uncertainty, ambiguity, and variability in the IT PPM function (Karimi & Walter, 2015, p. 40; Lee, DeLone, & Espinosa, 2007, p. 4). This situation requires a flexible adjustment of IT project portfolios and the pressuring of organizations to deliver projects at an increasing and unparalleled rate (Kock & Gemünden, 2016, pp. 670–671). Research showed that organizations which are able to quickly identify and implement IT-supported innovations are more successful than organizations with a reactive IT investment behavior (Sambamurthy, Bharadwaj, & Grover, 2003, p. 238). A nascent body of research further has claimed that firms should simultaneously pursue organizational alignment and rapid adaptations to short-term opportunities if they are to sustain their business (Gibson & Birkinshaw, 2004, p. 209; Merali, 2016, pp. 265–266). This dual focus requires firms to quickly explore new emerging digital technologies and strategies while concurrently ensuring the stability, reliability, and efficient use of existing resources for traditional enterprise IT systems (Gregory, Keil, Muntermann, & Mähring, 2015, p. 69). A few factors—namely the pace of change in the environment, short-term cost pressures, and a lack of management attention—increasingly jeopardize the idea of alignment with long-term goals and objectives, as this idea calls for a more sustainable approach that allows for the flexible re-prioritization and selection of projects as needed (O'Reilly & Tushman, 2008, p. 199; Vessey & Ward, 2013, p. 284). This urges IT PPM to establish rigor and discipline in its task execution while also building flexibility and agility to quickly sense important changes and to respond to them in a timely manner (Lee, DeLone, & Espinosa, 2006, p. 36; Mithas & Rust, 2016, pp. 237–238). However, organizations often base IT PPM on annual budget planning (Reyck et al., 2005, p. 529), and therefore this may not allow IT PPM to execute beneficial projects swiftly or to adaptively refine the portfolio structure without negative side effects (Bogsnes, 2016, p. 49; Daniel, Ward, & Franken, 2014, pp. 95–97). Research has pointed out that organizations face challenges when they seek to balance a consistent organizational alignment and the deliberate engagement in experimental activities to explore emerging opportunities (Kock & Gemünden, 2016, p. 678; O'Reilly & Tushman, 2008, p. 193; Raisch, Birkinshaw, Probst, & Tushman, 2009, p. 687). While this balancing act was often investigated from an corporate level (O'Reilly & Tushman, 2011, p. 9), researchers have strongly suggested that the mechanisms and associated impediments of balancing rigor and agility should be investigated at lower levels due to the heterogeneity (e.g., diversity of objectives and capabilities) across different units and project types within a firm (O'Reilly & Tushman, 2008, p. 201; Raisch et al., 2009, p. 693).

To date, studies at the project portfolio level have primarily investigated the phenomenon in the manufacturing or construction industries (Eriksson, 2013, p. 334). These are sectors that are currently said to still experience relatively little turbulence caused by digital technologies compared to other industries (Deloitte, 2015, p. 10). So far, no research has addressed this balancing act at a project portfolio level in an IT context. This is particularly striking, since today's IT context—which has been affected by the advent of digital innovation—is often characterized by complexity, uncertainty, and vigor, embedded in a harsh business climate with a high degree of competition (Nylén & Holmström, 2015, p. 59). This tension necessitates firms to address competing concerns as well as balance control and flexibility to explore new digital options through IT projects, but they must do this without jeopardizing existing competencies or falling into a rigidity trap (Svahn, Mathiassen, & Lindgren, 2017, p. 240). While existing research has yielded a broad range of publications on optimization approaches and mathematical models for IT PPM (Kaiser, El Arbi, & Ahlemann, 2015, p. 127), it has offered very little advice on how organizations can achieve a more balanced approach to IT PPM (Daniel et al., 2014, pp. 95–96; Frey & Buxmann, 2012, p. 1). Thus, we know too little about the challenges that hinder the effective orchestration of heterogeneous demands of alignment, flexibility, and efficiency on the IT PPM level, or about the ways to implement such an approach in practice (Gregory et al., 2015, p. 77). Against this backdrop, we aim to answer the following research question:

RQ: *How can organizations achieve an aligned and agile yet efficient IT PPM?*

From this, we derive two main research objectives, which are to empirically explore the problems that often impede a balanced portfolio and to derive requirements and recommendations for an IT PPM that is aligned and efficient yet adaptive to changing trajectories. While a clear strategic intent and effective decision processes are regarded as crucial factors for portfolio agility and success (Kock & Gemünden, 2016, pp. 670–671), prior findings indicate that complex dynamic power structures and opportunistic behavior of stakeholders are often found to result in ineffectiveness and inertia in IT PPM (El Arbi, Ahlemann, & Kaiser, 2012, p. 1; Martinsuo, 2013, p. 796). In this study, we take a critical-dialogic stance—which is so far underrepresented in this field of research (Hansen & Kræmmergard, 2014, p. 46)—in order to understand the intergroup tensions, human agency, social and material practices, information flows, and power dynamics that may have a negative impact on achieving a balanced IT PPM. Since critical-dialogical discourse emphasizes the analysis of cross-group relationships and agential asymmetries of power, motivations, and interests between stakeholders, this approach is particularly suited to deepen the examination of the potential tensions and their effects identified in previous studies (Tropp, 2012, p. 214). To empirically unravel the root causes associated with an imbalance of IT PPM agility and rigor, we first investigate a revelatory case to develop an in-depth understanding of the current IT PPM internal and external challenges and ultimately derive requirements and recommendations for a more balanced configuration. We employed Engeström's (1987, p. xvi) activity theory (AT) as guiding lens for our case study, as this was suggested by prior researchers as a systematic approach to investigate complex sociotechnical problems in project-based organizations (Vakkayil, 2010, p. 2). AT is particularly suited for a critical-dialogical approach, since it is situated in a Marxian tradition regarding dialectically changing social and material structures as well as agential activities (Engeström, 1987, p. 27). By offering an integrative framework for the analysis and transformation of work practices, AT postulates that studies of work systems should consider not only the activity itself, but also the subjects that engage in particular activities, goals, motives, organizational history, applied tools, norms and rules that guide interactions, and the social communities in which activities take place (Fuentes, Gómez-Sanz, & Pavón, 2004, p. 528). After our case study, we evaluated our intermediate recommendations in a focus group with subject-matter experts for further refinement. Finally, we subjected our refined set of recommendations to a series of structured expert interviews to test the utility of our recommendations.

Our research makes two important contributions to the field of IT PPM. First, we present a novel and theoretically grounded perspective on IT PPM, and in doing so we provide a new way to analyze project portfolio imbalances. Second, we develop requirements and recommendations to provide guidance for implementing mechanisms that allow tensions to be mitigated and that help to sustain alignment, agility, and efficiency on the level of IT PPM.

In the remainder of this paper, we first present an overview of our analytical model that is informed by AT, followed by the presentation of our research design. In Chapter 4, we move to the results of our case analysis, and in Chapter 5, we discuss our proposed recommendations, which is followed by an evaluation in Chapter 6. Chapter 7 critically reflects on our theoretical contributions and managerial implications; it also discusses the limitations of our study and presents avenues for future research. Finally, we conclude this paper with a brief summary of our core findings.

2 Background and Analytical Model

At a glance, the task-set of IT PPM subsumes periodic activities such as the evaluation, selection, and prioritization of IT projects based on a consistent set of criteria and a subsequent allocation of resources to projects (Blichfeldt & Eskerod, 2008, p. 358). The primary goal is to ensure that all projects meet strategic objectives and that benefits can be realized at an acceptable cost (Ghasemzadeh & Archer, 2000, p. 76). In contrast to portfolios of construction or other projects, an IT project portfolio may contain projects which are regarded as initiatives primarily geared to information systems development (ISD), but they may further encompass organizational projects (e.g., change projects); in such projects, IT artifacts may play a substantial role to achieve desired organizational goals (Daniel et al., 2014, p. 97). Although a broad range of standards and frameworks for IT PPM is available from a burgeoning professional body of knowledge, many organizations struggle with the effective management and balancing of complex portfolios of IT projects (Hansen, Kræmmergaard, & Mathiassen, 2017, p. 82). IT PPM faces certain internal and external challenges, such as politically motivated project selections (Martinsuo, 2013, p. 797), preference given to *pet projects* that are personally important to executives (Beringer, Jonas, & Kock, 2013, p. 842), disruption and uncertainty (Karimi & Walter, 2015, pp. 40–41), and outer-portfolio projects (Buchwald & Urbach, 2012, p. 7). These challenges result in cross-project resource conflicts, project delays, and overloaded employees (Jonas, 2010, p. 825; Zika-Viktorsson, Sundström, & Engwall, 2006, p. 391). Historically, most of the traditional research on project-based organizations is characterized by assuming decision-rationality (Floricel, Bonneau, Aubry, & Sergi, 2014, p. 1092); with this, the primary objective is seen as planning an *optimal* project portfolio configuration in the most efficient way by employing formal management methods during the annual budgeting process (Archer & Ghasemzadeh, 1999, p. 208; Cooper, Edgett, & Kleinschmidt, 1999, p. 347). In taking this stance, project-based organizations long “have been managed as technical systems instead of behavioral systems” (Belout, 1998, p. 22). More recent research has pointed out that besides calculating the *best* portfolio structure, the dynamics of “organizational and political realities” (Frey & Buxmann, 2011, p. 12) such as goal conflicts and the opportunistic or shirking behavior of stakeholders (El Arbi et al., 2012, p. 1) represent major challenges for IT PPM. Existing models and theories only offer limited explanations for the root causes and effects of these issues from a holistic perspective, and researchers have given virtually no recommendations on designing an IT PPM that is effectively able to cope with these challenges (Daniel et al., 2014, pp. 96–97; Frey & Buxmann, 2012, pp. 9–10). This becomes even more important in today’s business world where it is decisive to quickly adapt the project portfolio to changing strategic trajectories and shifting environmental conditions (Kock & Gemünden, 2016, pp. 673–674).

Against this backdrop, we transcend the rationality-based posture by employing Engeström's (1987, 2001) seminal work on AT to guide our analysis and explore frequent challenges and subsequently derive appropriate recommendations. AT overcomes the dichotomy between the individual, technical, and the social by considering the collective context of actions (Kuutti & Arvonen, 1992, p. 234). In contrast to the analysis of the *whole* social system or an arbitrarily selected context, AT centers around an intermediate unit of analysis—the *object-oriented activity system*—which can be characterized as a social structure with specific cultural and historical properties (Engeström, 2001, p. 136). AT allows users to comprehensively include analytical components that account for the organizational, technical, historical, environmental, as well as governance and task-related forces that influence IT PPM (Engeström, 2001, p. 137).

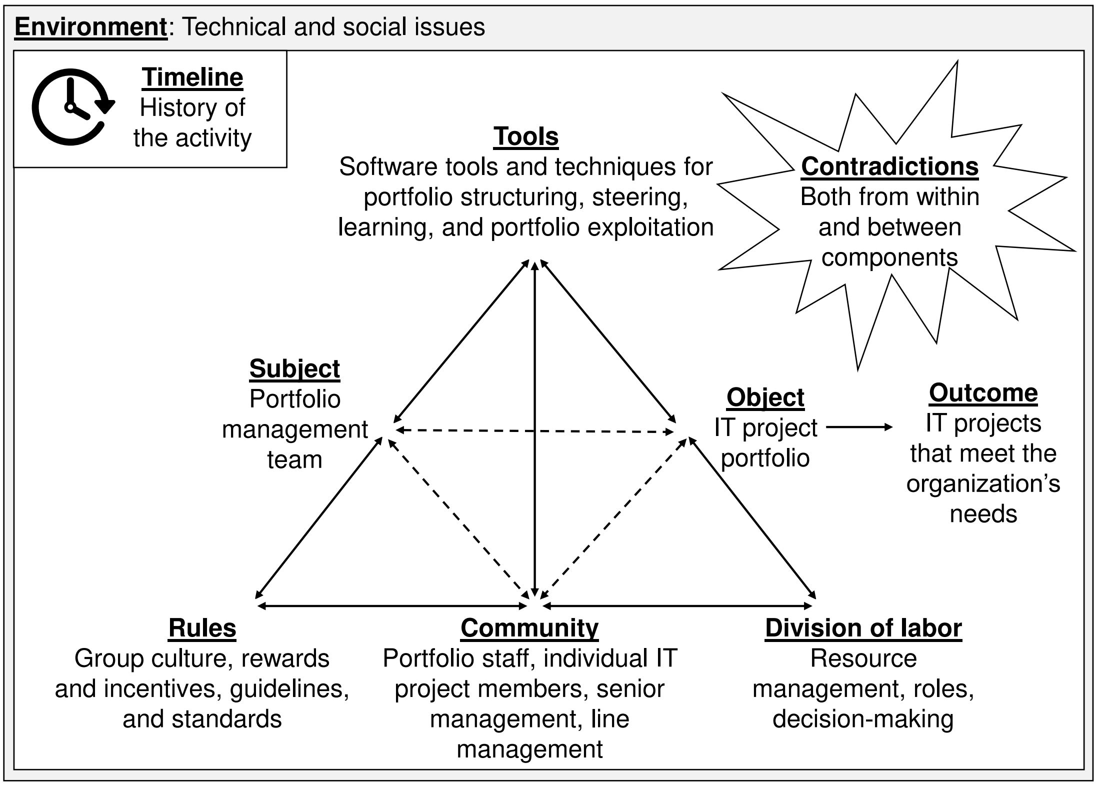

Figure III-1. Activity theory perspective on IT PPM (based on Engeström, 1987, p. 78).

We conceptualize IT PPM from an AT perspective by deriving the individual elements for each component from the large body of literature on IT PPM in Figure III-1. An activity system consists of *subjects*—those who exist in a *community*—that transform an *object* in order to produce a certain *outcome*, which is the overall purpose that motivates an activity (Vakkayil, 2010, p. 4). The subject is the individual or a group engaged in the activity whose viewpoint is adopted during the analysis. In this regard, the portfolio management team represents the activity's *subject*, which does not operate directly on the entire portfolio of IT projects that an organization is engaged in (i.e., the *object*). Instead, AT applies mediators to establish a relationship between its different components (Mwanza & Engeström, 2005, pp. 457–458): Specifically, *tools* mediate the subject's actions on the object and can be both material or conceptual, and they provide the subject with the historically collected experience of a community (Fuentes et al., 2004, pp. 528–529). We may understand the tools component generally as a "system of techniques" (Woodward, 1958, p. 16); they encompass material artifacts and conceptual techniques that the portfolio management team uses to organize the portfolio. Thus, the team's actions are mediated by the application of certain technological tools (e.g., planning software) and methods (e.g., portfolio structuring and steering) to frequently evaluate, prioritize, and monitor IT projects (Jonas, 2010, p. 821). The tools component further encompasses organizational learning approaches to re-evaluate results after project closure; this re-evaluation process assesses benefits realization, and it also secures and maintains relevant lessons learned as well as the utilization of this historical knowledge for future projects (Desouza & Evaristo, 2006, p. 416). The portfolio management team is part of a broader *community* of individual project staff, senior management, and line managers who are involved through direct participation in projects, decision making, or the provision of required resources. This community provides different guidelines and standards (i.e., *rules*) for the portfolio management team to follow. Rules further include formal rewards and incentives that relate to the completion of projects and the achievement of portfolio objectives (Barczak, Griffin, & Kahn, 2009, p. 18), as well as implicit norms that are influenced by organizational history and practices (i.e., group culture), which guide or constrain actions (Burke & Litwin, 1992, pp. 526–527). *Division of labor* refers to the explicit and implicit organization as the subjects carry out the activity in the community; this delegation results in the horizontal distribution of tasks between community members, and in the vertical division of power and status of subjects (Engeström, 2001, p. 136). IT PPM-related tasks are divided in two directions, namely horizontally between community members through resource management and the assignment of roles, and also vertically through lines of responsibility and authority, particularly in relation to the extent of enforcement authority about portfolio decisions (Desouza & Evaristo, 2006, p. 418; Mosavi, 2014, p. 389). Finally, the desired *outcome* of the IT PPM activity system is to produce projects that meet organizational needs (Martinsuo & Lehtonen, 2007, p. 57; Reyck et al., 2005, p. 526).

Activities also develop natural *contradictions*, which are "historically accumulating structural tensions" (Engeström, 2001, p. 137) that are either within each element of the activity (*primary contradictions*, e.g., within rules) or between elements of an activity (*secondary contradictions*, e.g., between community and rules). For example, sparse and infrequent project progress monitoring may be regarded as a primary contradiction within the PPM tools component, which itself may result in secondary contradictions in the object component (i.e., the IT project portfolio). Here, the ability for intervention during project execution in case of occurring exceptions is limited, and this limitation may result in undetected violations of time and budget constraints (Elonen & Artto, 2003, p. 396). Since contradictions indicate inefficiencies, inconsistencies, or incompleteness, they can reveal emergent opportunities for change and improvement but also for potential breakdowns of activities (Engeström, 1999, p. 32). Still, IT PPM is not a standalone phenomenon: It is part of a broader context of its hosting organization, which is intertwined in an ever-changing environment (Müller, Martinsuo, & Blomquist, 2008, p. 30). While components such as the community account for influences that are specific to the activity, social and technical environmental influences are not necessarily activity-specific and may affect multiple activities differently (Chen, Sharman, Rao, & Upadhyaya, 2013, p. 130). From the perspective of IT PPM, this might include social issues such as regulatory changes or technical issues such as sudden technological disruptions or discontinuities (Daniel et al., 2014, p. 96). Furthermore, while AT argues that contradictions arising in activities "can only be understood against their own history" (Engeström, 2001, p. 136, p. 136), the theory does not explicitly consider temporal aspects as component in the analysis. However, as portfolio management is often characterized by path dependence (Martinsuo, 2013, p. 797), the consideration of temporal developments may play a crucial role when pinpointing the root causes of tensions in the IT PPM activity. Thus, we decided to extend the traditional model—similarly to Chen et al. (2013, p. 131)—by incorporating the components *environment* and *timeline* to allow for a comprehensive analysis of relevant temporal aspects such as path dependence (Martinsuo, 2013, p. 798).

We apply this model on IT PPM to identify contradictions that may arise within and between the components of this activity system, and we subsequently elicit requirements and guidelines for a more sustainable setting.

3 Research Design

3.1 Overview of Research Process

To develop recommendations for an IT PPM that is able to deal better with contemporary challenges, we follow a design-oriented approach (Gregor & Jones, 2007, p. 316; Hevner, March, Park, & Ram, 2004, p. 80). As opposed to pure evaluative and explanatory research, the paradigm of *design science research* is prescription-driven (Van Aken, 2004, p. 227), and it aims to offer innovative solutions to highly relevant problems in practice (Holmström, Ketokivi, & Hameri, 2009, p. 78). This kind of research focuses on the design of abstract solutions for management issues, or more precisely, on "the development of scientific knowledge to solve a class of managerial problems" (Van Aken, 2004, p. 220). The prescriptive output of design research is typically formalized through *design goals*, which specify both the scope and purpose of what should be achieved and the associated design principles (Gregor & Jones, 2007, p. 325). *Design principles* may be viewed as general rules, interventions, or recommendations that have a purpose of guiding organizations to achieve the stated goals (Van Aken, 2004, p. 227). Thus, we aim at deriving both a set of design goals that constitute the nature of a more flexible and aligned yet efficient IT PPM and also the associated design principles that prescribe how to achieve and maintain this balance. While empirical insights about problems or best practices are commonly leveraged in the process to derive initial design goals and principles (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011, p. 6), we can use *justificatory knowledge* from extant literature to inform, refine, and validate design decisions (Gregor & Jones, 2007, p. 327).

Despite the significant influence of stakeholders' behavior on PPM-related outcomes (El Arbi et al., 2012, pp. 7–10), researchers in PPM research often factor out highly relevant aspects such as power and opinion-based instead of evidence-based decision making (Martinsuo, 2013, p. 800) (Hansen & Kræmmergard, 2014, p. 50). This becomes even more evident if we consider our AT-informed conceptualization presented in Chapter 2, which claims that strategic IT PPM is *something people do* (Langley & Abdallah, 2011, p. 218) and that organizational practices are deeply rooted in sociohistorical structures. We thus employed a qualitative approach, which in general is considered useful in the context of critical-oriented research when the objective is to understand the "hidden structures and tacit cultural dynamics" (Kincheloe & McLaren, 2002, p. 100) that underlie a phenomenon. In our context, we are particularly interested in how social practice and power relations shape IT PPM as a whole and the issues that impede the achievement of a balanced portfolio. First, we investigated a revelatory case to uncover typical contradictions that occur in the IT PPM activity. Based on the gathered insights, we then developed our design goals and principles, and we conducted a focus group with IT PPM experts to refine our results and increase their validity by considering more diverse viewpoints. Finally, we evaluated our design goals and principles using 17 structured interviews with IT PPM experts to check the potential relevance, viability, and utility of our recommendations for practice. By collecting additional insights from a focus group, comparing our findings to extant literature, and evaluating the relevance and usefulness of our results in a series of expert interviews, we believe that our recommendations go beyond our initial case company's specific situation and are applicable to the broader general IT PPM.

3.2 Investigation of a Revelatory Case

We started our research through the initial framing of issues that impede a balanced IT PPM activity by exploring a single revelatory case. Scholars acknowledge that in-depth single-case studies are useful for understanding a complex real-world problem in the early research, since such studies promise the revelation of the complex processes at work (Eisenhardt & Graebner, 2007, p. 27; Yin, 2002, p. 42). During our case selection, we placed particular emphasis on the fact that the phenomenon of interest is transparent observable and allows for an in-depth examination (Eisenhardt, 1989, p. 539), and that it has the potential to inform other organizations (Yin, 2002, p. 42). According to our research objectives, we selected a case company that met the following criteria:

1. It needed to have a strong focus on IT project activities which are primarily organized using institutionalized IT PPM.
2. It allowed us to engage in close dialogues with a broad range of different IT PPM stakeholders across hierarchies and viewpoints.
3. It should face challenges that impede IT PPM balance.

To this end, we chose an organization from the corporate travel management industry with a strong focus on portfolio-managed software development. Besides the fulfillment of all three criteria, we deemed the case as suitable and revelatory because of its long tradition in software development and its critical role for business operations. The organization also has a relatively stable employee base over time with individuals; such an employee base can produce informants who are proficient about the social and historical dynamics of the organization. Furthermore, the organization's environment was characterized by quick changes in regulatory and market requirements that necessitate effective and flexible IT PPM.

Our case organization forms part of a larger group, and it provides services and solutions that are focused on financial transactions. With over one thousand employees and an annual revenue of more than €250 million, it is a global leader in its specific industry. The company had institutionalized dedicated portfolio management structures and processes for approximately two years at the time of investigation. Nevertheless, the analysis of a provided portfolio overview revealed that the projects took 207% of their original time estimates on average (at the year of the investigation). Only 23% of projects were completed in time or with an overrun of no more than one month. Table III-1 provides a more detailed overview of the company's portfolio situation during the three years preceding our study. Among other things, these data show that only one third of the projects that started three years prior to our study were completed before the study was conducted, pointing to excessive delays owing to failed portfolio planning. Also, the displayed total overrun of planned project duration clearly indicates the alarming situation in the company's portfolio situation.

Table III-1. Overview of the case company's portfolio situation.

Figure	Year 1	Year 2	Year 3
Projects started	6	13	11
A-/Top-projects (relative)	83%	31%	45%
Completed in time or overrun ≤ one month (relative)	17%	8%	45%
Completed until year 4 (relative)	33%	69%	45%
Total overrun of planned project duration (months)[a] until year 4	126	91	110
Total projects running in this year	8	21	21

[a] Σ [(actual/expected end date to start date) – (initially planned end date in proposal or first status report to start date)]

Although the company was thoroughly successful in its business, upper management faced issues with its IT PPM, which continued to fall short of expectations in terms of achieving the desired project throughput and the timely seizing of emerging market opportunities. Prior to our study, the company had received many employee complaints owing to high workload, and first discussions showed that they viewed both the portfolio management and top management as responsible parties for this situation. Top management was not satisfied with the achieved portfolio throughput, while other employees reported high executive interference in project and portfolio decisions. Although the company was very successful in its business, its IT PPM fell short of expectations concerning achieving desired project throughput and the timely seizing of emerging market opportunities.

The company therefore found that it needed a more flexible IT PPM approach, which at the same time was able to efficiently exploit existing resources and maintain the overall strategic direction. During our examination, we took a critical-dialogic stance, which considers various viewpoints, social mechanisms, and conflicts such as power struggles during engagements (Bebbington, Brown, Frame, & Thomson, 2007, p. 367). The critical-dialogic paradigm places particular emphasis on the analysis of individuals, groups, as well as their interactions, communications, and the situating context (Tropp, 2012, p. 214). In considering how previous research results have indicated the role of stakeholder behavior and power structures for IT PPM inefficiencies (El Arbi et al., 2012, pp. 7–10; Martinsuo, 2013, p. 796), we reckon that this view is highly relevant for achieving our objectives. To engage in a close dialogue with the case, we conducted semi-structured interviews with 10 IT PPM-related stakeholders from the management board down to individual project managers, followed by two workshops; the goal is to uncover issues and their potential causes in the IT PPM. The interviews lasted between 60 and 90 minutes. We also reviewed archival data—including project reviews and portfolio reports—to triangulate and cross-check the interview data's validity (Eisenhardt, 1989, p. 538).

We used the interview data as follows. First, we deductively derived general categories of possible tensions from our AT framework (illustrated in Figure 1); this step provided our fieldwork with a "general sense of reference" (Patton, 2002, p. 456). We then investigated the extent to which these general categories were represented in our interview data, and based on the corresponding aspects that emerged from the data, we inductively narrowed these general categories, resulting in a larger set of lower-level categories (Miles & Huberman, 1994, pp. 62–65). The interview guide notably contained theory-neutral yet problem-oriented questions, such as *What problems do you encounter in your IT PPM?* and *What are the underlying causes and what should be changed?* Thus, our theoretical framework had no influence on the interview procedure. The interview method was purely qualitative, with open questions and no rating scales. Using the qualitative data analysis software ATLAS.ti 7, the interview data were coded, with our lower-level categories serving as codes. We took the interview passages identified through the coding, together with the causal relationships that were identified through an observation of the code networks in ATLAS.ti, to derive the set of tensions that served as input for the next step.

By systematically documenting the status quo of the IT PPM in this first phase using our analytical model, the weak points became apparent. For example, senior management intervention during project evaluation and selection processes has led to a high number of long-running and parallel projects, thus causing employees to be overloaded and creating a stalled portfolio. To develop a shared conception and to ensure intercoder reliability, the coding results were discussed among involved researchers and with the case organization in two workshops; after this, we compared the results to existing literature (Eisenhardt, 1989, p. 544). The identified tensions served as input for the next step.

3.3 Design and Refinement of Recommendations

We used the framed tensions from the case analysis and suggestions from extant literature to derive our first set of recommendations with the aim of achieving a more balanced IT PPM configuration. We formalized them as three design goals and eight associated design principles (Gregor & Jones, 2007, p. 320). Subsequently, we presented the DGs and DPs to 15 mid-level to senior-level management IT PPM experts who were not affiliated to our case company in a focus group session (Stewart & Shamdasani, 2014, p. 51), with one researcher serving as a moderator. The participants cover a broad range of different industries, and their diverse profiles strengthen our findings' cross-industry applicability. Furthermore, all participants were familiar with the kind of operative challenges relating to our DGs and DPs, and each had some experience of the reception of such principles at top management level.

The focus group session had two parts. In the first part, we asked the participants to articulate their issues with IT PPM, and we then asked for their ideas on addressing the challenges. The inputs were collected, clustered, synthesized, prioritized, and consented to a general requirements list for an IT PPM which is geared toward flexible and efficient operations. In the second part, the moderator presented our initial set of design principles to the participants to stimulate further discussion. In total, 90 minutes of discussions with the participants yielded 14 suggestions. To convert the insights from our case and from the focus group to recommendations that are applicable to a broader class of problems, we compared the focus group's suggestions with our initial set and extant literature from the field of IT PPM. We used these inputs to further develop four additional recommendations, which led us to arrive at 12 intermediate design principles while keeping our set of three design goals. After intensive discussions with researchers who are involved in the project and other researchers, the set of design principles was finally reduced to nine after we dropped recommendations that were too specific for certain contexts and merged design principles that showed conceptual overlaps. The set of design principles' evolution is reported in Appendix III-1.

3.4 Evaluation of Findings

To estimate and evaluate the relevance, viability, and usefulness of our design recommendations, we finally subjected them to a naturalistic ex ante evaluation (Venable, Pries-Heje, & Baskerville, 2016, p. 79). For this purpose, we invited 17 IT PPM experts from a range of industries (e.g., energy, finance, mining, software development) to a series of structured interviews and presented our recommendations as candidate management principles for their IT PPM. We asked them to quantitatively rate each design goal and principle according to the three applicability dimensions adapted from Rosemann and Vessey (2008, p. 3) on a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*):

- **Accessibility:** The design principle is easy to understand.
- **Importance:** The design principle meets the needs of practice and addresses a real-world problem.
- **Suitability:** The design principle is complete, provides useful guidance for achieving the design goal, and is feasible in practice.

Furthermore, we engaged in discussions with the experts on every rating to further corroborate their assessments. Participant roles ranged from project portfolio managers, head of PMOs, CIOs, and CEOs. More than 80% of interviewees had over four years of IT management experience, and none of the experts was affiliated with his or her current position and company for less than one year. That said, the chosen sample represents a qualified set of subject-matter experts to evaluate our design recommendations. Although the strength of our applicability check lies in the elicitation of qualitative feedback from the in-depth discussions with key interviewees and the check does not intend to replace a large-scale quantitative survey, we used IBM SPSS to derive basic key figures to examine the responses for a statistical significant above-average agreement on applicability. Thus, our aim was to reject the null hypothesis H_0: $\mu \leq 3$ for each design goal and principle, meaning that the null hypothesis is accepted when the mean would be 3 (neutral) or smaller (Spatz, 2011, p. 176). In other words, we sought to accept only design principles with a statistically significant above-average agreement on applicability. As the Shapiro-Wilk test revealed that our sample does not follow a normal distribution, we applied the non-parametric Wilcoxon signed-rank test (one-tailed) instead of a standard parametric t-test, although a follow-up analysis revealed that it would have resulted in similar inferences. This approach of using the Wilcoxon signed-rank test is particularly useful when the small sample size and non-normality of data renders the t-test to be ineffective (Davis, 2007, p. 251). In contrast to looking at the simple means and medians, applying this test allowed us to incorporate both the sample size and the variability in the data when judging the applicability of our principles. However, to enable a more fine-grained discussion of the evaluation results, we further looked at the interquartile range (IQR) of the responses, which represents the difference between the third and first quartiles in a distribution (i.e., Q3−Q1). This figure indicates whether opinions are clustered together or dispersed across the range of possible responses (Weinberg & Abramowitz, 2002, p. 73).

4 Case Findings: How Contradictions Trigger Vicious Circles

Based on our analytical framework, we were able to identify a series of contradictions in the organization's IT PPM activity, and these contradictions accumulated over time to create a complex *vicious cycle*—that is, a chain of events in which one problem leads to new difficulties that mutually reinforce each other, eventually leading to an inflexible organization (Platje & Seidel, 1993, p. 210). AT posits that these historically accumulating structural tensions often lead to innovative learning attempts to improve the activity (Engeström, 1987, p. 230). However, in our case company, we saw that issues originating in one component rippled through the entire IT PPM system; this ripple effect bred new contradictions in other components, causing further inefficiencies and posing a threat to the IT PPM at large. This chain of secondary contradictions between the constituent nodes of the activity resulted from a fairly stable and long-term process characterized by a coalescence of managerial disturbances, severe resource constraints, and a high degree of temporary and individual workarounds applied during project executions. These pressures locked the portfolio management in a negative feedback loop, in which the portfolio management constantly tried to adapt to external disturbances in a mechanistic manner; this situation eventually rendered the IT PPM incapable of flexibly seizing opportunities to innovate and renew from more explorative projects. The prevalent structures made it difficult for the IT PPM to change its plans and operations at the rate at which environmental conditions such as the business strategy or technological developments changed. Figure III-2 illustrates the identified vicious circle from the AT perspective.

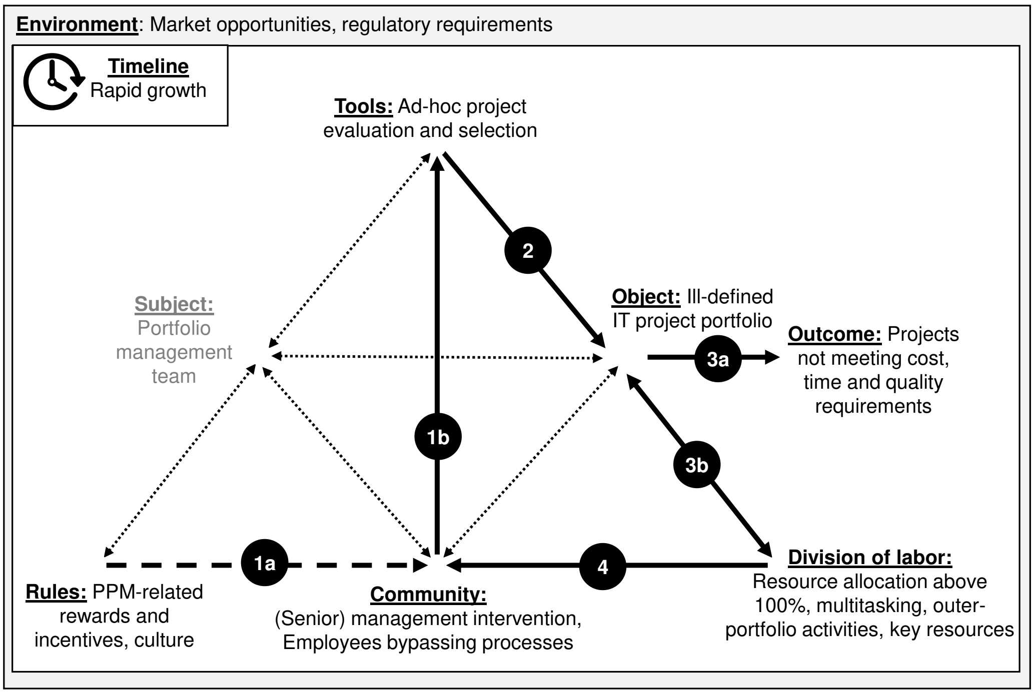

Figure III-2. Series of contradictions in the IT PPM activity forming a vicious cycle.

Particularly, we saw that the prevalent entrepreneurial culture combined with the executive's reward system caused several tensions (**1a** in Figure III-3). First, owing to the rapid growth over the past years, the organization went "*from a garage company to a professional, process-driven enterprise*," as noted by a project portfolio manager. Some interviewees stated that the organization implemented several new IT PPM-related structures and processes in a fairly short timeframe. However, the organization's cultural mindset retained its entrepreneurial spirit, often resulting in employees surpassing portfolio standards and guidelines. On this point, a departmental manager said, "*'I can quickly take care of that!' and 'Could you quickly do this for me?' are still in our culture. A lot of this is left and still happens.*" Many interviewees perceived the new IT PPM formalities as unnecessary and rampant bureaucracy, leading to many cases of process bypassing. Second, success-related variables (e.g., number of started or completed projects per quarter) were installed in personal targets and objectives of middle to upper management and were associated with monetary incentives.

This incentive system, which was amplified by the startup attitude in managing the firm and its project portfolio, led to frequent executive interventions in portfolio structuring decisions and force-ranking of projects, albeit the existence of formal project selection and prioritization procedures (**1b**). Senior managers frequently perceived a mismatch between the performance of the enacted IT PPM practices and their individual conceptions of those routines; because of this, they exerted their power to bypass established processes to influence project selections, prioritizations, and resource allocations. As several interviewees reported, many projects were initiated in a top-down way at short notice outside established processes, and this in turn would render existing portfolio plans void. Upper management initiated many short-notice projects as response to market and regulatory demands that stem from the organizational environment, and these projects were considered rather late in the portfolio planning. As one board member admits, "*Our prioritization should reflect our strategic objectives. However, many top projects are driven by regulatory requirements and short-term market opportunities.*"

This project approval and prioritization practices led to an imbalance of the portfolio cluttered by ill-defined projects (**2**). First, interviewees regarded the portfolio's fit to the company's business strategy as poor, as almost 50% of the projects were rated with the highest priority. On this point, a portfolio manager stated, *"The main problem is that we have too many high-prioritized projects in parallel."* Second, while regulatory projects and emerging business opportunities were often initiated too late in the already densely configured portfolio cycle, the organization constantly initiated new, high-prioritized projects without completing preceding initiatives. To start these new initiatives, running projects were prolonged or even stopped far beyond their initial schedules. Thus, the organization's portfolio had a considerable number of long-running projects, which were mostly continued due to political reasons and which were justified based only on a rudimentary assessment of business cases and intended benefits as set by the initial proposal process. A departmental manager said, *"Projects that are still unfinished after two planning cycles should be terminated. Currently, I must review several projects, and some are already up to two years old. Honestly, I don't think the assumptions taken in the beginning still hold true."* The portfolio structure ultimately showed adverse effects on individual projects, such as a low adherence to schedules and budgets, disappointing quality of outcomes, and projects gradually losing alignment and strategic legitimacy due to long runtimes **(3a)**.

The tensions in the portfolio structure had a reciprocal relationship to resource allocations **(3b)**. Many interviewees claimed that lower-ranked projects lacked resources when upper managers shifted employees from running projects to more important initiatives as new opportunities emerged; this shifting ultimately contributed to further project delays. The situation was aggravated by the fact that portfolio planning focused on maximum resource utilization without putting emphasis on unforeseen events. As another departmental manager noted, *"We are allocating people to more than 100% of their capacity on projects. We do not consider any buffers in our portfolio plans, so that projects create a domino effect if only one of it gets delayed."* Thus, the projects are often unable to meet predetermined delivery dates. Owing to high workloads, tight deadlines, and fostered by a high amount of custom software development, employees tend to carry out activities in *quick and dirty* ways, which produced easily achievable results but with flaws or unwanted side effects on legacy architectures. A project manager said: "*We struggle heavily with past technical debts, because people were unnecessarily working either too indulgently or simply inaccurately back then."* These legacy issues or *technical debts* (Allman, 2012, p. 51) that result from budgeting and resourcing constraints would constantly recur and accumulate over time, and they require additional effort, such as through code refactoring to remove workarounds. Several interviewees emphasized that these legacy issues often need to be solved as a precondition to implementing subsequent projects, but upper management often did not consider these issues during portfolio planning. Intensified through a lack of time to thoroughly test new software, technical debts were frequently paid back either after official project closure in the outer-portfolio projects—which were executed during the daily business and not monitored by the IT PPM—or at the start of new projects, leading to further schedule delays and causing severe problems in resource management. Furthermore, once a custom-developed architecture is based on workarounds, all subsequent activities tend to fall back to workarounds; this would accumulate further technical debts and architectural complexity, which would eventually result in *software entropy* (Bianchi, Caivano, Lanubile, & Visaggio, 2001, pp. 210–211), which refers to an increasing decline in understandability, quality, and maintainability of architectures. Often, only those employees who are familiar with the partially improvised architecture are able to work on such systems; this would eventually create key resource bottlenecks and lead to loose operational flexibility (Goldratt, 1999, p. 120). In turn, this reinforces the overload of resources as they carry out unplanned refactoring and maintenance activities. Owing to the consequent lack of time available for sharing knowledge, key resources remain under this pressure. While viewing their focus on custom software development over the past years as a strong competitive edge concerning innovation and differentiation, a board member identified it as major cause of the firm's key resource problems: "*By doing it all ourselves, we are limited by the scopes of the resources we have, not only financially, but also human resources and knowledge."* As single key resources often complained about excessive workloads, they were reluctant to share their knowledge among other employees, partly owing to high workloads and partly owing to cultural issues, and this knowledge restriction leaves no room for training other employees. As one project manager summarized, *"Our current key resources stay key resources forever."* Our data strongly suggests that in this complex situation, overloaded key resources are a primary cause of ineffective IT PPM performance and low software quality. Since planned efforts were already invested upfront to solve legacy issues, the company sometimes decided to integrate only partially tested software into productive environments, which caused serious errors in clients' operations. However, the top management deliberately accepted technical debts and their consequences. A board member said: "*By stretching ourselves, and not just deciding to do one thing perfectly and then moving on to the next thing, we can capitalize on some first-mover opportunities and rapidly exploit new markets."*

Tensions related to resource allocation (i.e., division of labor) were fed back negatively into the workforce (i.e., community) **(4)** and subsequently triggered additional management interventions. The parallel execution of a large number of often high-prioritized projects have impacted on project execution as well as employees' motivation and wellbeing. Although the company has had a very low turnover rate, many employees felt overwhelmed by the plethora of tasks, and many ultimately fell into an indifferent and mechanistic *work-to-rule* mode. A departmental head reported, "*Employees feel overwhelmed and frustrated, and projects progress much slower. Constant task switching and getting familiar with a different project context require additional resources that are not considered during project or portfolio planning."* As projects often could not be finished with the available resources and within the planned timeframe, managers tended to close unfinished projects prematurely to comply with their personal targets and objectives. Driven by the prevalent control orientation paradigm as well as executives' assumptions and mental models about effective IT PPM, management would intervene by enacting further countermeasures; for example, management would re-prioritize the portfolio, as the outcomes of the initially employed approach did not yield the expected results, and they would do this by once again bypassing implemented IT PPM routines. While managers presumably acted to the best of their knowledge with the intention to decrease the probability of future failures, they actually ended up doing a disservice to the organization by periodically subverting the power of the portfolio management. At the same time, managers strived to protect their interests (e.g., seizing incentives) through the incentive system (**1a)**—which was relatively stable over time—by launching new initiatives despite the critical resource situation. Altogether, this re-initiated the vicious circle while neglecting to address the root causes of inefficient IT PPM **(1b)**.

Finally, it should be noted that the portfolio management (i.e., the *subject* in the activity system) only played a passive role in frequently translating information from upper management into portfolio operations, instead of relying on structured evaluation and selection processes. The power-related interference caused a lack of transparency about strategic priorities and requirements in the portfolio management team, and this resulted in an insufficient cooperation between the IT PPM and higher management levels. As the institutionalized IT PPM was rather young compared to the overall corporate history, the conflict was also attributed to a number of factors, namely a lack of empowerment of portfolio management, the unavailability of sophisticated tools, and a low adherence to the new structured portfolio processes. While many employees appreciated the idea of setting up a dedicated IT PPM in the beginning, the tensions raised by the vicious circle prevented the initial acceptance of IT PPM from being reinforced by repeated success across all organizational levels. In sum, because the repository of collective beliefs and behavioral routines related to project executions consequentially did not evolve at the same pace as the portfolio management structures and processes, the organization was not able to leverage the full potential of its IT PPM.

5 Towards Sustainable IT Project Portfolio Management

5.1 Design Goals

To identify the scope of a more balanced IT PPM approach, we reflected on the contradictions revealed by our case analysis. Clearly, the surrounding internal and external environments can affect multiple components of the IT PPM activity. For instance, social-environmental concerns (e.g., market opportunities and regulatory requirements) may shape strategic planning and resource allocation processes, while technical environmental concerns (e.g., new technologies) may affect project implementation procedures. While the ability to capitalize on short-term opportunities represents a competitive edge, there is little guidance on how portfolio managers should handle uncertainty from the internal and external environments that affect their project portfolio (Drouin, Müller, & Sankaran, 2013, p. 71). To maintain economic sustainability and portfolio balance, even under strong turbulence, we propose three design goals (DGs) based on our case insights for flexible yet efficient IT PPM activities that are aligned to business needs. Drawing on related research (Chakravarty, Grewal, & Sambamurthy, 2013, p. 979; Vessey & Ward, 2013, p. 288), we regard IT PPM as balanced or sustainable if it fulfills three conditions:

- Its outcomes are *aligned* to the organizational goals.
- It *efficiently exploits* the IT project portfolio by utilizing scarce resources purposefully.
- It can rapidly *adapt* to changing conditions.

We generalized a set of three design goals for sustainable IT PPM based on our empirical investigations and on the justificatory knowledge from literature, and we summarize them in Table III-2.

Table III-2. Identified contradictions and associated design goals for sustainable IT PPM.

Identified contradictions in IT PPM activity components	Design goal	Justificatory knowledge
• **[Tools ↔ Timeline]** A high approval rate of long-running projects leads to several projects losing their strategic legitimacy over time, as project selection and evaluation criteria were usually not updated accordingly to changing strategic trajectories. Projects losing legitimacy were neither consequently re-assessed nor terminated. • **[Community ↔ Tools]** Senior management overriding project evaluation and selection techniques leads to having enforced project initiations, a high number of parallel projects with high priority, and a loss of employees' trust in the power and value of IT PPM.	**DG1 – Alignment:** IT PPM must align the project portfolio with the overall strategic objectives.	(Farjoun, 2002, p. 572; Kopmann, Kock, Killen, & Gemünden, 2017, p. 560; Meskendahl, 2010, p. 809)
• **[Rules ↔ Tools]** Corporate governance and budgeting practices require long-term or annual IT PPM planning. Since portfolio plans and resource allocations are made far in advance without considering buffers or the option for changes, IT PPM is unable to effectively absorb short-term initiatives, whereas ill-defined projects are initiated and bind scarce resources. • **[Environment ↔ Tools]** Both addressing regulatory requirements at a later phase and constantly striving to defend market leadership by frequently seizing short-term market opportunities have strong impacts on project selections, resource allocations, plan quality, and software quality.	**DG2 – Agility:** IT PPM must be able to alter its operations swiftly and responsively to allow for dynamic adjustments to changing strategic trajectories.	(Chakravarty et al., 2013, p. 979; Geraldi, 2008, p. 352; Kester, Hultink, & Griffin, 2014, p. 1203; Kock & Gemünden, 2016, p. 672)
• **[Rules]** Personal goals related to project achievements lead to either projects starting with insufficient resources or to premature closure of unfinished projects. • **[Tools ↔ Division of labor ↔ Community]** Ad hoc project initiations coupled with allocating employees to over 100% of their capacity results in high rates of overloaded employees, delayed projects, and defective software (technical debts), which binds resources to be not available for short-term initiatives. • **[Timeline ↔ Division of labor]** High time pressures and frequent technical workarounds have led to path-dependent IT architectures (technical debts) and workforce (single key resources) over time, which must be addressed through additional and often outer-portfolio projects. • **[Community ↔ Division of labor]** Withdrawal of resources from running projects due to executive intervention leads to multitasking, long-running projects, and delays.	**DG3 – Efficiency:** IT PPM must support projects to meet business requirements and quality, attain target dates, and be completed within budget.	(Jonas, 2010, p. 820; Martinsuo & Lehtonen, 2007, p. 57; Ness, 2005, p. 3)

5.1.1 Design Goal 1: Alignment

Our first premise is that an organization and its IT project portfolio are aligned when the project portfolio supports the organization's goals (Meskendahl, 2010, p. 809). This especially refers to the alignment of project objectives and resource allocations, and it also refers to the extent to which the portfolio reflects the overall strategy (Beringer et al., 2013, p. 832; Heising, 2012, p. 586). Alignment with the intended strategy is considered as a main driver of project portfolio success (Kopmann et al., 2017, p. 560), and the IT PPM should provide appropriate structures and activities to complement a firm's competitive actions (Farjoun, 2002, p. 563). In our case, some interviewees thought that long-running projects—which were assessed in terms of projected strategic contribution only at the outset—had lost their strategic legitimacy over time. Exacerbated through the needs that result from today's environmental pressures, the business strategy constantly evolved, but IT PPM selection and assessment criteria were not updated accordingly. This not only rendered the alignment of several in-flight projects void, but the organization found itself incapable of terminating such projects, mostly owing to prevalent power structures. Furthermore, forced or ad hoc project initiations continuously led to both an unjustified high number of top-prioritized projects and also situations where new emerging opportunities drew resources from other projects. Consequently, such project initiations resulted in schedule overruns, and they also aggravated the portfolio misalignment. Thus, we propose our first design goal for sustainable IT PPM:

> **DG1 – Alignment:** *IT PPM must align the project portfolio with the overall strategic objectives.*

5.1.2 Design Goal 2: Agility

Our second design goal, agility, refers to the organizational ability to adapt to the dynamic and uncertain environment in which IT PPM operates by quickly accommodating changes in the project portfolio without negative effects on time or costs (Fink & Neumann, 2007, p. 444; Gibson & Birkinshaw, 2004, p. 210). Adjustments in strategic trajectories may be triggered by a number of factors, such as changing customer or stakeholders demands, competitors' actions, technological shifts, and regulatory, or legal changes (Conforto, Amaral, da Silva, Di Felippo, & Kamikawachi, 2016, p. 667; Overby, Bharadwaj, & Sambamurthy, 2006, p. 121). IT PPM often needs to accommodate these changes in the portfolio structure in order to respond to opportunities and threats in the business context, and also to maintain operational and strategic rigor within a short timeframe (Kock & Gemünden, 2016, p. 675). Alignment and agility are distinct yet interdependent and mutually supportive; these traits typically bring out a positive correlation between them (Cassiman & Veugelers, 2006, p. 73). As the analysis of our case demonstrated, a traditional IT PPM that solely plans on a long-term horizon is unable to integrate short-term initiatives without risking vicious circles of project delays, postponements, and negative impacts on the workforce and the IT architecture. While researchers found project portfolio management to play an important role in proactively responding to environmental perturbations by sensing emergent changes and reconfiguring the portfolio accordingly (Kopmann et al., 2017, pp. 566–567), we see general lack of short-term focus and flexibility in traditional IT PPM activities. In our case, we saw that a long-term planning of the portfolio resulted in a long binding of valuable resources, which are not available for seizing short-term opportunities. Furthermore, a late adaptation to environmental changes such as new regulatory requirements would lead to a series of ad hoc project initiations in addition to the already densely configured portfolio. As the IT PPM did not consider any reserves for such activities in its annual planning, it was hardly able to set up the required projects with adequate resource equipment. Research has demonstrated that IT PPM agility is one key driver for the economic value of projects in the portfolio and overall success of the business unit (Kester et al., 2014, p. 1210; Kock & Gemünden, 2016, p. 679). An active and close interaction of business units and IT PPM can enhance knowledge sharing and enable organizations to quickly seize emerging opportunities by appropriating corresponding projects; it also allows for a flexible and frequent realignment of the IT project portfolio to business needs as required by pressing demands (Chakravarty et al., 2013, p. 981; Lu & Ramamurthy, 2011, p. 933). Keeping a project in line with business objectives requires a continuous co-alignment and adaptation to the firm's changing context (Farjoun, 2002, p. 572). Here, we seek to increase IT PPM's agility to enable organizations to benefit from the realization of short-term opportunities, and to address this we thus propose our second design goal:

DG2 – Agility: *IT PPM must be able to alter its operations swiftly and responsively to allow for dynamic adjustments to changing strategic trajectories.*

5.1.3 Design Goal 3: Efficiency

When taken together, alignment and agility provide a basis for the efficient exploitation of IT projects and associated resources (Gibson & Birkinshaw, 2004, p. 221). IT PPM efficiency may be understood as the relation between the *output* of the IT PPM function and its total *efforts* (Schmidt & Buxmann, 2011, p. 173). As noted earlier, the output of the IT PPM activity is represented as a portfolio of projects and its degree of meeting organizational needs (Martinsuo & Lehtonen, 2007, p. 57; Reyck et al., 2005, p. 526). IT PPM's efforts include the goal-oriented distribution of technologies, knowledge, and other resources across the portfolio, as well as the management of resource interdependencies between projects (Belout, 1998, p. 22; Jonas, 2010, p. 820; Teller, Unger, Kock, & Gemünden, 2012, p. 599). Here, agility becomes the primary means by which IT PPM achieves improved the project delivery capabilities that are aligned to both uncertainty and changing business demands (Ness, 2005, p. 4). The assumption is that the appropriate mixture of rigor and flexibility that is induced by alignment and agility allows IT PPM activities to better grasp resource needs and limitations, thus enabling IT PPM to operate more efficiently. Agility enables IT PPM to activate additional resources or to transform existing resources in a more timely manner if these resources are already understood and are in close proximity to the locus of change; in this way, the resources can operate more efficiently by reducing set up times and minimizing the waste of resources (Kock, Heising, & Gemünden, 2014, p. 5; Tallon & Pinsonneault, 2011, p. 468). As our case shows, ad hoc project postponements and inadequate resource allocations or withdrawals often led to budget and schedule overruns as well as poor project results. Applied workarounds led to an accumulation of technical debts, which could only be addressed by an increasing number of single key resources in projects without the oversight of IT PPM. Frequently, employees had to work simultaneously in a broad range of different projects, and this resulted in work-related stress and schedule overruns. Meeting stakeholder expectations and delivery dates via maximum resource utilization and parallelization of projects is often not possible. We thus propose the third goal for a sustainable IT PPM:

DG3 – Efficiency: *IT PPM must support projects to meet business requirements and quality, attain target dates, and be completed within budget.*

In sum, alignment refers to coherence among all the IT PPM activity patterns, specifically in working towards a portfolio of projects which fulfill organizational needs. Agility seeks to respond rapidly to changes in the task environment, such as the ability to utilize emergent technologies and new strategic trajectories in a timely way. Efficiency refers to supporting the successful and cost-efficient execution of IT projects while maintaining the current overall direction (Gibson & Birkinshaw, 2004, pp. 220–222; Vessey & Ward, 2013, p. 305).

5.2 Design Principles

In the previous section, we identified three design goals based on tensions in the IT PPM activity system. For phase two in the research, we drew on extant literature and the insights from our case study and focus group discussions to cultivate design principles (DPs). These provide an abstract blueprint for achieving the stated design goals (Gregor & Jones, 2007, p. 326).

5.2.1 How Can IT PPM Sustain Alignment?

We see that prioritization criteria are defined only once a business or IT strategy is formally approved—or if they are updated, which seldom occurs. Our case results concur with related empirical insights, specifically that project portfolios are most often planned and prioritized based on a fixed set of selection criteria that are derived a priori from the business strategy (Cooper, 2008, p. 505; Sandalgaard, 2013, p. 37). However, static criteria do not reflect short-term business opportunities and operational needs once ex ante business cases no longer properly reflect opportunities to realize benefits; this inhibits an adaptive approach to assess the current states of IT projects (Eisenhardt & Zbaracki, 1992, p. 25; Unger, Kock, Gemünden, & Jonas, 2012, p. 676). Among our interviewees from the focus group, the business strategy was considered to be the essential imperative in determining selection and prioritization decisions. As strategies change, selection and prioritization practices should also be updated on a regular basis. Interviewees also stressed that no project should be allowed to be labelled as *urgent* and *mandatory* by decision makers before it passes through a rigorous evaluation process. However, our case company followed path-dependent practices with heavy executive intervention acting as a catalyst, and these practices lead to a portfolio where almost 50% of all active projects exhibited the highest priority. Thus, to ensure that the portfolio of projects remains aligned over time, IT PPM needs flexible evaluation and prioritization criteria that are informed by up-to-date strategic goals, and IT PPM also needs to re-align the portfolio configuration as the business and its environment changes (Christiansen & Varnes, 2008, p. 96; Kopmann, Kock, Killen, & Gemünden, 2015, p. 538). Thus, we define DP1 as follows:

> **DP1 – If strategic priorities change, adjust project selection and prioritization criteria during each portfolio planning cycle:** *To maximize IT's contribution to current strategic objectives, IT PPM should regularly derive and update the relevant prioritization criteria from the strategy and from operational necessities.*

Over the past two decades, organizations have increasingly used business cases to evaluate IT investment decisions' profitability (Ward, Daniel, & Peppard, 2008, p. 5). Research has empirically demonstrated that the effective use of business cases on the project portfolio-level is significantly associated with project portfolio success (Kopmann et al., 2015, p. 537). However, since many traditional approaches lack a distinct benefits realization perspective, most anticipated benefits are simply not achieved (Doherty, Ashurst, & Peppard, 2011, p. 1). Research has suggested integrating benefits management practices into portfolio management as important mechanisms for the successful implementation of business strategies (Ashurst & Doherty, 2009, p. 20). Moreover, economic and strategic potentials are not regularly re-assessed or scrutinized once projects are approved and initiated. To avoid unjustified resource binding, organizations should continuously monitor progress towards delivering the intended benefits (Serra & Kunc, 2015, p. 61). It is also common practice to plan the project portfolio far in advance, mostly as part of the annual budgeting process planning (Reyck et al., 2005, p. 529). This was also a key issue in our case organization and was mentioned by several of our focus group interviewees as one inhibitor to portfolio balance. Once the portfolio schedule is planned and the budgets are approved, there are no opportunities to flexibly respond to upcoming strategic opportunities, since there are usually no stipulations in place to re-allocate budgets throughout the year process (Bogsnes, 2016, p. 2; Sandalgaard, 2013, p. 37). Maintaining a continuously aligned project portfolio requires the ongoing validation of active projects' business cases against changing internal (e.g., scope changes) and external conditions (e.g., moves of competitors or new technological developments), as well as post-project evaluations to verify whether promised benefits have actually been delivered (Archer & Ghasemzadeh, 1999, p. 212; Bogsnes, 2016, p. 70; Müller et al., 2008, p. 31; Ward et al., 2008, p. 18). One focus group participant claimed that he preferred to reconfigure the portfolio three to four times a year rather than annually. The stated benefits of this approach were that the planning effort is distributed over the year, and a monolithic portfolio configuration is avoided, which is unable to react to inevitable changes occurring throughout the year. Thus, we define DP2 as follows:

> **DP2 - Plan and/or reconfigure the portfolio in short cycles:** *To respond to strategic adjustments and to ensure strategic and economic contributions of running projects, IT PPM should re-plan the entire project portfolio in short planning cycles (e.g., three months).*

Similarly, many firms have a tendency to continue *sick* projects that lost their overall strategic legitimation over time (Beringer et al., 2013, p. 842). However, empirical research demonstrated that the rigorous termination process for troubled projects has a strong positive relationship to the strategic fit and overall project portfolio success (Killen & Hunt, 2013, p. 135; Unger et al., 2012, p. 681). Hanging onto unbeneficial projects was one major issue in our case company, and the participants of our focus group also stressed that managers need to have the courage to terminate projects that have a jeopardized profitability. This not only points to a diligent selection of projects but also to the establishment of mechanisms that can detect issues at an early stage and abandon projects that are expected to no longer deliver their initially intended benefits. This also requires that the IT PPM effectively communicates termination reasons to all relevant stakeholders in order to ensure decision transparency and to learn about the underlying causes. Thus, we define DP3 as follows:

> **DP3 – Immediately terminate projects that are no longer beneficial and inform all stakeholders:** *To avoid pursuing deprecated trajectories, IT PPM should abandon projects with insufficient projected benefits realization.*

5.2.2 How Can IT PPM Sustain Agility?

Traditionally, project portfolios are planned for 12 months in advance during the annual budgeting process, considering that all projects that are expected to be executed during this timeframe (Cooper, 2008, p. 220; Platje, Seidel, & Wadman, 1994, p. 103). However, we observed the practice where frequently immature projects, which are intended to start beyond the portfolio planning horizon, receive approval just for the reason of having them approved as soon as possible. These projects are usually initiated with only limited resources and unclear requirements specifications, and consequently the portfolio becomes cluttered by ill-defined and ineffective projects that drain resources from other projects. As more projects are approved than are manageable, IT PPM loses its overall flexibility to meet truly urgent short-term needs. Furthermore, as potential effects of environmental influences, budget and resource availabilities, time constraints, and risks become increasingly uncertain beyond the established planning cycle, we argue that management should approve only the projects which are expected to be fully operational within the upcoming portfolio cycle. One focus group participant agreed that by following this principle, "the portfolio management can avoid dealing with topics and initiatives that will only get relevant at a much later point in time." Thus, DP4 is formed as follows:

> **DP4 – Only approve projects when they are scheduled to start in the next portfolio cycle:** *To account for ever-shorter strategic planning cycles, IT PPM should approve a project only if it starts in the next portfolio cycle (e.g., within the next quarter).*

Similarly, we observed the tendency to schedule IT projects with durations of nine months or even periods spanning across multiple years in our case company. Research has demonstrated that many large and long-running projects tend to be executed with no strong link to the business strategy (Alsudiri, Al-Karaghouli, & Eldabi, 2013, p. 597). Moreover, the risk of underperforming increases dramatically as project duration increases, while short projects typically have a higher likelihood of success (Sauer, Gemino, & Reich, 2007, pp. 81–82). Drawing on an agile *quick win philosophy*, focus group participants considered that relying on iterative and short projects creates visible and unique results faster, thus speculating on possibly generating many small successes throughout the year with individually trackable benefits. Furthermore, benefits realization in longer projects is found to be significantly lower, since projects approved for a long timeframe are based on assumptions that are potentially no longer valid as projects progress (Doherty et al., 2011, p. 8). Managers can decompose large-scale projects into an array of smaller projects with separate benefits realization and evaluation plans allows managers to assess whether initial assumptions still hold true after each project and subsequently reduces sunk costs when deciding to discontinue the overall initiative. Thus, we define DP5 as follows:

> **DP5 – Only approve short projects:** *To increase average project success and planning agility, IT PPM should minimize project durations as much as possible and break down longer projects into several smaller ones with clear benefits.*

Common portfolio management approaches usually employ traditional task order and scheduling techniques to allocate staff at full effort levels in order to minimize idle times; this causes a cascading effect on all projects that are initiated later in the planning period (Ben-Zvi & Lechler, 2011, p. 1). Our case company took such approaches as well. IT PPM research that draws on the notion of critical chain project management advocates the introduction of safety margins to manage slack time and to better leverage project resources (Yaning, 2011, p. 2). While some of our focus group participants suggested implementing buffers of up to 50% of the total portfolio resources, the actual implementation depends on the unique resource situation in each organization. However, researchers have demonstrated that portfolio buffers might yield "substantially higher value and throughput than a full 100% allocation of the resources" (Ben-Zvi & Lechler, 2011, p. 6). The consensus of our focus group was that a budget and resource buffer may serve as a powerful tool to govern the portfolio. We argue that having adequate reserves in place that allow for a timely activation of unallocated capacities may increase IT PPM's responsiveness to unanticipated perturbations without disrupting ongoing operations. Thus, we propose DP6 as follows:

> **DP6 – Establish a portfolio buffer:** *To account for organizational and environmental disruptions, IT PPM should establish a resource buffer at the portfolio level that allows for adaptive planning.*

5.2.3 How Can IT PPM Sustain Efficiency?

We saw that IT projects are often scheduled and staffed without the appropriate consideration of key resources. However, since the replication of knowledge held by single individuals is often a lengthy or even impossible process (Fontaine, 2010, p. 4), IT PPM must acknowledge such realities by considering these resources during cross-project resource planning and allocation in order to allow for efficient project executions. In line with prior research (Buchwald & Urbach, 2012, p. 7), we observed that several outer-portfolio activities were binding resources that were not available for official initiatives. The identified main drivers for the shortage of key resource capacities were executive interventions and the execution of tasks that are related to closed projects which could not be completed during the official project runtime. As the PPM is typically not involved, key resource capacities vanish in such activities and suffer from multitasking-related work stress, further reducing their capacities (Stettina & Smit, 2016, p. 82). To mitigate such issues, organizations need to implement appropriate governance mechanisms and adequate reporting structures. Thus, we propose DP7 as follows:

> **DP7 – Consider single key resources:** *To avoid single key resource usage overload, IT PPM should ensure that there are no outer-portfolio project activities that bind project resources.*

As our case demonstrated, a high parallel demand for specific key resources is a primary cause of limited project throughput, and this leads to longer average project durations. Furthermore, focus group participants highlighted that having many interdependent projects which have started in parallel often leads to situations where dependencies are only identified once projects have progressed too far to adequately resolve resource conflicts. This intensifies the workload and amount of multitasking, particularly in situations where key resources are prevalent. Multitasking and frequent overload associated with task switching can severely impact project throughput, portfolio performance, and employee wellbeing (Pearson, 2008, p. 57; Zika-Viktorsson et al., 2006, p. 391). Extant research indicates that executing interdependent projects in a coordinated sequence on the PPM level reduces average lead times and increases overall project throughput (Morais & Sbragia, 2012, p. 2511). We propose to increase efficiency by executing interdependent projects sequentially, where possible, to avoid unnecessary resource bindings. Thus, we define DP8 as follows:

> **DP8 – Execute projects sequentially to minimize multitasking:** *To increase execution speed and minimize coordination efforts, IT PPM should sequentially execute interdependent projects.*

Our case showed that top management team often enforces resource shifts to the projects which it perceived to be more important, and this would result in cascading project delays. Since many IT PPM decisions are based on politics and the self-interests of individuals or groups (Martinsuo, 2013, p. 796), such biased decisions will likely not contribute to efficient project deliveries; in fact, these decisions often lead to vicious and path-dependent circles of overloaded resources, excessive costs, schedule overruns, and major quality deficiencies (Zika-Viktorsson et al., 2006, p. 387). Focus group participants pointed out that executive intervention is one major challenge of contemporary IT PPM, and one participant added that to ensure successful completions, "re-prioritization or re-scheduling of running projects should be a rare exception." Thus, DP9 is proposed as follows:

> **DP9 – Do not postpone projects or withdraw resources from projects:** *To ensure uninterrupted project completions, IT PPM should not stop projects or revoke any necessary resources it might require.*

6 Evaluation

To evaluate the applicability of our design principles, we conducted 17 structured interviews with IT PPM experts. We discussed our recommendations with the interviewees based on the three applicability criteria of accessibility, importance, and suitability as proposed by Rosemann and Vessey (2008, p. 3). To accept a recommendation from a statistical point of view, the null hypothesis H_0: $\mu \leq 3$ needed to be rejected, meaning that the applicability was overall rated above average. Table III-3 reports both the mean and median values that were achieved for each design goal and design principle as well as the inter-quartile range, and as seen in the table these values illustrate the degree of dissent. Detailed statistical results on the level of individual applicability criteria can be found in Appendix III-2. Results from the Wilcoxon signed-rank test are reported as standardized *z*-test statistics, one-tailed *p*-values, the effect sizes ($|Z_{\text{Wilcoxon}}| / \sqrt{N}$) classified according to Cohen's (1988, p. 80) heuristic, and the statistical power ($1 - \beta$) of each test. The effect size denotes the practical importance of the difference between the reported degree of agreement from the hypothesized neutral value. Additionally, statistical power may aid the judgment of the results, as it provides an indication that the test will correctly reject a null hypothesis if it is in fact false, thus denoting the probability of *not* making a Type II error (Baroudi & Orlikowski, 1989, p. 88). Values above .80 are usually considered as appropriate statistical power (Cohen, 1988, p. 56).

Table III-3. Overview of evaluation results.

	Mean	Median	Inter-quartile range	*Wilcoxon signed-rank test*			
				|*z*-Value|	*p*-Value (one-tailed)	Effect size [c]	Power [d]
DG1	4.176	4	1.000	3.272	**.001** [b]	**.794*****	**.920**
DP1	3.959	4	0.667	3.546	**.000** [b]	**.860*****	**.952**
DP2	4.314	4	1.333	3.643	**.000** [b]	**.884*****	**.960**
DP3 [a]	3.901	4	0.333	3.292	**.000** [b]	**.798*****	**.923**
DG2	4.412	5	1.000	3.520	**.000** [b]	**.854*****	**.949**
DP4 [a]	3.687	3	1.333	2.480	**.007** [b]	**.601*****	.748
DP5	3.315	2	2.000	1.118	.132	.271*	.274
DP6 [a]	3.764	3	0.667	3.143	**.001** [b]	**.762*****	**.901**
DG3	4.294	4	1.000	3.508	**.000** [b]	**.851*****	**.948**
DP7	4.569	5	1.000	3.687	**.000** [b]	**.894*****	**.963**
DP8 [a]	3.882	4	1.000	3.210	**.001** [b]	**.779*****	**.911**
DP9 [a]	4.019	4	1.333	3.094	**.001** [b]	**.750*****	**.893**

[a] Concerns regarding suitability dimension

[b] Null hypothesis H_0: $\mu \leq 3$ rejected at $\alpha = 1\%$ (values printed in bold indicate significant results)

[c] The effect size indicates the magnitude of the difference from the neutral value
*** .5 and above indicates large effect (printed in bold); * .1 indicates small effect (Cohen, 1988, p. 80)

[d] Statistical power was calculated using G*Power software (http://www.gpower.hhu.de/en.html; values printed in bold indicate appropriate statistical power)

To allow for an intuitive presentation of our findings, we computed aggregated figures for each applicability dimension for all design goals and principles as surrogate key values. However, besides the analysis of the aggregate score, we also closely analyzed the individual applicability criteria for each design principle and aimed to reject the principles which would raise a large dissent for single criteria. For instance, we would deem principles unsuited when they do not seem feasible to implement even though they might address a real-world problem. As we engaged in close dialogues during the interviews, we were able to determine the rationales behind the individual feedback and develop a comprehensive account for the idiosyncratic background of each answer.

Overall, the design goals and principles obtained rather positive evaluations from our 17 interviewees. All our design goals obtained high agreement with low variation (IQR = 1). Some interviewees regarded the alignment goal as less important, and instead they considered optimum capacity utilization and distribution of plans, budgets, and forecasts as the primary goals of the IT PPM. This is to some extent in line with a more traditional perspective that regards IT PPM primarily as a management framework to optimize the throughput of a project portfolio (Kaiser et al., 2015, p. 127). However, we opted to include feedback from a more traditional view in our evaluation for a broad reflection. In looking at the individual applicability dimensions, the interviewees considered all our design principles as easy to understand (i.e., accessible), and they gave most principles a high agreement and consensus that these address real-world problems (i.e., importance). However, interviewees mentioned challenges for certain design principles when it comes to their feasibility to be implemented in practice (i.e., suitability).

Regarding our principles for achieving *alignment*, the termination of projects that are no longer beneficial (DP3) raised some discussions on its practical feasibility. Interviewees frequently mentioned cultural challenges—such as the admission of failure—as one obstacle for implementation. Although respondents regarded this principle as important, most interviewees argued that terminating such projects will face cultural and political challenges, particularly when the projects are being implemented under executive sponsorship. Admitting errors or wrong decisions at upper management level by terminating projects is the exception rather than the rule, since managers strive to fulfill institutional expectations, seize incentives, and avoid failure being attributed to them. This is in line with prior studies that have regarded error and failure as anathema in most corporate cultures, and this mentality in turn suppresses both learning and improvement from constructive feedback loops by advocating the *zero-error principle* (Kriegesmann, Kley, & Schwering, 2007, p. 270; Lyytinen & Robey, 1999, p. 92). Some interviewees do not regard this principle as a responsibility of the IT PPM activity; rather, respondents saw that it was the duty of individual project managers to escalate problems early. For IT PPM to be functional, our interviewees considered it necessary for the work environment to foster a climate of trust and prudence, as well as strong assertive capabilities on the part of decision makers.

Although deemed as highly important, the design principles that were aimed at achieving *agility* were the most controversial ones. Interviewees raised concerns for the suitability of approving only the projects which are scheduled to start in the next portfolio cycle (DP4), as IT budgets and resources are usually allocated on an annual basis. Applying this principle would jeopardize the security and stability needed for long-term planning, especially for large and strategic projects; this is because stakeholders are pressurized to organize project budgets and project plans in a very short timeframe. Nevertheless, interviewees stated that the implementation of this principle would restrict stakeholders from stockpiling project budgets without having any near-term project plans. Due to very similar reasons, DP5 (i.e., only approve short projects) was the design principle that received the most critical feedback, while it also was the most controversial item. It did not pass the importance and suitability criteria, mostly owing to common budgeting practices. Executing only short projects on a quarterly basis could lead to the situation where IT budgets are consumed before the last quarter, thus potentially leading to a *shutdown situation*. Executing short projects would require a dynamic budgeting process throughout the year, but one-time annual budgeting does not seem compatible with this design principle. Experts further raised concerns regarding this design principle, specifically in that breaking down large projects into several sequential subprojects would not necessarily lead to projects that create independent benefits on their own. Interviewees also stated the concern that an increased number of projects per year would also increase the overall complexity for the portfolio planning and increased coordination efforts with the single-project management. Concerns often relate to the project types or the company's industry. For instance, interviewees claimed that it is not purposeful to split large transformational or organizational projects into subprojects, and that projects running in the hardware or financial industry often necessitate long durations. Interviewees noted that this design principle is probably better suited to small organizations with projects that are less complex than those in larger organizations. While this criticism appears understandable at a first look, recent research advocates for the benefits of flexible and agile engineering approaches—including short cycle times—in hardware-centered IT projects (Huang, Darrin, & Knuth, 2012, p. 8). The recommendation to establish a portfolio buffer (DP6) received some disagreement for its suitability. Interviewees pointed out that such a buffer could raise disputes and create resistance among stakeholders for three reasons. First, experts see problems in assigning the responsibility of the determining, allocation, and usage of the portfolio buffer to a specific role. Second, some portfolio managers see the likelihood that a portfolio buffer would lead to a decreased responsibility of individual project managers, who would rely on the portfolio buffer instead of focusing on efficient project execution. Some experts also see problems in cases when buffers are not fully used; this could lead to conflicts with senior executives, who might require the portfolio managers to justify unused buffers. Finally, some also pointed out challenges when integrating a portfolio buffer concept into existing corporate controlling and planning systems. In sum, these aspects call for dedicated governance mechanisms for buffer management at a portfolio level.

Experts also provided critical feedback on one principle that is geared towards *efficiency*. High organizational pressure to execute many projects as quickly as possible is often deeply rooted in the business side. This trend leads to a necessity to simultaneously execute many projects to fulfill expectations, in turn making it difficult to implement sequential execution (i.e., DP8) in some organizations. From an operational perspective, unforeseen events, such as ad hoc management decisions and resource fluctuations, are practical challenges to sequential project execution. Finally, executive intervention and power structures were also mentioned as obstacles for the feasibility of DP9 (i.e., never postpone projects or withdraw resources from projects). While one interviewee stated that this design principle should be a matter of course for any organization, others mentioned that non-influenceable resource fluctuations could also jeopardize this principle.

In sum, we see some interesting patterns across the feedback from interviewees disagreeing on the feasibility of design principles, and their comments confirmed our case findings. While cultural challenges were mentioned as an obstacle for alignment-related principles, common budgeting and resource allocation practices were highlighted as challenges for implementing agility-related principles. Ad hoc decision making and coercive control of executives were identified as hindrances for implementing principles aimed at achieving a higher portfolio efficiency. However, the effect sizes and the statistical power of the suitability dimension of these design principles were rather small. Nevertheless, as Hess et al. (2014, p. 16) suggested that even small effects can be of importance, we see that these principles deserve a more careful study in the future.

7 Discussion

7.1 Contributions to Research

Our findings make important contributions to the body of research on IT PPM. Many organizations struggle when trying to adapt their operations to short-term opportunities and changing strategic trajectories, while still aiming to maintain alignment and efficiency (Kock & Gemünden, 2016, p. 678; O'Reilly & Tushman, 2008, p. 193; Raisch et al., 2009, p. 687). To date, only very few studies have focused investigations on an agile and balanced management of project-based organizations at a project portfolio level (Eriksson, 2013, p. 339), and even fewer studies focus on IT project portfolios or on using approaches with a sound theoretical underpinning. Thus, contemporary research on IT PPM suffers from namely two deficiencies, which we strive to address with our study: First, literature only provides a limited and atheoretical understanding on the factors that impede the achievement of an aligned and agile yet efficient IT PPM, and second, literature generally lacks recommendations for achieving a more balanced IT PPM configuration.

Regarding the first deficiency, previous research has provided largely unsatisfactory insights into the causes that hamper organizations to achieve a more flexible mode of operation while still maintaining alignment and efficiency. To gain a better understanding about the contemporary issues of project-based organizations, scholars have demanded research to better anchor contributions in established behavioral theories and set a deeper focus on behavioral aspects (Floricel et al., 2014, p. 1093; Söderlund, 2004, p. 189). Since project management is a practice-oriented domain, research in this field is traditionally said to be theory-poor and has faced deficiencies in concepts (Killen, Jugdev, Drouin, & Petit, 2012, p. 526; Shenhar & Dvir, 1996, p. 608; Söderlund, 2004, p. 184). Traditional conceptual frameworks that try to explain how portfolio methods influence performance results (e.g. Cooper et al., 1999, p. 337) are mostly based on rational decision-making theory, and they often factor out highly relevant aspects such as human actors' interests, social structures and associated information flows, or the role of technology (Floricel et al., 2014, p. 1092). As portfolio misalignment, inefficiencies, and inertia are assumed to be rooted in power structures and in opportunistic behavior of stakeholders to a large extent (El Arbi et al., 2012, pp. 7–10; Martinsuo, 2013, p. 796), previous research has recommended redirecting efforts to rethink IT PPM as a sociotechnical system and understanding the complex sociotechnical relations and deep structures at work (Floricel et al., 2014, p. 1094; Killen et al., 2012, p. 527). It was further argued that IT PPM should be considered as a collective activity that is shaped by the actions of diverse actors (Burga & Rezania, 2017, p. 1033) and aims to mitigate project portfolio complexity and environmental uncertainty (Martinsuo, 2013, pp. 801–802; Teller et al., 2012, p. 604). Along these lines, we demonstrated that AT offers a novel perspective on how firms organize their IT project portfolios; these portfolios are mediated through tools that are historically provisioned by an organization situated within a unique idiosyncratic context. In contrast to other perspectives, AT views human activity and technology as mutually shaping, and activities transform over time based on the interactions between their subjects and artifacts (Engeström, 2001, p. 136).

Our findings confirm previous studies that highlight how the alignment to business strategy and resource allocations between projects represents major challenges in the context of IT PPM (Stettina & Hörz, 2015, p. 141). However, we went one step further beyond previous research and conceptualized IT PPM as behavioral activity system that encompasses "more than just projects that survived rational decision-making processes" (Blichfeldt & Eskerod, 2008, p. 358). This goal here was to study the actions of IT PPM participants, as these actions are situated in their behavioral and material contexts that forms IT PPM as a whole (Floricel et al., 2014, p. 1095). We demonstrated how the project-related practices of our case company evolved along the company's transformation from a *garage company* to a professional enterprise, and which problems arose in certain elements of the IT PPM activity along this process. In adopting the qualitative adjustments proposed by Chen et al. (2013, pp. 130–131), we confirmed the theoretical merit of extending traditional AT with the components of timeline and history; this was done in order to draw an even more complete picture of an activity system by framing the historically grown tensions even more precisely. Through a close dialogue with a case company across hierarchical levels and various viewpoints, we uncovered and analyzed the asymmetrical conceptions of portfolio tensions between different groups, and in this way our research approach embraced a critical-dialogic stance (Bebbington et al., 2007, p. 366) by identifying contradictory situations and their root causes in the IT PPM activity. Our study demonstrated that the mechanisms at work in the IT PPM activity are not merely based on actors simply following and executing formalized guidelines, but they are to a large extent based on constantly changing power relations between different stakeholders groups (Hansen & Kræmmergard, 2014, p. 43).

Second, the body of knowledge lacks general recommendations and explicit prescriptions for designing a more flexible IT PPM that account for the characteristics of today's disruptive environment while maintaining alignment and efficiency. After the critical reframing and decomposition of the issues using our AT-informed analytical model, we iteratively developed design recommendations to promote transformative action. To the best of our knowledge, our research is the first attempt to provide empirically-grounded design recommendations that focus on the confluence among the IT PPM goals of alignment, agility, and efficiency. Previous studies have considered approaches such as frequent portfolio reviews, iterative planning, and avoidance of multitasking as suitable measures to address alignment and resource overload issues (e.g. Rautiainen, Von Schantz, & Vähäniitty, 2011, p. 4; Stettina & Hörz, 2015, p. 142). These studies are consistent with our design recommendations; specifically, our design recommendations on sequential project execution, dynamic prioritization, and the focus on short-running projects align with evidence from prior research (e.g. Daniel et al., 2014, pp. 106–107). Contrary to some researchers who warn of an *exploitation trap* when primarily favoring short-term and low-risk projects (Killen & Hunt, 2010, p. 164), we advocate that incremental projects which are aimed at rapid delivery tend to prevent progress from becoming too stale (Steindl, 2005, p. 260; Thomas & Baker, 2008, p. 259). While one study argued that avoiding frequent priority changes increases transparency and stability (Rautiainen et al., 2011, p. 8), our recommendations draw on research that advocates for allowing changes to the prioritization criteria, namely that the criteria should at least be able to vary over time to respond to changing business conditions and thus maintain in-flight alignment (Steindl, 2005, p. 261; Yang, Thorogood, Van Toorn, & Vlasic, 2015, p. 8). Furthermore, our recommendations concur with the studies which indicate that projects subjected to high uncertainty and centered around fast-paced innovation should be carried out in small-sized iterations (Cooper, 2013, pp. 29–30). In line with our recommendations, extant research has emphasized that stopping projects depending on business and organizational changes increases alignment and benefits realization; it also reduces complexity and risks (Unger et al., 2012, p. 681). While we generally agree with the idea of re-allocating resources between projects as needed (Daniel et al., 2014, p. 96), re-allocation should not be arbitrarily practiced by exerting political power at the expense of existing initiatives, and it should be justified based on sound decision processes. By providing recommendations on how to achieve a more flexible portfolio management, we added actionable advice to studies that regard IT PPM as critical activity for supporting emergent strategies (Kopmann et al., 2017, p. 567).

In conclusion, our paper makes two valuable contributions to research. First, our analytical model helps to theoretically frame individual, technical, and social components and issues on the level of IT PPM, and it demonstrated the utility of AT and a critical-dialogic approach for this purpose. Second, our recommendations add to the scarce body of design knowledge by providing recommendations on how to shape a more sustainable IT PPM that is aligned and efficient yet is able to swiftly adapt to technological disruptions and new strategic trajectories.

7.2 Managerial Implications

This paper has sought to increase our understanding of what are the contemporary challenges facing IT PPM in practice and how can organizations achieve a more sustainable configuration in practice. Our case study confirmed that executive intervention often adds complexity to the process, thus resulting in vicious circles of strategic inflexibility and decreasing employee motivation (Hansen et al., 2017, p. 95; Platje & Seidel, 1993, p. 210). It turned out that executives often lack trust in portfolio processes, and consequently they favor the overpowering of portfolio plans and project prioritizations for emerging short-term opportunities and *pet projects* to fulfill personal objectives. Our case showed that these practices resulted in a broad range of adverse effects such as a high presence of parallel projects, thereby leading to cascading project delays. As the company was incapable of managing this organizational adhocracy, it frequently suffered from overloaded employees and an accumulation of prolonged, resource-poor projects. This highlights that IT PPM requires rigorous compliance to the agreed portfolio governance standards as well as to transparency about decision making in order to avoid such negative feedback loops and enable frictionless operations. While our case company had formal accountability systems such as portfolio planning boards and project evaluation processes in place, upper executives frequently overruled the recommendations made by the IT PPM. However, organizations need to consider that overly formalized structures may add even more complexity and limit agility (Hansen et al., 2017, p. 86). Furthermore, to ensure process performance and portfolio success, organizations need to install strong portfolio managers who are equipped with certain traits and skills, such as exercising appropriate autonomy and authority for their activities, and also having the ability to mitigate arising conflicts across all organizational levels (Jonas, 2010, p. 824). The interplay between the various stakeholders who are involved in the IT PPM activity necessitates an ongoing engagement between the different antagonist groups; the aim here is to identify and resolve the issues that deter balanced operations and success.

We found that a major obstacle for improving IT PPM is the systemic lack of awareness and visibility of information among these stakeholders regarding the problems in the components of the IT PPM activity. For example, traditional approaches suggest that all projects should be subjected to a stage-gate process in the context of PPM (Cooper, 2008, p. 214). Contradictorily, our study confirms that a broad range of activities and projects are often not under the integral oversight of PPM in practice, and thus they consume considerable amounts of time and drain resources (Buchwald & Urbach, 2012, p. 7). We believe that our analytical model ingrained by AT can serve as a powerful tool for practitioners that enables them to better identify deficiencies in their IT PPM system, particularly during early investigations; in this way, they can frame potential components that are causing issues, such as by complementing other methods for problem identification and process improvement such as the Shewhart-Deming (1939) cycle. Managers may utilize the model to take stock of their IT PPM from a holistic perspective and update their analysis on a regular basis. As the model is parsimonious by nature, its application may foster communication among heterogeneous stakeholder groups and raise awareness by pinning down unresolved social and technical issues in a systematic way. Our application of the model to a real-live company demonstrates its ability to reflect upon the complex collective context of IT PPM and to detect historically grown tensions and imbalances.

Once factors inhibiting a sustainable IT PPM are identified, organizations need to ensure that adequate measures are in place, and these measures should be designed to resolve issues and prevent the factors from reoccurring. While traditional project portfolio management often aims to anticipate or determine an *optimal* portfolio of projects based on mathematical procedures (Archer & Ghasemzadeh, 1999, p. 211; Kaiser et al., 2015, pp. 131–132), our study demonstrated that in today's business world, mere rationality-based planning approaches to IT PPM are not sufficient. Although our case company built its institutionalized IT PPM on supposedly proven management principles, these principles could neither efficiently manage changing demands from within (e.g., changing strategic requirements) and outside (e.g., regulatory requirements) the organization, nor could they quickly seize the business opportunities emerging in the market. Considering the turbulent nature of today's digital technologies that puts constantly changing demands on companies, one of the most prevalent challenges for project-based organizations is developing and sustaining an IT PPM that is able to adapt to rapidly changing conditions while ensuring alignment and efficiency (Daniel et al., 2014, pp. 106–107; Kock & Gemünden, 2016, pp. 681–682). We believe that our design principles will streamline IT PPM to better achieve alignment and flexibility while maintaining overall efficiency of portfolio operations. However, our recommendations do not intend to entirely replace the established IT PPM guidelines and standards from the professional body of knowledge. Instead, our recommendations may complement existing approaches by making them more flexible, and they also support firms in balancing opposing demands. One note of caution is that extending or transforming an established IT PPM using our recommendations requires a careful analysis of the as-is situation of the IT PPM activity itself and of the context; this is necessary in order to ensure organizational compatibility of individual principles. While our design principles provide a general blueprint for an IT PPM approach oriented towards sustainability, our applicability check revealed that instantiation in an organization depends on its idiosyncratic context, and this necessitates context-specific extensions and adjustments (Gregor & Jones, 2007, p. 326). Some interviewees deemed an iterative portfolio budgeting as only fairly suitable in practice, while prior research has discussed the necessity for dynamic budgeting approaches in order to be adaptable to fast-changing operational environments (Stettina & Hörz, 2015, p. 141). As stressed during the interviews, our design principles require a dynamic budgeting process throughout the year, while the common approach of one-time annual budgeting does not seem compatible with our suggestions. Similarly, research that concurs with agile principles recommends flexible budgeting approaches oriented to fast-changing operational environments by making resources available as needed, and not by means of annual budget allocations (Bogsnes, 2016, p. 70; Kaarbøe, Stensaker, & Malmi, 2013, p. 108; Sandalgaard, 2013, p. 94). Hence, our recommendations might be limited to organizations that already operate or are able to implement flexible budgeting practices. Consequently, our design principles, which are focused on continuous portfolio reconfigurations, require organizations to shorten their strategy formulation horizon from annual planning to multiple iterations throughout the year—if these are not yet in place. To implement a sustainable IT PMM in practice, our interviewees further considered it vital to have an open climate of trust and prudence as well as strong assertive capabilities on the part of decision makers (Kock & Gemünden, 2016, p. 682). As IT PPM capabilities usually develop over a longer time period following evolutionary and co-evolutionary dynamics (Kwak, Sadatsafavi, Walewski, & Williams, 2015, p. 1653), our design principles will certainly take time before their benefits materialize. Organizations may consider to first apply the principles in a smaller part of their IT PPM that is separated from the traditional portfolio. This might be appropriate for evaluating the overall utility of the principles for the specific organizational context, and this also allows for adjustments where needed, followed by a later implementation on a larger scale. Such a staged approach might as well sustain organization-wide commitment to the change if the successful implementation of the principles is evidenced by a visible and demonstrated pilot approach.

7.3 Limitations and Avenues for Future Research

Our study contributes to both the research and practice of IT PPM. Nevertheless, our paper has limitations, some of which point towards avenues of further research.

Our design goals and principles are empirically derived from a single, cross-sectional yet revelatory case and a focus group. Although some researchers relegate single case studies for their lack of generalizability, we argue that the revelatory case allowed us to engage in an in-depth examination of the contemporary issues occurring in the complex, sociotechnical context of IT PPM (Yin, 2002, p. 42). We posit that both internal validity and reliability are major strengths of our results. Specifically, we engaged in a close dialogue with the case company to capture the causal relationships and effects associated with ineffective IT PPM, which were subsequently triangulated with insights from a focus group and subjected to a series of expert interviews (Patton, 2002, p. 584). The richness of the information we gathered during our in-depth interviews from both the case and the focus group enabled us to reveal contradictions and to derive recommendations which we triangulated with extant literature before we derived our final set of design principles. Although our study did not strive for formal or statistical generalization, we acknowledge that in a strict sense, our empirical findings are limited to the context and conditions of this organization for the time being. Future research might assess our design principles and their effects in different and ideally in longitudinal settings.

Next, while many of our design principles passed the applicability check unconditionally, the results provide first cues on how the design principles could be refined. In line with the stages of design science research, our results and the insights from the validation stage can be fed back into another design cycle and tested to re-examine whether our recommendations solve problems as intended (Bebbington et al., 2007, p. 365; Hevner et al., 2004, p. 80). However, future design research might develop concrete specifications on how to implement the design principles in specific contexts, and it may accompany this groundwork with implementations in a real-world setting as illustrative examples to test its viability in practice (Gregor & Jones, 2007, p. 329). A possible approach would be to develop a context-specific management and governance framework or reference model as a concrete implementation of our abstract design principles, which may serve as blueprints (Gregor & Jones, 2007, p. 326). In this context, action design research (Sein et al., 2011) might represent a promising approach that could be utilized to yield valuable insights. Action design research aims to implement design knowledge in a real-world situation; it also observes changes and effects that are longitudinal over time.

Furthermore, we see that the potential of AT as theoretical underpinning for IT PPM research is far from having been fully exploited. We must also acknowledge that we may have neglected to take into account certain components in the IT PPM activity that contribute to contradictions. This could be either because our specific case organization did not exhibit any issues in these components, or that we missed *hidden* theoretical elements during the development of our analytical model. Although the used components are based on a thorough analysis of contemporary literature and have successfully helped us to systematically reveal contradictions in the IT PPM activity of a case company, it could be argued that our choice of components narrowed the analytical view on the phenomenon. Hence, the AT perspective on project organizations also allows further empirical studies to be conducted; this further exploration can uncover and address tensions beyond the ones identified in our revelatory case by considering different or additional elements. Moreover, AT aims to conceptualize organizations as configurations or networks of different yet partially overlapping and interacting activity systems, where each is geared towards individual yet interdependent outcomes (Vakkayil, 2010, p. 6). As our study is limited by being specifically focused on the behavioral patterns and tensions within the IT PPM activity itself, future research guided by AT might investigate the phenomenon in greater granularity. For instance, one might conceptualize the management board (e.g., providing governance rules for IT PPM activity) or single projects (e.g., part of the IT PPM activity's community, and contributing the projects to its *object* component) as separate activities; such directions may help researchers understand the nonlinearities and behaviors of participants in an in-depth manner. This is particularly of interest, as we confirmed that different actors in the realm of IT PPM often share goals that only partially and frequently pursue different motives (e.g., driven by financial incentives), and consequently tensions ensue in the activity system under investigation. From our interviews, we also noted the different development stages of the IT PPM activity over the company's history. AT argues that the components in an activity and an activity system as a whole tend to develop over time as conditions change, with contradictions being the central source for change (Engeström, 2001, p. 135). Future longitudinal studies may investigate the evolutionary development of IT PPM activities and its various elements to understand how organizations modify or substitute different components of the activity over time and to investigate the impact of changes made. As AT suggests, all actions performed by subjects on a specific object are mediated by certain tools (Engeström, 2001, p. 134). In our study, we treated material technology (i.e., hardware and software) as well as conceptual portfolio techniques (e.g., methods for portfolio structuring) within the tools component of AT more traditionally as collective "system of techniques" (Woodward, 1958, p. 16). However, AT puts a large emphasis on a materiality perspective and therefore is particularly suited to spark IT PPM research. Researchers might seize the materiality perspective offered by AT to investigate the moderating role of technical artifacts in more depth, such as by studying how the enactment of planning software contributes to the achievement of goals or how misuse of technology leads to portfolio failure.

Our research further confirmed that executives' behavior and decision-making processes decisively impact the attainability of IT PPMs' goals. During our interviews, many interviewees stressed the ambivalent role of the top management in the context of IT PPM. On the one side, executive intervention in operational processes was one of the most frequently mentioned root cause for tensions and conflicts. Although our design recommendations may provide a first guidance on how to potentially constrain undesired executive behavior, further conceptual and empirical research is needed to understand how senior management intervention impacts the sustainment of alignment, agility, and efficiency on the IT PPM level. We thus support recent calls (e.g. Kock & Gemünden, 2016) to investigate both the roles of decision-making and the enforcement of portfolio decisions on portfolio-related outcomes. In acknowledging seminal work from the strategic management domain, we propose to leverage management control theory (Ouchi, 1977, 1979) as a promising analytical lens to shed light on how upper executives exert power over the IT PPM activity. In the research domain of project-based organizations, the effects of coercive executive controls is only rarely investigated (e.g. Müller et al., 2008), and prior studies have predominantly focused on the single-project level (e.g. Bonner, Ruekert, & Walker, 2002). On the contrary, top management support and effective decision making is generally regarded as a necessary condition for enabling successful portfolio management. Research revolving around agile PPM empirically has demonstrated that the quality of managerial decision making is one of the main drivers that allow for quick adaptations to changing needs and overall business unit success (Kock & Gemünden, 2016, p. 671). While we add to this discourse on agile IT PPM approaches, the contribution of a more sustainable IT PPM to the organizational bottom line is yet to be verified on the empirical level. Future research could address this issue by investigating how a more balanced IT PPM contributes to firm-level agility and performance.

8 Conclusion

Our research question addressed which problems cause portfolio imbalance and which principles should guide an aligned and efficient yet agile IT PPM. In this study, we leveraged AT as an analytical lens in investigating a single revelatory case to understand the systemic tensions (i.e., contradictions) that frequently arise within and between individual elements on the PPM level; in doing so, we demonstrated the utility of AT for investigating IT PPM-related phenomena. Our study shows that the path-dependent accumulation of single key resources—in conjunction with executives bypassing formal portfolio governance—leads to a vicious circle of workarounds applied in outer-portfolio projects, buildup of technical debts, overloaded resources, poorly performing projects, and the inability to flexibly react to changing strategic trajectories. Based on a subsequent focus group discussion and the review of extant literature, we derived nine design principles for a more sustainable approach, accounting for the goals alignment, agility, and efficiency. While some of our design principles raised concerns regarding the feasibility of implementation in today's business environment, most of the recommendations achieved high agreement regarding their overall applicability during a series of expert interviews. While this research provides opportunities to further refine and test our results, it may already offer valuable guidelines for managers in setting up a more sustainable IT PPM.

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Appendices III

Appendix III-1. Evolution of Design Principles

<table>
<tr><th>Design principles case study results</th><th>Focus group suggestions</th><th>Design principles 1st refinement</th><th>Design principles 2nd refinement</th><th>AT component</th></tr>
<tr><td>Consider the net capacity of resources: New projects should only be approved if the resource situation allows for it. This means that the planned effort is covered by the net capacity of the allocated resources. However, projects may also be postponed to avoid a lack of resources.</td><td>Um die Überlastung von Engpassressourcen zu vermeiden, können einzelne Projekte aus dem aktuellen Zyklus in zukünftige Zyklen verschoben werden</td><td rowspan="2">Consider single key resources: To avoid single key resource usage overload, IT PPM should postpone supernumerary projects to the next portfolio cycle and should ensure that there are no un-enacted project activities that bind project resources.</td><td rowspan="2">Consider single key resources: To avoid single key resource usage overload, IT PPM should ensure that there are no outer-portfolio project activities that bind project resources.</td><td rowspan="2">Division of labor</td></tr>
<tr><td>Avoid un-enacted project work that binds project related resources: Make all un-enacted (“hidden”) project work transparent and consider them in resource management. Avoid any significant task allocations that are not monitored by resource management.</td><td>Keine U-Boot-Projekte, keine nicht registrierten Ressourcen-bindenden Aktivitäten; alle halten sich an den Portfolio-Prozess</td></tr>
<tr><td>Focus on key resources while scheduling multiple projects: Approve and schedule projects so that key resources’ multitasking is minimized. The additional workload from daily business has to be considered when assigning key resources’ tasks.</td><td>Projekte werden (tendenziell) hintereinander und nicht parallel durchgeführt; Multitasking wird minimiert.</td><td>Execute projects sequentially to minimize multitasking: To increase execution speed and minimize coordination efforts, IT PPM should execute interdependent projects sequentially</td><td>Execute projects sequentially to minimize multitasking: To increase execution speed and minimize coordination efforts, IT PPM should sequentially execute interdependent projects</td><td>Division of labor</td></tr>
<tr><td rowspan="2">Enforce sufficient plan quality: Always conduct a sufficient, detailed effort estimation and planning before approving projects. Estimation has to comply with corporate standards and has to be checked by the Portfolio Management.</td><td>Es wird stetig an der Professionalisierung des Projektmanagements gearbeitet, dieses bildet die Grundlage für ein funktionierendes PPM.</td><td colspan="3">Implicitly covered by the other principles.</td></tr>
<tr><td rowspan="2">Es gibt ein Reporting, dass über die Agilität des Portfolios Auskunft gibt. Das Reporting kann Aspekte enthalten wie Multitasking-Häufigkeit, durchschnittliche Projektlaufzeit, Varianz der Projektlaufzeit, Puffer-Nutzung, etc.</td><td rowspan="2">Establish agile reporting: To operatively monitor the achievement of strategic objectives, portfolio reporting should consider aspects such as multitasking, project variance, and buffer usage.</td><td rowspan="2" colspan="2">Dropped</td></tr>
<tr><td rowspan="2">Plan and manage buffers effectively (on the project and portfolio level): Only approve a project if necessary buffers are in place.</td></tr>
<tr><td>Wenn die durchschnittliche Projektlaufzeit länger</td><td>Establish a portfolio buffer: To account for</td><td>Establish a portfolio buffer: To account</td><td>Division of labor</td></tr>
</table>

Design principles case study results	Focus group suggestions	Design principles 1st refinement	Design principles 2nd refinement	AT component
	ist als die Zyklus-Dauer muss ein Puffer installiert werden. Dieser Puffer gilt für die Zeit nach dem aktuellen Zyklus, d.h. es müssen (!) jeweils Ressourcen im nächsten Zyklus verfügbar sein (Vorschlag: min. 30-50%).	organizational and environmental disruptions, IT PPM should establish a resource buffer at the portfolio level that allows for flexible planning even when the average project duration is longer than the portfolio cycle.	for organizational and environmental disruptions, IT PPM should establish a resource buffer at the portfolio level that allows for adaptive planning.	
Set benefit and business case-oriented priorities: In the absence of a formal approach, bias and politics can play a major role in project selection.	Keine Projekte sind verpflichtend. Auch vermeintliche „Muss-Projekte“ können wirtschaftlich bewertet werden	Use structured benefits analysis as a basis for project selection and prioritization: To ensure benefits-oriented project selections, IT PPM should create a benefits dependency network for each project proposal in the business case preparation.	***Dropped***	
	Bei Strategiewechseln oder veränderten strategischen Prioritäten werden die Projektpriorisierungskriterien sofort angepasst.	If strategic priorities change, adjust project selection and prioritization criteria during each portfolio planning cycle: To maximize IT's contribution to current strategic objectives, IT PPM should regularly derive and update the relevant prioritization criteria from the strategy as well as operational necessities.	If strategic priorities change, adjust project selection and prioritization criteria during each portfolio planning cycle: To maximize IT's contribution to current strategic objectives, IT PPM should regularly derive and update the relevant prioritization criteria from the strategy as well as operational necessities.	*Rules*
	Das Management besitzt den Mut alle nicht mehr nutzenstiftenden Projekte sofort zu beenden.	Immediately terminate projects that are no longer beneficial: To avoid pursuing deprecated trajectories, IT PPM should abandon projects with insufficient projected benefits realization.	Immediately terminate projects that are no longer beneficial and inform all stakeholders: To avoid pursuing deprecated trajectories, IT PPM should abandon projects with insufficient projected benefits realization.	*Rules*
	In jedem Zyklus werden alle (!) Projekte und Pro-	Completely (re-)assess benefits each portfolio planning cycle: To ensure strategic and economic	***Dropped***	

Design principles case study results	Focus group suggestions	Design principles 1st refinement	Design principles 2nd refinement	AT component
	jektanträge einer strategischen Prüfung unterzogen sowie neu priorisiert	contributions of running projects, IT PPM should (re-)evaluate all projects and project proposals at the start of every planning cycle.		
Avoid withdrawing resources from running projects to allow for fast and efficient execution: Only approve new projects if there is no risk of negative side effects on current projects. In particular, do not withdraw allocated resources that are already in use.	Kein laufendes als sinnvoll bewertetes Projekt wird angehalten oder verlangsamt; es werden keine einmal zugewiesenen Ressourcen entzogen	Never postpone projects or withdraw resources from projects: To ensure uninterrupted project completions, IT PPM should not stop projects or revoke any necessary resources they might require.	Do not postpone projects or withdraw resources from projects: To ensure uninterrupted project completions, IT PPM should not stop projects or revoke any necessary resources they might require.	*Community / Division of labor*
Limit the duration of projects to a feasible and practicable level: Only approve projects with an expected duration that is within the firms planning period.	Projekte sind kurz und nach wenigen Monaten beendet	Only approve short projects: To increase the average project success and ensure project alignment, IT PPM should minimize project durations as much as possible and should break longer projects down into several smaller ones with clear benefits.	Only approve short projects: To increase average project success and ensure project alignment, IT PPM should minimize project durations as much as possible and should break down longer projects into several smaller ones with clear benefits.	*Rules*
	Das Portfolio wird in kurzen Abständen (z.B. 3 Monate) immer wieder vollständig (!) neu geplant (Zyklus).	Plan and/or re-configure the portfolio in short cycles: To respond to strategic adjustments, IT PPM should re-plan the entire project portfolio after a short cycle (e.g. three months).	Plan and/or re-configure the portfolio in short cycles: To respond to strategic adjustments and ensure strategic and economic contributions of running projects, IT PPM should re-plan the entire project portfolio in short planning cycles (e.g. three months).	*Instrument*
	Projektanträge werden nur dann genehmigt, wenn der Projektstarttermin im Zeitraum des kommenden Zyklus liegt	To account for ever-shorter strategic planning cycles, IT PPM should approve projects only when the project starts in the next portfolio cycle.	Only approve projects when they are scheduled to start in the next portfolio cycle: To account for ever-shorter strategic planning cycles, IT PPM should approve a project only if it starts in the next portfolio cycle.	*Rules*

Appendix III-2. Detailed Evaluation Results

	Mean	Median	Inter-quartile range	*Wilcoxon signed-rank test*			
				Z-Value	p Value (one-tailed)	Effect Size	Power[a]
DG1	4.176	4	1.0	-3.272	**0.001*** **	**0.794†††**	**0.920**
DG2	4.412	5	1.0	-3.520	**0*** **	**0.854†††**	**0.949**
DG3	4.294	4	1.0	-3.508	**0*** **	**0.851†††**	**0.948**
DP1.1	4.647	5	0.0	-3.690	**0*** **	**0.895†††**	**0.964**
DP1.2	3.824	4	0.0	-3.116	**0.001*** **	**0.756†††**	**0.896**
DP1.3	3.412	3	1.0	-1.941	**0.026** **	**0.471††**	**0.566**
DP1 (total)	3.959	4	0.7	-3.546	**0*** **	**0.860†††**	**0.952**
DP2.1	4.647	5	1.0	-3.758	**0*** **	**0.911†††**	**0.968**
DP2.2	4.235	4	1.0	-3.391	**0*** **	**0.822†††**	**0.935**
DP2.3	4.059	5	2.0	-2.950	**0.002*** **	**0.715†††**	**0.866**
DP2 (total)	4.314	4	1.3	-3.643	**0*** **	**0.884†††**	**0.960**
DP3.1	4.941	5	0.0	-4.025	**0*** **	**0.976†††**	**0.982**
DP3.2	4.118	5	1.0	-2.480	**0.007*** **	**0.601†††**	0.748
DP3.3	2.647	3	2.0	-1.192	0.117	**0.289†**	0.297
DP3 (total)	3.901	4	0.3	-3.292	**0*** **	**0.798†††**	**0.923**
DP4.1	4.235	4	1.0	-3.520	**0*** **	**0.854†††**	**0.949**
DP4.2	3.706	4	2.0	-2.097	**0.018** **	**0.509†††**	0.623
DP4.3	3.118	3	2.0	-0.144	0.443	0.035	0.065
DP4 (total)	3.687	3	1.3	-2.480	**0.007*** **	**0.601†††**	0.748
DP5.1	4.706	5	1.0	-3.787	**0*** **	**0.918†††**	**0.970**
DP5.2	2.765	3	3.0	-0.679	0.248	**0.165†**	0.156
DP5.3	2.471	2	3.0	-1.431	**0.076***	**0.347††**	0.379
DP5 (total)	3.315	2	2.0	-1.118	0.132	**0.271†**	0.274
DP6.1	4.588	5	1.0	-3.739	**0*** **	**0.907†††**	**0.967**
DP6.2	3.706	4	2.0	-2.070	**0.019** **	**0.502†††**	0.613
DP6.3	3.000	3	2.0	-0.122	0.451	0.030	0.063
DP6 (total)	3.764	3	0.7	-3.143	**0.001*** **	**0.762†††**	**0.901**
DP7.1	4.765	5	0.0	-3.827	**0*** **	**0.928†††**	**0.973**
DP7.2	4.765	5	0.0	-3.827	**0*** **	**0.928†††**	**0.973**
DP7.3	4.176	5	1.0	-3.109	**0.001*** **	**0.754†††**	**0.895**
DP7 (total)	4.569	5	1.0	-3.687	**0*** **	**0.894†††**	**0.963**
DP8.1	4.706	5	1.0	-3.787	**0*** **	**0.918†††**	**0.970**
DP8.2	4.059	4	2.0	-2.659	**0.004*** **	**0.645†††**	0.798
DP8.3	2.882	3	1.0	-0.426	0.335	**0.103†**	0.106
DP8 (total)	3.882	4	1.0	-3.210	**0.001*** **	**0.779†††**	**0.911**
DP9.1	4.647	5	1.0	-3.704	**0*** **	**0.898†††**	**0.965**
DP9.2	3.941	4	2.0	-2.491	**0.006*** **	**0.604†††**	0.751
DP9.3	3.471	3	2.0	-1.333	**0.091***	**0.323††**	0.345
DP9 (total)	4.019	4	1.3	-3.094	**0.001*** **	**0.750†††**	**0.893**

n.1: Accessibility; n.2: Importance; n.3: Suitability (see section 3.4)

Null hypothesis H_0: $\mu \leq 3$ rejected at α ***1% level; **5% level; *10% level
††† 0.5 and above: large effect; †† 0.3: moderate effect; † 0.1: small effect
[a] Statistical power was computed using G*Power software (http://www.gpower.hhu.de/en.html). Values above .8 are usually considered as appropriate statistical power (Cohen, 1988, p. 56).

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CRITICAL REFLECTION AND CONCLUSION

Abstract

The objective of this thesis was to develop an understanding of the capabilities required for successful digital enterprise transformations. To this end, three separate yet interrelated research papers investigated the phenomenon and contributed to the extant body of knowledge. This conclusion summarizes the main findings by reflecting the key research problem and questions identified in the introduction paper. Furthermore, the major contributions to research and practice as well as limitations and implications for future research are discussed.

Keywords: *summary, discussion, contributions, limitations, implications, future research*

Table of Contents

1 Summary of Key Findings

This thesis focused on the phenomenon of digital enterprise transformations, that is, the utilization of digital technologies to fundamentally change organizational strategies, culture, structures, and business models (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013, p. 472; Matt, Hess, & Benlian, 2015, p. 341). More specifically, the thesis focused on the microfoundations of dynamic capabilities, which are understood as the managerial processes and organizational structures required to reconfigure organizational resources and competences to address changing business environments in the broader context of digitalization (Kesting, Cavalcante, & Ulhøi, 2011, p. 1337; Teece, 2007, p. 1320). These microfoundations may consist of the "distinct skills, processes, procedures, organizational structures, decision rules, and disciplines" (Teece, 2007, p. 1319) that serve as foundation for the dynamic capabilities required to carry out digital enterprise transformations. The introduction paper framed the ability to carry out digital enterprise transformations as dynamic capability, since it focuses on the reconfiguration of substantive resources and capabilities by utilizing digital technologies (Kesting et al., 2011, p. 1337). Despite the relevance in practice and research, the extant body of knowledge offered very little advice on their microfoundations that are up to date (Gianvito et al., 2018, p. 378; Ryan, Geoghegan, & Hilliard, 2018, p. 16). The introduction paper further identified the strategy, structure, and the environment as the primary contingencies that moderate between digital enterprise transformation capabilities and competitive advantage (Barreto, 2010, p. 277; Wilden, Gudergan, Nielsen, & Lings, 2013, p. 88). For the strategy-environment contingencies, the concept of digital business strategies was reviewed, thus setting the scene for the subsequent course of the thesis. In terms of structure, both digital innovation management and project portfolio management (PPM) were identified as key microfoundations in terms of the basic (sub-)elements that enable companies to realize the required sensing, seizing, and reconfiguration capacities (Kesting et al., 2011, p. 1337; Nylén & Holmström, 2015, p. 58). The overall objective of this thesis was to elucidate the microfoundations of digital enterprise transformation capabilities on an empirical and conceptual basis. To fulfill this objective, three key research questions were addressed in individual stand-alone research papers. The first key research question addressed was as follows:

> **RQ1:** *Which issues and phenomena at the intersection of strategy, technology, and organization have to be revisited in light of digital business strategies?*

The first research paper applied Rajagopalan's and Spreitzer's (1997) theory of strategic change to systematically chart the current body of literature on digital business strategies; this was done to shed light on the environmental and organizational conditions that influence changes in the content of strategies. Overall, it was shown that two primary reasons are progressively jeopardizing a traditional understanding of a business-IT alignment that emphasizes a mere supporting role of IT. First, an increasing number of organizations put digital technologies at the heart of their core business logic, and secondly, the rapid change in digital technologies sets the pace for strategic renewal more frequently compared to earlier years. To stay competitive in a digitalized world, both issues require that firms find new ways of organizing which allow them to flexibly position the IT as a strategic trigger for digital innovations. To this end, the paper demonstrated that digital business strategy represents a promising concept that overcomes the traditional business/IT-strategy dichotomy by emphasizing a unified view on business and technology, and thus positions IT closer to the center of the business logic. The review revealed several knowledge gaps related to the processes and structures for implementing digital business strategies and their contribution to organizational performance. Furthermore, the review confirmed that extant research provides little insights so far into how firms adjust their substantive capabilities and resource base to digital business strategies, or how firms may leverage digital resources to successfully execute such strategies. Here, digital innovation management and PPM were identified as promising means for digitally-enabled strategic renewal. Thus, the thesis aimed to investigate these microfoundations in more depth. Building on the insights from the literature review, the second research paper addressed the following key research question:

> **RQ2:** *How does digital innovation management's organizational design contribute to digital business model innovativeness?*

By examining effective organization structures of digital innovation management, the second research paper focused on the sensing and seizing features of digital enterprise transformation capabilities. The thesis conceptualized digital innovation management as the primary microfoundation to embed digital technologies at the strategic core by developing novel digital business models. The paper first clarified the notion and the different dimensions of digital business model innovation, and it then set out to unravel organizational designs of digital innovation management that are able to effectively generate digital business model innovation. Based on Galbraith's (1973, 1974) organizational information processing theory, a conceptual framework for predicting the effectiveness of digital innovation management's design was developed, where effectiveness can be realized in terms of digital business model innovativeness. The model applied a Gestalt perspective (Doty & Glick, 1994, p. 240) to the strategy-structure-environment fit (Priem, 1994, p. 430; Volberda, van der Weerdt, Verwaal, Stienstra, & Verdu, 2012, p. 1051) for achieving high digital business model innovativeness. The model further considered the subsequent effect of digital business model innovativeness on organizational performance. The framework was subsequently operationalized and empirically tested in a quantitative survey study. By applying fsQCA as analytical procedure, the paper identified common organizational archetypes that are effective in achieving both high digital business model innovativeness and structural configurations of digital innovation management that perform poorly at digital business model innovation. Using PLS-SEM to investigate the direct effects of the conceptual framework, it was shown that firms with high degrees of digital business model innovativeness tend to actually exhibit higher overall organizational performance. By employing MANOVA, we were able to relate effective digital IM configurations to performance. In sum, the second paper addressed the multiple research gaps uncovered in the first research paper. Nevertheless, digital innovation management represented only the first essential microfoundation of digital enterprise transformation capabilities. Hence, the third research paper addressed the final key research question of the thesis:

> **RQ3:** *How can organizations achieve an aligned and agile yet efficient IT PPM?*

Since innovation activities are most often brought into practice through projects, the third paper investigated principles for a PPM configuration that satisfies requirements of the digital era. By answering the final key question, the third paper focused on providing insights into the seizing and reconfiguration features of digital enterprise transformation capabilities. Since many firms struggle with the timely deployment of projects in predicted quality and budget particularly when facing a fast-changing digital environment, a revelatory case study was performed to uncover the organizational, historical, social, and environmental forces that commonly impede the effectiveness of PPM. Guided by Engeström's (1987, 2001) activity theory, the analysis revealed various interrelated tensions in the different components of the PPM system. These tensions were primarily fueled by excessive executive intervention and ultimately accumulated to a vicious circle of technical debts, overloaded resources, and poorly performing projects. Based on the case insights and a focus group session, we developed three design goals and nine design principles for an aligned and efficient yet agile PPM configuration. The subsequent evaluation of our goals and principles confirmed their applicability and utility for practice, but they still offered some room for future improvements. In sum, all research papers contributed to addressing the thesis' overarching research problem as elaborated in the introduction paper:

> **RP:** *Due to a lack of theoretical and empirical underpinnings, many organizations struggle with the understanding and implementation of capabilities and the microfoundations that are required for digital enterprise transformations; this situation manifests in low success rates of transformation initiatives.*

Taking all research results into account, this thesis provides a theoretically-grounded and empirical understanding of the dynamic capabilities' nature and their microfoundations required to carry out digital enterprise transformations effectively. The thesis's results highlight that digital business strategies and models alike determine what constitutes the core of digital enterprise transformations. Furthermore, appropriate dynamic capabilities need to be in place that allow for strategic renewal resulting from the emergence of novel digital technologies, thus rapidly changing customer needs and changing market structures. The results demonstrate that digital innovation management and PPM represent key managerial and organizational processes (i.e., microfoundations) that enable digitally-enabled change. However, rather than applying a general *one-fits-all solution* derived from one universal grand theory of digital enterprise transformation, organizations need to determine the digital innovation management's and PPM's designs that fit most to their unique idiosyncratic contexts in order to successfully carry out digital transformations. To ensure a successful implementation of digital strategies by digitally transforming the business model through the commercialization of digital innovations, firms further need to enable their PPM to be agile and efficient while maintaining overall strategic directions. This balancing of concerns is vital in the digital era, since traditional PPM practices are often insufficient for integrating digital short-term initiatives without risking vicious circles of operational inefficiencies that may hinder the effectiveness of digital enterprise transformations. The thesis's contributions are discussed in detail in the next chapter.

2 Discussion

2.1 Contributions to Research and Practice

The results of this thesis contribute to research in several regards. The results are *novel* from a scientific perspective, since they challenge traditional assumptions about managerial processes and structures, and they advance our understanding of digital enterprise transformation capabilities, their microfoundations, and their interrelationships (Ågerfalk, 2014, p. 594; Straub, 2009, p. v). Throughout the individual research papers, multiple key research questions were addressed that have not been answered before, thus charting the underexploited scientific territory of digital enterprise transformations. The findings put forward that digital business strategies and models, digital innovation management, and PPM constitute the key microfoundations for effective digital enterprise transformation capabilities.

By applying Rajagopalan's and Spreitzer's (1997) theory of strategic change as a framework of analysis in a systematic literature review, the first research paper contributed to research not only by revealing fruitful paths for future research in the field of digital business strategies, but it also further challenged existing conventions about business-IT alignment. The results acknowledge that digital technologies are increasingly integrated into the core of business logics (Mithas & Lucas Jr, 2010, p. 4; Pagani, 2013, p. 619) and that they overcome the traditional emphasis of the subordinate role of IT, namely a role that focuses on supporting existing processes (Chan & Reich, 2007, p. 298; Sabherwal & Chan, 2001, p. 13). Consequently, the results concur with Bharadwaj et al. (2013, p. 473) by advocating unified digital business strategies instead of disjunct IT and business strategies as likely future standard for the *logic of competitive strategy* of many organizations (Woodard, Ramasubbu, Tschang, & Sambamurthy, 2013, p. 538). The research paper contributes to research since it identified digital business strategies as one key microfoundation of successful digital enterprise transformations, since strategy represents the primary means to address environmental changes and new opportunities (Teece, 2012, p. 1396; Teece & Pisano, 1994, p. 545).

The second research paper challenged traditional assumptions about innovation management success factors, such as thorough and complete product development processes (e.g. Cooper & Kleinschmidt, 1995, p. 384). Instead, it positioned the information processing capacity resulting from different "causal recipes" (Ragin, 2013, p. 172) of organizational design variables as key driver for innovations success as measured by digital business model innovativeness. By extending and applying Galbraith's (1973, 1974) organizational information processing theory, the paper provided a novel perspective on the phenomenon of digital innovation management, which typically is dominated by theories such as the transaction cost theory or organizational learning perspectives (Dixon, Meyer, & Day, 2010, p. 418). Nevertheless, the results in general concur with recommendations that adequate innovation resources and cross-functional teams may play important roles (Gassmann, Widenmayer, & Zeschky, 2012, p. 122). Yet, it is the specific combination of different design variables as a whole that contributes to digital innovation success. The paper also contributed to our understanding of digital business models by conceptualizing their nature and constituents, as well as by offering a measurement model to assess their degree of newness. The paper also provided a novel empirical and methodological account of digital enterprise transformations. By applying fsQCA as an analytical procedure, we captured the causal asymmetry and complementary effects in the organizational design of digital innovation management, which would not have been possible with other widely-applied methods such as linear regression or cluster analysis (El Sawy, Malhotra, Park, & Pavlou, 2010, p. 844; Nambisan, Lyytinen, Majchrzak, & Song, 2017, p. 232). Since digital innovation management's activities are geared toward sensing and seizing new digital opportunities and typically result in reconfigured resources and operational routines (Nylén & Holmström, 2015, p. 58; Zollo & Winter, 2002, p. 340), an effectively designed digital innovation management constitutes the second pivotal microfoundation of successful digital enterprise transformations. Digital innovation management contributes to dynamic capabilities since the "crafting of competitive business models is a critical microfoundation of a firm's seizing capabilities" (Schoemaker, Heaton, & Teece, 2018, p. 11).

The third research paper extended and employed Engeström's (1987, 2001) activity theory in a critical-dialogic approach to add new insights into the causes for portfolio inefficiencies to the body of PPM knowledge, which is typically characterized as being theory-poor or emphasizing rational decision-making theory (Floricel, Bonneau, Aubry, & Sergi, 2014, p. 1093; Söderlund, 2004, p. 189). The application of activity theory allowed us to systematically frame prevalent tensions that hamper the portfolio agility that is required in the digital era. The paper further added to nascent body of design science research on portfolio management (Frey & Buxmann, 2012, p. 11) by empirically developing and evaluating goals and principles for an agile yet aligned and efficient IT PPM that may serve as appropriate microfoundation for digital enterprise transformations. Since such an IT PPM is able to effectively reconfigure a firm's assets and capabilities as outlined in digital business strategies and models (Berman, 2012, p. 21; Petit & Hobbs, 2010, p. 50), it represents the final key microfoundation of successful digital enterprise transformations.

Moreover, the results are scientifically *useful*, since they may prompt "further theoretical elaboration beyond the current research context" (Ågerfalk, 2014, p. 594). The implications for future research associated with the aforementioned contributions are discussed in the next section. By taking these contributions together and by empirically examining the under-explored relationships between digital enterprise transformations and the required capabilities grounded on extant theories, this thesis' contributions to research may be considered significant, according to Colquitt's and Zapata-Phelan's (2007, p. 1283) classification.

This thesis' findings also contribute to effective digital enterprise transformations in practice. The results' *relevance and utility* for managers are grounded in the fact that they address the prevailing problem of failing digital enterprise transformation initiatives (Bucy, Finlayson, Kelly, & Moye, 2016, p. 2) in two ways. One way is by providing a clear understanding of the essential capabilities required to digitally-transform an enterprise; the other way is by empirically showing pathways to cope with the challenges of digital enterprise transformations, which can be done by disseminating the relevant capabilities. More specifically, the thesis presents managers the increasing importance of digital technologies and their consideration during the strategizing process. In fast-changing markets with high degrees of digital disruption such as media and finance (Manyika et al., 2015, p. 5), it now seems mandatory to treat technology and business as coequal, or to even move toward the formulation of a unified digital business strategy in order to sustain a competitive edge. Nevertheless, a digital business strategy is neither a panacea for digital enterprise transformations nor an end in itself. Senior management needs to assess the maturity of their firm's capabilities to implement digital business strategies in their organization. Here, digital innovation management was identified as one important foundation for implementing digital business strategies by detecting technological changes and by subsequently developing new digital business models. The results demonstrate that no single most effective solution to digital innovation management exists in practice, meaning that managers need to scrutinize their organizational design and adjust structural variables based on the firm's strategic orientation and the environmental context (e.g., industry) they are operating in. To this end, the thesis presents the managerially amendable options that may be used to align the digital innovation function to strategic trajectories and varying conditions of technological turbulence. Furthermore, having effective digital innovation structures in place does not only improve the ability to capitalize on emerging opportunities and enhance digital innovativeness, but it further has direct effects on overall firm performance. This implies that senior managers need to ensure a seamless transition between the development of new digital business models and their subsequent implementation throughout the firm, typically by leveraging PPM. Here, the thesis also lends credence to the assumption that senior management involvement plays a crucial role for the success of digital enterprise transformation initiatives and projects (Matt et al., 2015, p. 341). While top management support is important for project success, excessive management intervention may lead to a vicious circle of overloaded employees and to projects that fail to deliver their intended objectives in time and budget. Hence, managers need to balance operational flexibility and rigorous compliance when designing their PPM; the purpose is to simultaneously enable agility, alignment, and efficiency to successfully carry out digital initiatives. To this end, our evaluated design goals and principles for sustainable PPM may serve as blueprint for managers that aim to achieve these objectives. When taken together, the thesis represents a valuable starting point for managers that aim to build the required capabilities for digital enterprise transformations in practice.

2.2 Limitations and Implications for Future Research

Despite its contributions, it is worth keeping in mind this thesis's limitations, some of which warrant further investigations. Moreover, the contributions discussed in the previous section yield several research implications that may fertilize further exploration and theoretical elaboration. This final section first briefly summarizes the limitations and research implications of each individual research paper, and it then discusses limitations and implications from the overarching dynamic capabilities perspective.

First, the literature review's contribution is limited in that it does not differentiate the relative importance of digital business strategies across industries. To date, formulating and implementing digital business strategies may not be of pressing importance in more stable industries such as chemicals or public administration compared to others (Bucy et al., 2016, p. 2). Hence, future research may investigate the effects of digital business strategy implementations across various industries. From a methodological point of view, the review results are limited to the application of the framework of analysis and the applied keywords. Considering the pace of technological developments and scientific publications, it may be worthwhile to inform the review with updated insights in the near future. Second, the research paper on digital innovation management is limited by its theoretical underpinning and its quantitative nature. The organizational information processing theory served as compelling lens to approach the phenomenon. Nevertheless, different other theories that are prevalent in innovation research (Dixon et al., 2010, p. 418) may provide different explanations that could be compared to the paper's results. Furthermore, although the first qualitative studies on digital innovation management have come to the fore (e.g. Böhl, Hoffmann, & Ahlemann, 2016), further in-depth case studies would add to our understanding of digital innovation management. Here, future research may build on the identified configurations to uncover the underlying causal connections between the conditions in detail that could not be explained through fsQCA (Berg-Schlosser, De Meur, Rihoux, & Ragin, 2009, p. 12). Researchers may either adapt the organizational information processing theory or more micro-level frameworks to theoretically elaborate on these inner mechanisms. For example, researchers may employ the perspective of socio-cognitive sensemaking to investigate individual digital innovation processes in more depth (Nambisan et al., 2017, p. 228). Future research may also apply design science research (Hevner, March, Park, & Ram, 2004) to develop empirically-grounded prescriptive knowledge for designing different organizational archetypes.

Third, although we empirically evaluated the applicability of our design goals and principles on sustainable PPM in a series of expert interviews, we lack up-to-date empirical insights and measures into whether the recommendations increase portfolio performance in practice. Future research may assess the overall efficacy and efficiency of an expository PPM instantiation that applies our design goals and principles (Gregor & Jones, 2007, p. 329), either by comparing the performance of an existing PMM that is close to an *ideal* configuration with more traditional variants or by employing the principles to solve a specific case's problems in the course of an action design research study (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011, p. 3). Here, the latter would be a longitudinal case by nature. Comparing evaluation criteria such as average project success rates, portfolio throughput, employee wellbeing, and contribution to the achievement of strategic objectives both before and after the intervention may yield valuable insights into the design principles effectiveness in practice (Pries-Heje, Baskerville, & Venable, 2008, p. 9).

In considering the broader frame of dynamic capabilities to connect the explored microfoundations for effective digital enterprise transformations, some overarching limitations and research implications may be derived from the results. Because the thesis focused on the first identification and assessment of the microfoundations that enable organizations to carry out digital enterprise transformations, an overarching integration and empirical evaluation of all building blocks is still pending. Hence, the integration of digital business strategy, digital innovation management, and PPM into one coherent and testable model promises insights into the interplay between these microfoundations. Researchers should also consider observing dynamic capabilities for digital enterprise transformations over time, since the thesis is based on cross-sectional data. Although the cross-sectional approach provided us substantial new insights into enterprise transformation capabilities and allowed to identify their key microfoundations, Laaksonen and Peltoniemi (2018) pointed out that "dynamic capabilities theory is about change over time" (p. 200). Although the thesis contributed to the body of knowledge by providing answers to the *why* and *what is and what will be* questions about digital enterprise transformation capabilities, it does not provide an end-to-end description of the *how* to achieve such capabilities (Gregor, 2006, p. 620). Despite the normative design prescriptions for sustainable PPM that provide a first cue on the *how to*, dedicated process theories including cost and antecedents may guide research and practice to better understand the nature of the specific digital enterprise transformation capability building process. Exploring the *how* of capability building implies a future focus on longitudinal studies. Similarly, future research may investigate the reciprocal feedback loops between digital enterprise transformation capabilities and substantial capabilities in more detail. Here, researchers may explore the mechanisms and effects of how digital enterprise transformation capabilities reshape a firm's resource base and vice versa (Schilke, Hu, & Helfat, 2017, p. 422).

This thesis focused on the organizational level. Hence, future research may investigate the determinants on the individual and group levels that contribute to effective digital enterprise transformation capabilities. Although the thesis included the human aspect throughout the research papers (e.g., slack resources, collaboration, managerial intervention), investigating the role of managerial human capital and social capital (i.e., individual level) in more detail would shed light on the social components of digital enterprise transformations (Helfat & Martin, 2015, p. 1304). Since digital enterprise transformation involves individuals and groups, it may be fruitful to investigate how *digital entrepreneurial intent* is routinized below the strategic or organizational level (Mahringer & Renzl, 2018, p. 77). On the one hand, researchers may explore how entrepreneurial leadership traits of individual middle or senior managers contribute to a digitally-enabled business model renewal, which was found as one success factor of dynamic capabilities in previous studies (Schoemaker et al., 2018, p. 27). On the other hand, research may complement the thesis's strategic top-down approaches to digital enterprise transformation by offering insights into bottom-up transformation initiatives (Fromhold-Eisebith & Eisebith, 2005, p. 1251). For example, empowered production managers may notice emerging digital technologies by monitoring their environment themselves, and they subsequently may consider adapting their production routines to these new technologies. Additionally, it would be worth investigating specific technological foundations of the proposed microfoundations. For example, big data analytics capabilities were conceptualized as one specific sub-form of innovative capabilities, and they may further enhance information processing capacities if orchestrated correctly with other resources (Mikalef, Pappas, Krogstie, & Giannakos, 2018, p. 557). Similarly, the concept of integrative capabilities denotes the ability of communicating and coordinating internal activities and resources, as well as supporting the relationships with external parties (Helfat & Raubitschek, 2018, p. 1400). Since an increasing amount of innovation activities is carried out in digital platform ecosystems (Tilson, Sørensen, & Lyytinen, 2013, p. 3), it would be promising to investigate the mechanisms that firms apply in order to orchestrate their innovation and project activities in highly-distributed ecosystems using the lens of integrative capabilities in more detail.

Although the thesis addressed the theory-measurement gap that is prevalent in dynamic capabilities research (Laaksonen & Peltoniemi, 2018, p. 184) by providing operationalizations for measuring the effectiveness of digital innovation management design, it does not offer quantitative measures for digital business strategies or sustainable PPM due to the qualitative nature of these papers. Since measurement is vital to assess the validity of theoretical concepts and to perform comparisons among organizations (Venkatraman & Grant, 1986, pp. 71–72), future research may develop quantitative measures based on areas such as managers' evaluations, firm actions (e.g., the number of digital projects completed), or financial data; using such measures, firms can operationalize digital business strategies and sustainable PPM (Laaksonen & Peltoniemi, 2018, p. 190).

Organizations today are in constant flux due to ever-changing socio-technological developments, which pose as tremendous challenges for many. Despite the limitations of this thesis, the work done here has made significant steps toward a deeper understanding of the capabilities that are required for digital enterprise transformations.

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List of Abbreviations

Abbr.	**Explanation**
AI	Artificial intelligence
ANOVA	Analysis of variance
API	Application programming interface
ASCI	Accelerated Strategic Computing Initiative
AT	Activity theory
AVE	Average variance extracted
Bca	Bias-corrected and accelerated bootstrap confidence interval
CAD	Computer-aided design
CB	Benchmark consistency
CD	Compact disc
CDO	Chief digital officer
CEO	Chief executive officer
CIO	Chief information officer
CNC	Computerized numerical control
CO	Observed consistency
CPU	Central processing unit [computer processor]
DARPA	Defence Advanced Research Projects Agency
DBS	Digital business strategy
DG	Design goal
DP	Design principle
ELR	External lateral relations
fsQCA	Fuzzy set qualitative comparative analysis
H	Hypothesis
H0	Null hypothesis
HCM	Hierarchical component model
ILR	Internal lateral relations
IM	Innovation management
IND	Industry
INV	Digital business model innovativeness
IP	Intellectual property
IQR	Interquartile range
IS	Information system
ISD	Information systems development
ISO	International Organization for Standardization
IT	Information technology
MANOVA	Multivariate analysis of variance
NAICS	North American Industry Classification System
NASA	National Aeronautics and Space Administration

Abbr.	Explanation
OD	Organizational design
OECD	Organisation for Economic Co-operation and Development
OIPT	Organizational information processing theory
OP	Organizational performance
P	Proposition
PLS-SEM	Partial least squares structural equation modelling
PMO	Project Management Office
PPM	Project Portfolio Management
PRI	Proportional reduction in consistency
Q	Quartile
QCA	Qualitative comparative analysis
R&D	Research and development
RDT	Resource dependence theory
RoN	Relevance of necessity
RP	Research problem
RQ	Research question
SAM	Strategic alignment model
SCT	Self-containment
SD	Standard deviation
SDK	Software development kit
SE	Standard error
SLR	Slack resources
SPI	Seconds-per-item
SRMR	Standardized root mean square residual
STRAT	Strategic posture
TURB	Turbulence
US	United States
USA	United States of America
VAR	Variance
VIF	Variance inflation factors
VoIP	Voice over Internet Protocol
XML	Extensible Markup Language

Index