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Success Factors for Digital Transformation Strategies in Established Organizations – A Configurational Approach

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Preface

As I write this preface, exciting and challenging times come to an end and a new chapter of my life begins. Conducting research for my doctoral thesis and working at the Chair of Information Systems was a demanding as well as rewarding journey. Throughout my time at TUM, I have met many people that have led and accompanied me on this long journey. Without them and their support, finishing this thesis would not have been possible and I want to take the time to extend my thanks to them.

First of all, I want to express my deepest gratitude to my doctoral supervisor, Prof. Dr. Helmut Krcmar. You provided me with many challenging and interesting opportunities which will certainly have a long-lasting impact on me. The next exciting task was always just around the corner—from managing the chair's teaching portfolio to working with innovative companies to juggling different teaching obligations at the same time. Providing me the chance to not only design and plan, but also to actually introduce and manage a new Bachelor's program at TUM Campus Heilbronn has been an extraordinary experience with many valuable learnings. I want to thank you for your support and guidance and also for placing your trust in me. I also want to thank my research group leader, Prof. Dr. Markus Böhm. You always had an open ear and were always available to discuss paper ideas. Without your input, many of my papers would probably not have been published. I wish you all the best for your new journey as a full professor and your personal life. I also want to thank Prof. Michael Myers, Prof. Ojelanki Ngwenyama, and Prof. Rikard Lindgren for your feedback on my dissertation and fruitful discussions at the doctoral consortium of the European Conference on Information Systems 2019.

During my time as a doctoral candidate, I had the chance to work on many different projects such as the Initiative for Digital Transformation. I extend my special gratitude to Gerhard Oswald, who, as a member of SAP's supervisory board, gave my colleagues and me the chance to work with extraordinary companies on many different case studies. This helped me to learn more about digital transformation from a practitioner-oriented perspective and provided me with inspiration on how to transfer concepts from theory to practice. During my time as the program manager for the Bachelor's program in Information Engineering, I had the chance to work with Prof. Dr. Florian Matthes and Dr. Holger Wittges. Thank you for your guidance and the valuable lessons that you taught me when building up and later running the program. Also, thank you to the entire team of the TUM Campus Heilbronn gGmbH and all the people from TUM School of Management at Heilbronn with whom I had the pleasure to work with. Being a part of this growing ecosystem was a very special experience and I hope that the campus will grow even further in the future. I want to extend a very special thank you to Edoardo and Leonard who helped me achieve the impossible many times and with whom I laid the foundation for the first generation of information engineers at TUM Campus Heilbronn.

I am very grateful that TUM has provided me with so many opportunities to develop myself in an academic, professional, and personal way. From representing my fellow doctoral candidates in Informatics to being a member of the Graduate Council, I can only urge other prospective doctoral candidates to take advantage of the chances that TUM offers and to take as well as

give back to the community. I also want to thank Carolin and Daniel for being my co-representatives at CeDoSIA.

Working at the chair would not be half the fun and excitement it is without the people that I met there. In no particular order: Max, Jörg, Andreas, Martin (all of them), Barbara, Sebastian, Michael (again, all of them), Rob, Timo, Julia, Harry, Manuel, Christoph, Christopher, Tobias, Kai, Vroni, Mohammad, Lukas, Norman, Thomas, and many others—thank you, for countless coffee breaks and discussions, many rounds of kicker, and the occasional beer or two. I also want to thank the students whose theses I supervised and with whom I had many interesting discussions in class.

Finally, I want to thank my family. I am eternally grateful to my parents, my brother, and my wife Andrea who have given me their unconditional support as well as their help and advice throughout this journey. Without them, none of this would have been possible.

Munich, October 2021 David Soto Setzke

Abstract

Problem Statement: Digital technologies are radically changing how established organizations compete and interact in traditional markets. Digital transformation strategies are formulated executed to integrate digital technologies in business models and processes and to ensure competitiveness against a rising number of start-ups. However, many digital transformation strategies fail due to different reasons and little is known about the respective success and failure factors. Therefore, this thesis aims at developing an empirical understanding of success factors for digital transformation strategies of established organizations by taking a configurational perspective into account.

Research Design: To investigate success factors for digital transformation strategies in established organizations, we adopt a critical realist stance combined with a configurational research perspective. We use Qualitative Comparative Analysis (QCA) as a research method to derive several configurations for successful and unsuccessful outcomes. To collect the data needed for QCA, we conduct case studies and case surveys. Additionally, this thesis builds on a conceptual paper and two literature reviews for the methodological and conceptual basis.

Results: We first introduce a formalized approach for combining the case survey methodology and QCA and, based on a critical literature review, we provide an extensive overview of how QCA has been used in IS research and how future QCA-based Information Systems research can be improved. Second, we analyze different cases of digital transformation to identify how dynamic capabilities can be used to reduce socio-technical and socio-cognitive inertia during digital transformation. Third, we identify success and failure factors for digital transformation strategies that are oriented towards digital service innovation and business model innovation. Fourth, we analyze how platform design impacts the success of platform-based digital transformation strategies.

Contribution: This thesis contributes to different theoretical concepts and literature streams in the context of digital transformation. First, we contribute to the literature on both dynamic capabilities and inertia by linking these concepts and investigating them using configuration theory. Second, our findings contribute to the literature on innovation in digital transformation, in particular digital service and business model innovation. Regarding digital service innovation, our thesis is among the first studies to integrate this perspective with digital transformation and thus paints a more complete picture. Regarding business model innovation, we provide a conceptualization of eleven organizational capabilities that are required to successfully engage in Internet-of-Things-enabled business model innovation. Third, the results contribute to the literature on digital platform ecosystems by showing how platform openness and extension modularization influence the degree of value capture of a newly established platform. Fourth, our results contribute to an outcome-oriented perspective on digital transformation. Fourth, our thesis provides methodological contributions by showing how researchers can use QCA to calibrate qualitative data and by introducing a formalized approach to combine the case survey methodology and QCA. For practice, we derive guidelines that firms can apply when designing and executing their digital transformation strategies.

Limitations: Our research is subject to several limitations. Literature reviews are limited by the search and coding process. To mitigate this risk, we conducted forward and backward searches and, where possible, let two people code the articles independently. For our QCA-based studies, we used relatively small samples. Although this allowed us to become more familiar with the cases and pay attention to context, small sample sizes limit the generalizability of the analyses. Furthermore, two analyses are based on interview data, which can include a researcher bias and is challenging to calibrate. Additionally, we may have left out dimensions in our research framework that may have provided additional explanatory power.

Future Research: Our thesis shows several fruitful avenues for future research. First, researchers could focus on and investigate different facets of centralized decision-making and their impact on digital transformation. Second, scholars may investigate different types of inertia besides socio-technical and socio-cognitive inertia. Third, other outcomes of digital transformation strategies, for example, concerning sustainability, could be explored. Fourth, scholars could further investigate the usefulness of our approach that combines QCA and the case survey method. To further improve it, we encourage other scholars to apply and test this method with other research questions. Lastly, future research could validate the results of this thesis by using other research methods such as regression analysis.

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List of Abbreviations

AMCIS	Americas Conference on Information Systems
API	Application Programming Interface
BIS	Business Information Systems
CDO	Chief Digital Officer
CEO	Chief Executive Officer
CIO	Chief Information Officer
CON	Conference
ECIS	European Conference on Information Systems
EJIS	European Journal of Information Systems
EM	Electronic Markets
FsQCA	Fuzzy-set Qualitative Comparative Analysis
IOT	Internet of Things
ISF	Information Systems Frontiers
ICIS	International Conference on Information Systems
IS	Information Systems
IT	Information Technology
JCSM	Journal of Competences, Strategy, and Management
JNL	Journal
NR	Not ranked
P	Publication
PACIS	Pacific Asia Conference on Information Systems
QCA	Qualitative Comparative Analysis
QM	Quine-McCluskey
RBV	Resource-Based View
RQ	Research question
SLR	Structured Literature Review
VHB	German Academic Association for Business Research
WI	Internationale Tagung Wirtschaftsinformatik

Part A

1 Introduction

> *"At first sight, the digital revolution poses an existential threat to established incumbents. But we believe they can thrive in the digital age – if they adapt. […] The fact that Kodak's story is cited so often is evidence that its fate is the exception rather than the rule. Digital disruption is not (yet) bankrupting Forbes Global 2,000 companies."* (World Economic Forum 2016)

This quote from the World Economic Forum illustrates that digital technologies represent both a threat and an opportunity for established organizations. However, the success of a digital transformation strategy depends on the context of the organization and the environment it operates in. In this dissertation, we build an empirical understanding of success factors for digital transformation strategies of established organizations. By using a configurational perspective, we move beyond traditional net-effect thinking and provide context-specific insights. Thereby, we fill various gaps in research on digital transformation and provide actionable recommendations for practitioners.

1.1 Motivation

Digital technologies and their implications play a decisive role in today's society. They have brought advances to the individuum, organizations, and society as a whole (Vial 2019). Digital technologies such as in-memory databases, distributed ledgers, or cloud computing are nowadays widespread and easily accessible for organizations of any size. They enable them to radically transform business models and processes. The easy access to digital technologies has also enabled startups to enter and attack virtually every traditional market and industry sector, such as manufacturing, banking, and automotive (Fitzgerald et al. 2013). Companies such as Uber, Airbnb, or Spotify are increasingly pressuring and threatening established organizations and their business models (Skog et al. 2018). To embrace digital technologies, established organizations need to integrate them into their organizational structures, processes, and business models, among others. This process is known as digital transformation (Vial 2019). On the one hand, many organizations are struggling with formulating and executing effective digital transformation strategies, resulting in low success rates (La Boutetière et al. 2018). On the other hand, companies have many valuable assets that can be positioned at the center of a successful strategy. The Berlin Philharmonic Orchestra, for example, faced declining record sales and launched a virtual streaming platform that allows fans around the world to watch live concerts and access recordings at any time (Soto Setzke et al. 2018a; Fesz 2015). SIEMENS developed a cloud platform that allows manufacturing companies to create digital twins for their physical assets and process their data with a large selection of third-party applications (Petrik/Herzwurm 2019).

Information systems (IS) research as well as organization and management theory have a long history of exploring and explaining the relationship and interdependencies between organizational change and information technology (IT) (Besson/Rowe 2012). However, the phenomenon of digital transformation offers different avenues for research due to its focus on digital technologies. These are fundamentally different from earlier technologies due to their characteristics such as their self-referential nature, programmability, and the homogenization of data

(Yoo et al. 2010). Therefore, the transformational potential of digital technologies is considerably higher and different and their abilities go beyond mere process automation and satisfaction of information needs. In particular, digital technologies enable fundamental changes in a company's business and working models (Besson/Rowe 2012). Therefore, digital transformation is not simply "old wine in new bottles" and findings from earlier schools of thought, such as IT-enabled organizational transformation may not necessarily apply to organizational change in the context of digital transformation (Vial 2019). Research on digital transformation strategies is still relatively new and focuses, to a large extent, on how strategies are designed and executed as well as the emergence of new organizational roles, such as the Chief Digital Officer (CDO) and how these roles are integrated into the organization.

Despite the growing interest in digital transformation, little is known about the characteristics of and the differences between successful and unsuccessful digital transformation strategies. Extant literature focuses on how strategies are formulated and executed but neglects their degree of success (Berghaus/Back 2017; Matt et al. 2015). Furthermore, digital transformation strategies are explored mostly through conceptual works or case studies (Matt et al. 2015; Hess et al. 2016; Chanias et al. 2019). We argue that the findings from these case studies depend highly on their context and offer very limited generalizability. For example, established organizations such as SAP or Hilti have successfully managed their transition from traditional to digital business models through the use of digital technologies and the execution of a large-scale digital transformation strategy (Schreieck et al. 2021; vom Brocke et al. 2017). However, mere formulation of a strategy does not guarantee a successful transformation. General Electric developed an Internet of Things (IoT) platform along with digitally-enabled services and still witnessed a languishing stock price leading to the departure of its former Chief Executive Officer (CEO). These differences suggest that the success of digital transformation strategy depends on a multitude of factors that cannot be explored in a single case study and only to a limited extent through multiple-case studies. Strategies that work effectively in one organization can lead to failure in other organizations. Due to the properties of digital technologies, there may also be multiple configurations of IT and organizational resources that enable innovation and high performance (Park et al. 2020). Against this background, we argue that identifying success and failure factors of digital transformation strategies dependent on the context of the organization at hand fills both a theoretical gap as well as provides actionable guidelines for practitioners. In the following, we summarize four gaps in the literature that we address with this thesis.

First, various IS scholars propose that configurational research methods are an appropriate tool to analyze research problems that involve interdependencies between digital technologies, organizational or environmental elements, and organizational performance (Park et al. 2020; El Sawy et al. 2010). In particular, the combinatorial nature of digital innovation calls for configurational causal models where different antecedents combine and jointly cause outcomes (Park et al. 2020). While this research setting applies to our core research question, there are only a few insights on how configurational research methods can be used to inform research on success factors for digital transformation strategies. Configurational research methods have, so far, only been used rarely in IS research and only a few guidelines exist so far (Mattke et al. 2021).

Second, extant research has found that the execution of digital transformation strategies is oftentimes hindered by organizational inertia (Schmid 2019; Schmid et al. 2017). However, despite its importance and negative influence, IS research so far lacks an understanding of how organizational inertia can be reduced during digital transformation to increase success rates. First exploratory analyses show that dynamic capabilities may be an appropriate lens to analyze this phenomenon but neglect the context of digital technologies (Rowe et al. 2017). Analyzing how different established organizations configured their resources to reduce inertia will improve our understanding of successful digital transformation.

Third, extant literature rarely investigates the effectiveness of digital transformation strategies and the impact on the desired outcome. With few notable exceptions (Leonhardt et al. 2018), digital transformation strategies are oftentimes regarded as successful if they are implemented as planned by the organizations but without measuring or comparing the actual results (Singh/Hess 2017; Hess et al. 2016). This limitation is also acknowledged by scholars: for example, Berghaus/Back (2017, 14) note that they "cannot make any remarks on one approach being more successful than another". Matt et al. (2015, 342) suggested that future research on digital transformation could compare "digital transformation strategies across different industries […] in order to increase success rates". Therefore, measuring and comparing different outcomes of digital transformation strategies will deepen our understanding of how these strategies can be successfully planned and executed.

Fourth, many digital transformation strategies focus on launching a digital platform (Riasanow et al. 2021; Hermes et al. 2020). However, extant literature sparsely analyzes the factors that lead to successful digital platforms launched by established organizations (Hein et al. 2020) Due to the specific features of digital platforms and their corresponding ecosystems, there may be certain success factors that do not apply to non-platform-centric strategies. Investigating different platform-based strategies and their respective success factors will improve our understanding of different facets and foci of digital transformation strategies.

1.2 Research Questions

To address the gaps outlined above, this thesis develops an empirical understanding of success factors for digital transformation strategies of established organizations by employing a configurational perspective. Thereby, we answer the following four research questions.

RQ1: *How can configurational research methods inform research on success factors for digital transformation strategies?*

Configurational research methods provide many potential advantages for research on strategy and management due to their focus on equifinality (Fiss 2011; Wagemann et al. 2016). Digital technologies and their implications, in particular, are especially suited to the pattern-oriented approach that is found in methods such as Qualitative Comparative Analysis (QCA) (Riasanow et al. 2019; Park/El Sawy 2013). To analyze and illustrate how configurational thinking can be applied to research on success factors for digital transformation strategies, we employ a two-step approach. First, we develop a formalized approach that enables the use of QCA with relatively novel phenomena for which a researcher may be unable to conduct a sufficiently large set of case studies due to limited resources. Second, we conduct a critical review on the use of

QCA in IS research that highlights good and bad practices that should be used or avoided when using QCA in general or in the context of the previously developed approach.

RQ2: *What are configurations for reducing inertia during digital transformation?*

Inertia represents a barrier to successful digital transformation for many established organizations (Besson/Rowe 2012; Rowe et al. 2017). Despite its importance and negative influence, inertia is surprisingly understudied in the context of digital transformation (Schmid 2019; Schmid et al. 2017). To investigate how inertia during digital transformation can be reduced, we focus on two types of inertia: socio-technical and socio-cognitive inertia. These types of inertia are particularly relevant in the context of digital transformation due to their socio-material nature. We conduct two case surveys and use QCA to derive several configurations. The results illustrate the importance and usefulness of dynamic capabilities and highlight different pathways to the reduction of inertia.

RQ3: *What configurations of digital transformation strategies lead to successful and unsuccessful innovation outcomes?*

Extant literature rarely measures the outcome of digital transformation strategies (Berghaus/Back 2017; Matt et al. 2015). It remains unclear how certain choices for the formulation of a digital transformation strategy influence the outcome and what strategy is more effective in what context (Riasanow et al. 2019). We analyze two innovation-oriented potential outcomes of digital transformation strategies: digital service innovation and business model innovation. First, we identify dynamic capabilities as potential antecedents for successful business model innovation in the context of digital transformation. We then conduct case studies and use QCA to derive configurations for success and failure. Second, we identify distinct building blocks of digital transformation strategies through a literature review, conduct case studies on digital service innovation and again use QCA to derive success and failure configurations.

RQ4: *What are successful configurations for platform-based digital transformation strategies?*

Platform-based digital transformation strategies represent unique instances of strategies that have received scarce attention in the literature so far (Hein et al. 2020; Riasanow et al. 2019). To provide a first empirical understanding of this phenomenon, we first conduct a literature review and identify platform openness as a potential success factor for digital platforms. We then conduct a case survey to investigate the impact of platform openness on the success of a digital platform in the context of a digital transformation initiative. Again, we use QCA to derive different pathways that lead to success.

1.3 Structure

This publication-based dissertation consists of three parts (see Figure 1). Part A provides an introduction that motivates the topic of this thesis, summarizes the research gap by providing three research questions, and describes the structure of the thesis (Chapter 1). It provides an overview of the conceptual background related to digital transformation, organizational capabilities, digital platform ecosystems, and configuration theory (Chapter 2), and explains the research strategy and methods employed in this thesis (Chapter 3).

Part B consists of nine peer-reviewed, published publications (Chapters 4-10). The first two publications provide the methodological foundations for the thesis (Chapters 4-5). The two following publications explore how organizations reduce inertia during digital transformation (Chapters 6-7). Three publications analyze the influence of digital transformations strategies on innovation-oriented outcomes (Chapters 8-10). Finally, the last two publications shed light on platform-based digital transformation strategies (Chapters 11-10).

Part C concludes the thesis. We first provide a summary of the results from the embedded publications (Chapter 13). We also discuss the findings considering related literature (Chapter 14) as well as limitations of the thesis (Chapter 15), show implications for both research and practice (Chapter 16), highlight potential avenues for further research (Chapter 17), and finally provide a conclusion of the thesis (Chapter 18).

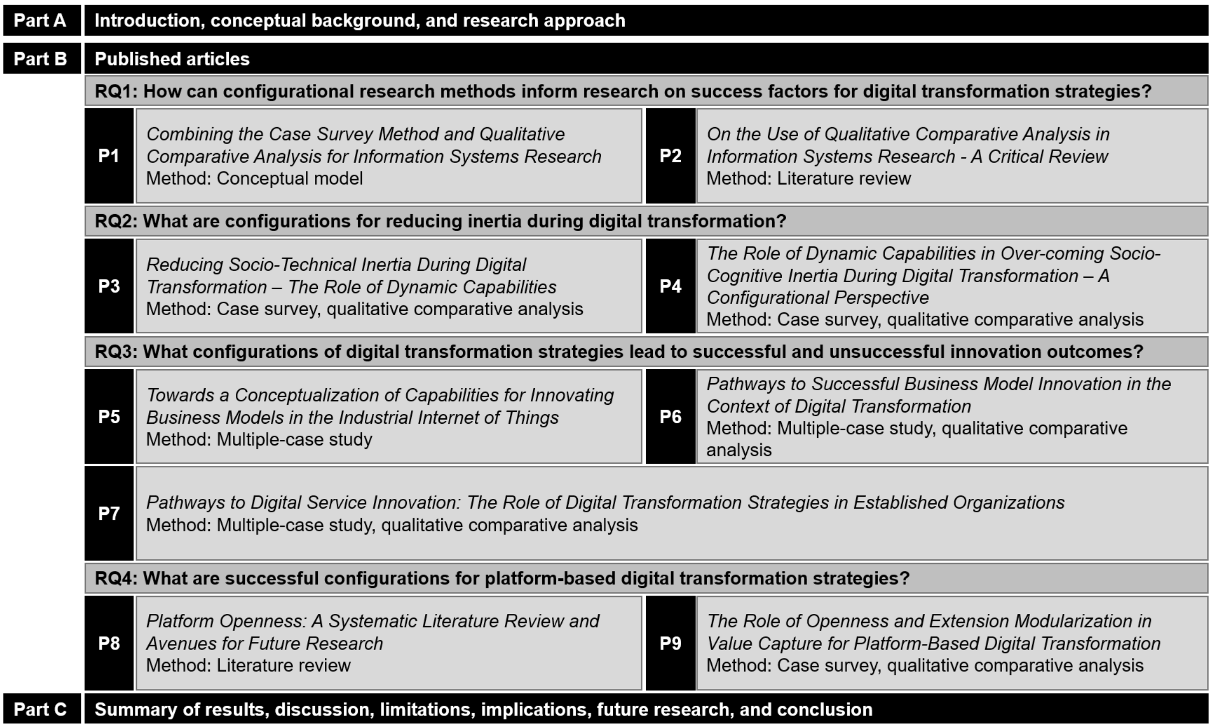

Figure 1: Structure of the Thesis

In Table 1 and the following paragraphs, we provide a summary of the nine publications that are embedded in part B of this dissertation. For each publication (P), we outline the research problem, the methodological approach, and the main contributions.

No.	Authors	Title	Outlet	Type
P1	Soto Setzke, Böhm, Krcmar	Combining the Case Survey Method and Qualitative Comparative Analysis for Information Systems Research	*AMCIS 2020 (published)*	CON (VHB: D)
P2	Soto Setzke, Kavili, Böhm	On the Use of Qualitative Comparative Analysis in Information Systems Research - A Critical Review	*ECIS 2020 (published)*	CON (VHB: B)
P3	Soto Setzke	Reducing Socio-Technical Inertia During Digital Transformation – The Role of Dynamic Capabilities	*ECIS 2020 (published)*	CON (VHB: B)
P4	Ertl, Soto Setzke, Böhm, Krcmar	The Role of Dynamic Capabilities in Overcoming Socio-Cognitive Inertia During Digital Transformation – A Configurational Perspective	*WI 2020 (published)*	CON (VHB: C)
P5	Soto Setzke, Rödel, Böhm, Krcmar	Towards a Conceptualization of Capabilities for Innovating Business Models in the Industrial Internet of Things	*WI 2019 (published)*	CON (VHB: C)
P6	Soto Setzke, Opderbeck, Böhm, Krcmar	Pathways to Successful Business Model Innovation in the Context of Digital Transformation	*PACIS 2020 (published)*	CON (VHB: C)
P7	Soto Setzke, Riasanow, Böhm, Krcmar	Pathways to Digital Service Innovation: The Role of Digital Transformation Strategies in Established Organizations	*ISF (published)*	JNL (VHB: B)
P8	Soto Setzke, Böhm, Krcmar	Platform Openness: A Systematic Literature Review and Avenues for Future Research	*WI 2019 (published)*	CON (VHB: C)
P9	Soto Setzke, Böhm, Krcmar	The Role of Openness and Extension Modularization in Value Capture for Platform-Based Digital Transformation	*BIS 2020 (published)*	CON (VHB: C)

Outlet:
AMCIS: Americas Conference on Information Systems
BIS: Business Information Systems
ECIS: European Conference on Information Systems
ISF: Information Systems Frontiers
PACIS: Pacific Asia Conference on Information Systems
WI: International Conference on Wirtschaftsinformatik

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

Table 1. Overview of Embedded Publications

P1: Combining the Case Survey Method and Qualitative Comparative Analysis for Information Systems Research (Soto Setzke et al. 2020a). The first paper provides the methodological groundwork for this thesis. Both the case survey method and QCA are well-established research approaches in several disciplines but have only recently made their way into IS research. Several authors have started to combine these two methods. However, so far there is no formalized approach that can easily be applied by other researchers. In this paper, we present a framework to integrate the two methods and demonstrate how this approach can be used to resolve several limitations intrinsic to these methods when being employed on their own. We furthermore discuss the potential of applying our approach for IS research, in particular phenomena such as digital transformation.

P2: On the Use of Qualitative Comparative Analysis in Information Systems Research - A Critical Review (Soto Setzke et al. 2020c). The second paper provides further methodological groundwork, in particular regarding QCA. There are several pitfalls and bad practices when applying QCA. Since QCA has only recently made its way into IS research, we intend to be aware of these pitfalls before applying the learnings to our research. Therefore, we review articles from IS journals and conferences using an extensive coding scheme based on methodological literature and QCA reviews from other research disciplines. First, our results show standards of reporting and justification, well established in other disciplines, are often not fulfilled. Second, we find that extant research is predominantly based on large-N analyses, which limits some of the key capabilities of QCA. Third, we show that necessity analysis is under- and sometimes even misused. Lastly, extant research suffers from low solution coverage values that are not adequately discussed and sensitivity analyses that are not employed frequently. While our findings provide the basis for the articles in this thesis that apply QCA, they furthermore represent the current state of QCA in IS research.

P3: Reducing Socio-Technical Inertia During Digital Transformation – The Role of Dynamic Capabilities (Soto Setzke 2020). The third paper sheds light on how dynamic capabilities can be used to reduce socio-technical inertia during digital transformation. We conducted a case survey on a set of digital transformation case studies and applied fuzzy-set QCA (fsQCA) on the results. Our results show that reconfiguring and, to some degree, sensing capabilities have a positive influence on the reduction of socio-technical inertia. Seizing capabilities neither have a positive nor a negative impact. Furthermore, our findings show that socio-technical inertia is also reduced through highly participative, centralized approaches.

P4: The Role of Dynamic Capabilities in Overcoming Socio-Cognitive Inertia During Digital Transformation – A Configurational Perspective (Ertl et al. 2020). The fourth paper sheds light on how dynamic capabilities can be used to reduce socio-cognitive inertia during digital transformation. We combine a case survey and a fsQCA approach to identify patterns of interactions between dynamic capabilities of a firm and its transformation project design that led to the reduction of socio-cognitive inertia. We show that sensing and, in particular, reconfiguring capabilities positively contribute to reducing socio-cognitive inertia when combined with a centralized governance approach. However, seizing capabilities neither have a positive nor a negative influence. Furthermore, we show that socio-cognitive inertia can also be reduced by ensuring high participation among employees, even in combination with decentralized governance approaches.

P5: Towards a Conceptualization of Capabilities for Innovating Business Models in the Industrial Internet of Things (Soto Setzke et al. 2019b). The fifth paper provides the theoretical and conceptual groundwork for the sixth paper. Many of these traditional manufacturers lack or are unaware of the required capabilities for successfully reinventing their business model using IoT technologies. We adopt the lens of dynamic and operational capabilities and conduct an empirical analysis of organizational capabilities required for successful IoT-enabled business model innovation. Through an exploratory, qualitative study based on interviews with decision-makers in industrial manufacturing companies and experts in practice-oriented research institutions, we identify eleven distinct dynamic and operational capabilities. Our findings provide useful insights for research and practice and advance the understanding of enablers in IoT-enabled business model innovation.

P6: Pathways to Successful Business Model Innovation in the Context of Digital Transformation (Soto Setzke et al. 2020d). The sixth paper sheds light on how organizations can successfully innovate their business models in the context of digital transformation. We draw on a resource-based view (RBV) by analyzing firms' dynamic and IT capabilities. We apply a configurational perspective to explore how companies can successfully transform their business models. To do so, we collected data from 15 established companies and employed fsQCA to derive the specific configurations that ultimately lead to success. We extend existing research on business model innovation in the context of digital transformation and provide new insights regarding the combination of IT and dynamic capabilities.

P7: Pathways to Digital Service Innovation: The Role of Digital Transformation Strategies in Established Organizations (Soto Setzke et al. 2021). The seventh paper sheds light on how digital transformation strategies can be used by organizations to perform successful digital service innovation. We employ fsQCA on a set of 17 case studies of digital transformation strategies from established organizations with different industry backgrounds. We identify several distinct configurations of digital transformation strategies that lead to successful and unsuccessful digital service innovation. Based on these configurations, we deduce that the threat of digital disruption negatively impacts an organization's innovation activities. Furthermore, we find that strategic partnerships can be leveraged by organizations that face an imminent threat of digital disruption while organizations with competitive advantages may rely on "do-it-yourself" approaches. Lastly, we find that the involvement of a C-level executive is a necessary requirement for successful digital service innovation.

P8: Platform Openness: A Systematic Literature Review and Avenues for Future Research (Soto Setzke et al. 2019a). The eighth paper provides the methodological groundwork for the ninth paper. This paper aims to synthesize and integrate extant interdisciplinary research on the concept of platform openness. Towards this end, we conducted a literature review and analyzed the results with deductive and inductive coding approaches. We identified five distinct themes: measurement frameworks, implementation mechanisms, drivers for opening and closing platforms, trade-offs in designing openness, and the impact of changing openness on ecosystems.

P9: The Role of Openness and Extension Modularization in Value Capture for Platform-Based Digital Transformation (Soto Setzke et al. 2020b). The ninth and last paper sheds light on how openness and extension modularization influence the degree of value capture in platform-based digital transformation. We combined a case survey strategy with a configurational approach using fsQCA. We found that there is no single condition necessary to achieve a high degree of value capture. Furthermore, our results show the importance of closedness and tight coupling of platforms and their applications. Finally, we confirmed the importance of interface conformance to a high degree of value capture. In addition, our results contribute to both theory and practice and provide implications for future research into the role of digital platforms in digital transformation.

Besides the nine publications that are embedded in this thesis, we published additional articles that are indirectly related to the research questions (see Table 2). These publications provide additional findings and were often led by co-authors or published in books without a double-blinded peer-review process. Related to RQ1, we conducted a transdisciplinary review of the literature on digital transformation (Riasanow et al. 2019) and developed a taxonomy of digital transformation initiatives to highlight several building blocks of digital transformation strategies (Soto Setzke et al. 2020e).

Related to RQ3, we provided an overview of current technological trends in digital transformation strategies (Oswald et al. 2018) and analyzed a digital transformation strategy at a German orchestra (Soto Setzke et al. 2018a).

Related to RQ4, we conducted a literature review and case study on digital platform ecosystems (Hein et al. 2020), derived success factors for digital platform owners (Hein et al. 2019; Soto

Setzke et al. 2018b), and analyzed digital platform ecosystems of different industries (Riasanow et al. 2018b; Riasanow et al. 2018a).

RQ	Authors	Title	Outlet	Type
RQ1	Riasanow, Soto Setzke, Böhm, Krcmar	Clarifying the notion of digital transformation: a transdisciplinary review of literature	*JCSM*	JNL (VHB: C)
RQ1	Soto Setzke, Opderbeck, Riasanow	Toward a Taxonomy of Digital Transformation Initiatives	*ECIS 2020*	CON (VHB: B)
RQ3	Soto Setzke, Hoberg, Murgoci, Franzbonenkamp, Gaß, Wolff, Krcmar	Digitale Transformation bei den Berliner Philharmonikern	*Book 2018*	Chapter (VHB: NR)
RQ3	Oswald, Soto Setzke, Riasanow, Krcmar	Technologietrends in der digitalen Transformation	*Book 2018*	Chapter (VHB: NR)
RQ4	Hein, Schreieck, Riasanow, Soto Setzke, Wiesche, Böhm, Krcmar	Digital Platform Ecosystems	*EM*	JNL (VHB: B)
RQ4	Hein, Soto Setzke, Hermes, Weking	The Influence of Digital Affordances and Generativity on Digital Platform Leadership	*ICIS 2019*	CON (VHB: A)
RQ4	Riasanow, Flötgen, Soto Setzke, Böhm, Krcmar	The Generic Ecosystem and Innovation Patterns of the Digital Transformation in the Financial Industry	*PACIS 2018*	CON (VHB: C)
RQ4	Riasanow, Burckhardt, Soto Setzke, Böhm, Krcmar	The Generic Blockchain Ecosystem and its Strategic Implications	*AMCIS 2018*	CON (VHB: D)
RQ4	Soto Setzke, Scheidl, Riasanow, Böhm, Krcmar	Platforms for the Industrial Internet of Things: Enhancing Business Models through Interoperability	*Book 2018*	Chapter (VHB: NR)

Outlet:
AMCIS: Americas Conference on Information Systems
ECIS: European Conference on Information Systems
EM: Electronic Markets
ICIS: International Conference on Information Systems
JCSM: Journal of Competences, Strategy, and Management
PACIS: Pacific Asia Conference on Information Systems
WI: International Conference on Wirtschaftsinformatik

Type:
CON: Conference
JNL: Journal
NR: Not ranked
VHB: German Academic Association for Business Research

Table 2. Overview of Additional Publications

2 Conceptual Background

In this section, we describe the theoretical foundations of this thesis. We introduce the concept of digital transformation and explain its connection with organizational inertia before we discuss the concepts of organizational capabilities, organizational inertia, and digital platform ecosystems.

2.1 Digital Transformation

Digital transformation has attracted attention from scholars of different disciplines as well as from practitioners of different industries (Vial 2019; Matt et al. 2015). It fundamentally transforms the environment of organizations and forces them to transform themselves to remain competitive (Kane 2017; Yoo et al. 2010). Organizational transformation due to technological innovation is not an entirely new topic (Besson/Rowe 2012). With regards to the usage of digital technologies, however, the phenomenon of digital transformation is rather novel (Vial 2019). In contrast to former technologies, digital technologies have "three unique characteristics: (1) the reprogrammability, (2) the homogenization of data, and (3) the self-referential nature of digital technology" (Yoo et al. 2010, 726). Additionally, digital technologies "accelerate the speed of change, resulting in more volatility, complexity and uncertainty" (Sousa-Zomer et al. 2020, 1096). According to Vial (2019), digital transformation represents an evolution of IT-enabled transformation. Further, digital transformation exceeds what is often called "digitization". Digitization refers to "the mere process of transforming analog into digital" (Riasanow et al. 2019, 23) and "makes physical products programmable, addressable, sensible, communicable, memorable, traceable, and associable" (Yoo et al. 2010, 725). In contrast to digitization, the transformational abilities of digital transformation go beyond the automation of processes and the provision of information. In general, digital transformation is considered a large-scale business transformation that fundamentally affects multiple dimensions within an organization (Berghaus/Back 2017; Bilgeri et al. 2017; Haffke et al. 2016; Hartl/Hess 2017; Matt et al. 2015). Along with the growing scholarly attention, there is "considerable disagreement on the characteristics of an organization's digital transformation" (Riasanow et al. 2019, 5). Both the IS and management literature have seen an emergence of various schools of thought with different views on digital transformation. Furthermore, there are also different definitions of the term itself. For this thesis, we adopt the definition of Vial (2019, 118) who defines digital transformation as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies".

To react to digital transformation, established organizations design and execute digital transformation strategies (Chanias et al. 2019; Hess et al. 2016; Matt et al. 2015). Since digital transformation is a relatively novel topic, research on digital transformation strategies is still in its infancy. Scholars have focused mainly on how strategies are designed and executed, but less on how effective they have proven to be (Hanelt et al. 2021; Vial 2019). Oftentimes, digital transformation strategies are initially designed as the product of different strategizing activities of distinct organizational subcommunities. This is the result of a bottom-up process, usually before an organization's top management designs a holistic strategy, trying to align preexisting, scattered approaches (Chanias/Hess 2016). The process of designing a strategy is highly dynamic with several iterations between learning and doing, with no foreseeable end (Chanias et al. 2019).

When implementing the strategy, organizations choose between a centralized or a decentralized approach (Berghaus/Back 2017; Singh et al. 2019). Both approaches have advantages or disadvantages, depending on the specific conditions of an organization. Decentralized approaches may make an organization more responsive and flexible due to fewer levels of hierarchy and a decrease in information decay (Mihalache et al. 2014). Furthermore, decentralized approaches may provide more local control over IT systems since they can be more easily adapted to the individual, internal needs (Huang et al. 2010). However, in particular, for digital transformation strategies, centralized approaches may also be helpful (Horlacher et al. 2016). A smaller group of people may increase the speed of decision-making and lead to higher innovation performance (Teece 1996). Furthermore, centralized approaches allow for stricter control over IT systems and reduce uncertainty through earlier planning (Brown/Grant 2005; Reynolds et al. 2010). Especially in highly turbulent environments, centralized decision-making may also lead to higher digital innovation performance (Leonhardt et al. 2018). Centralized approaches often involve a novel executive position: the CDO who is in charge of a digital transformation strategy (Haffke et al. 2016). The specific tasks and role of the CDO depend on the strategic focus of an organization (Singh et al. 2019). They are usually part of the management board but in organizations where business departments exercise control over innovation management, CDOs may not be needed or even harm innovation performance (Leonhardt et al. 2018).

Apart from new management positions, digital transformation strategies may also induce changes in organizational structures. While heavily debated, there is evidence that separating parts of an organization both physically and from an organizational point of view may be desirable for successfully conducting innovation-related activities (de Visser et al. 2010). In practice, this is often realized through new organizational units: so-called digital innovation labs that bundle innovation activities and capabilities (Hund et al. 2019). In more extreme cases, organizations also create spin-offs that are autonomous entities, completely separated from the organization’s main corporate structure. This extreme degree of structural separation may increase the speed of decision-making as well as facilitate faster responses to market changes.

2.2 Organizational Capabilities

In dynamic or unpredictable environments, organizational capabilities allow an organization to create new products and processes and to react to changing market conditions (Helfat 1997). Therefore, they are essential to a successful digital transformation. In this section, we revise the concepts of IT and dynamic capabilities, which are distinct conceptualizations of organizational capabilities.

2.2.1 IT Capabilities

IT capabilities are a firm’s “ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities” (Bharadwaj 2000, 171). IT capabilities that are valuable, rare, imperfectly imitable, and non-substitutable are key organizational capabilities and enablers for superior firm performance (Wade/Hulland 2004; Bharadwaj 2000). They enable companies to make use of digital technologies to respond to changing and turbulent environments (Nwankpa/Roumani 2016; Park/El Sawy 2013). Lu/Ramamurthy (2011) identified three dimensions of IT capabilities: IT infrastructure capability, IT business spanning capability, and IT proactive stance. IT infrastructure capability refers to the ability to design data, network, and processing architecture (Lu/Ramamurthy 2011; Bharadwaj et al. 1999). IT business spanning capability refers to the ability to exploit IT resources to successfully support business objectives. IT proactive stance refers to a firm's ability to generate novel ideas regarding the use of IT resources and thereby identify new business opportunities.

Extant research shows that IT capabilities enable an organization to outperform competitors and therefore positively impact organizational performance (Bharadwaj 2000; Mithas et al. 2011; Melville et al. 2004). On the other hand, other evidence shows that IT capabilities influence firm performance rather indirectly by impacting other resources (Chen et al. 2013; Wade/Hulland 2004). Park/El Sawy (2013) even found that IT capabilities negatively impact the performance of firms that are faced with a stable environment with predictable changes. A possible explanation for these ambiguous results is the high mobility and the lack of heterogeneity of IT resources (Bhatt/Grover 2005). Those IT capabilities that can easily be scaled and standardized are less likely to provide a competitive advantage to individual companies. Still, IT capabilities such as IT infrastructure are necessary for a firm, since their absence may, in turn, lead to negative performance or competitive disadvantage. Therefore, investments in IT capabilities are important to avoid falling behind competitors, but they may not be sufficient for competitive advantage (Bhatt/Grover 2005).

2.2.2 Dynamic Capabilities

Dynamic capabilities describe capabilities that help companies in creating a sustainable, competitive advantage when faced with quickly changing environments (Teece 2007). They are defined as an "organization's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al. 1997, 516) and enable organizations to modify existing capabilities, organizational structures, and their culture (Leih et al. 2015). Therefore, they represent the velocity and the degree to which a firm can realign its resources to react to a changing environment as well as shape it by identifying and exploiting new opportunities (Katkalo et al. 2010). Dynamic capabilities differ from other capabilities regarding the time horizon of competitive advantages. While ordinary capabilities provide a competitive advantage for a limited, short period, dynamic capabilities enable creating a sustainable, long-term competitive advantage (Teece 2007). Furthermore, their transformative potential enables and facilitates the digital transformation of established organizations (Vial 2019).

Teece (2007) introduced three micro-foundations of dynamic capabilities: sensing, seizing, and reconfiguring. Sensing, which is similar to explorational capabilities, encompasses the ability to identify new opportunities. Seizing capabilities are related to organizational value creation, service innovation, and product development. They enable generating value by implementing new business models, building new competencies, and recombining resources. Reconfiguring capabilities enable organizations to innovate business models or react to threats by enhancing, combining, protecting, and reconfiguring resources.

2.3 Organizational Inertia

Organizational inertia has been of high interest for scholars in managerial and organizational sciences (Hannan/Freeman 1984; Tushman/O'Reilly 1996). Inertia is a characterization of the “degree of stickiness” of an organization under transformation and describes the first level of analysis of organizational transformation (Besson/Rowe 2012, 105). It therefore also defines the effort that is required to enable organizational transformation driven by technology such as IS (Besson/Rowe 2012). Historically, inertia was considered favorable for the survival of an organization (Schmid 2019). For example, Hannan/Freeman (1984, 162) defined organizational inertia as an “organizations’ ability to sustain reliable and accountable performance in turbulent environments”. However, organizational routines and strategies that persist over time become more complex and, eventually, almost irreversible. Creating and working with reliable structures in organization may be desirable and beneficial in relatively stable environments with no or little pressure from outside the firm (Mikalef et al. 2019). Today, however, organizations are faced with a frequently changing and disruptive environment. Organizations with a high degree of inertia are at risk of considerably losing competitive advantage. While this may be caused by an organization’s inability to adapt due to, for example, missing resources, further influencing factors may be of economic, cultural, or political nature (Collinson/Wilson 2006; Datta 2020; Cooper 1994).

Over the last years, inertia has become a topic of interest for scholars in the context of digital transformation and IT-enabled organizational transformation (Mehrizi/Modol 2012; Besson/Rowe 2012). Besson/Rowe (2012) have identified five distinct dimensions of organizational inertia: socio-technical, socio-cognitive, negative psychology, economic, and political. In this thesis, we focus on socio-technical and socio-cognitive inertia, since we expect these to have high relevance in the context of digital transformation. Socio-technical inertia is defined as the dependence on socio-technical capabilities arising from the interaction of social and technical systems (Rowe et al. 2017; Mikalef et al. 2018). Since digital transformation represents an interplay between social and technical entities of an organization, there is considerable change in the socio-technical deep structure enabled by emerging IT (Sarker et al. 2013; Schmid 2019). This type of inertia is caused by employees who are unwilling or unable to work with new processes or technology (Besson/Rowe 2012). Socio-cognitive inertia, on the other hand, is based on routines that are embedded in an organization. The degree of inertia is usually stronger if the routines have been in place for a long time (Le Mens et al. 2015). Employees feel more comfortable when facing familiar situations and learn from past experiences. Therefore, instead of thinking of new ideas, they rather focus on solutions that were useful in the past (Le Mens et al. 2015).

So far, few scholars have investigated the relationship between dynamic capabilities and organization inertia (Besson/Rowe 2012). Regarding the order of the relationship, two different schools of thought have emerged. The first school argues that dynamic capabilities are useful to reduce inertia during an organization’s digital transformation (King/Tucci 2002; Rowe et al. 2017; Schreyögg/Kliesch-Eberl 2007; Suddaby et al. 2020; Tushman/O'Reilly 1996). For example, Tushman/O'Reilly (1996) argue that dynamic capabilities enable organizations to build, integrate, and reconfigure organizational assets and thereby help to escape inertial dynamics.

Following Suddaby et al. (2020), organizations can escape the burden of history, overcome cognitive limitations, and engage in adaptive change by developing dynamic capabilities.

The second school of thought postulates that inertia hinders the positive effects of dynamic capabilities on firm performance (Mikalef et al. 2019; Nedzinskas et al. 2013; Wang/Wang 2017). For example, Nedzinskas et al. (2013, 377) argue that inertia "inhibits the effectiveness of DC in a volatile environment". Similarly, Mikalef et al. (2019) find that inertial forces could inhibit the formation of dynamic capabilities and therefore negatively impact firm performance. However, this second school of thought is not as dominant in literature as the first school. Following Rowe et al. (2017, 407) and their central argument that dynamic capabilities "can regulate and reconfigure lower-level capabilities […] and hence reduce organizational inertia", we adopt the first school of thought for this thesis.

2.4 Digital Platform Ecosystems

The notion of ecosystems has its root in the field of biology (Li 2009). Over time, the notion has been adopted by the fields of computer science, management, and IS and is now used to denote different concepts such as software ecosystems (Mens et al. 2014), business ecosystems (Moore 1993), or digital platform ecosystems (Hein et al. 2020). While these ecosystems concepts differ in their focus, they generally adopted the term of ecosystems as a "set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled" (Jacobides et al. 2018, 2264). Therefore, digital platform ecosystems represent a certain type of business ecosystem in which the main business was constructed around a digital platform. Digital platforms, such as Uber or the SAP cloud platform, combine and deploy technologies "in new ways to incubate and coordinate an ecosystem of supply and demand" (Hein et al. 2020, 88). The supply side is represented by complementors that create complementary products or services on a platform, while customers that consume these digital goods represent the demand side. Complementors use boundary resources such as Application Programming Interfaces (APIs) that are provided by the platform owner to create these goods. In summary, a digital platform ecosystem "comprises a platform owner that implements governance mechanisms to facilitate value-creating mechanisms on a digital platform between the platform owner and an ecosystem of autonomous complementors and consumers" (Hein et al. 2020, 90).

Hein et al. (2020) identified three distinct building blocks of digital platform ecosystems: platform ownership, value-creating mechanisms, and autonomy of complementors. Platform ownership is related to whether power is distributed centralized or decentralized, which also affects the relationships in an ecosystem. Centralized digital platform ecosystems such as Facebook or Apple iOS are characterized by a single entity, such as a company or consortia that maintains governance mechanisms while decentralized ecosystems such as blockchain can be governed by a community (Riasanow et al. 2018a; Hein et al. 2020). Value-creating mechanisms ensure the facilitation of transactions as well as the provision of affordances to stimulate innovation in the ecosystem (Yoo et al. 2012). On the one hand, digital platforms act as intermediaries for transactions between different parties to match supply and demand and thereby create two-sided markets, leveraging cross-side network effects (Evans 2012; Hein et al. 2020; Armstrong 2006; Rochet/Tirole 2003). On the other hand, platform owners provide affordances through boundary resources which can be used by third parties to create complementary applications for a platform (Ghazawneh/Henfridsson 2013; Nambisan et al. 2019; Tiwana 2014; Hein et al. 2020). Autonomy of complementors refers how to how much freedom is given to complementors in terms of creating complimentary applications (Ye/Kankanhalli 2018; Hein et al. 2020). High-autonomy complementors are characterized by a loosely coupled relationship with the digital platform where the complementor is independent and separate from the platform (Boudreau 2012; Orton/Weick 1990). Complementors with low autonomy, on the other hand, are tightly coupled with the platform as well as dependent and aligned with the platform owner (Orton/Weick 1990). This implies a relationship determined by trust, a common goal, and contracts defining whether a party can provide services to competitors (Steensma/Corley 2000; Hein et al. 2020).

3 Research Approach

To investigate success factors for digital transformation strategies at established organizations, we adopt a critical realist stance and a configurational strategy of inquiry. We conduct case studies and case surveys to collect data that is subsequently analyzed with QCA.

3.1 Critical Realist, Configurational Research Strategy

Critical realism is increasingly receiving attention as a philosophical tradition in IS research (Mingers et al. 2013). Advanced by Bhaskar (2008), this stance assumes the existence of a reality independent of our knowledge and perception that can be approached through the scientific method (Losch 2009; Sayer 2010; Gerrits/Verweij 2015). Therefore, it reconciles realist ontology with an interpretive epistemology and can be seen as a way of navigating between other philosophical views such as empiricism and the interpretive sciences (Wuisman 2005; Gerrits/Verweij 2015; Henfridsson/Bygstad 2013). It is suited particularly for relatively novel phenomena that provide opportunities to apply existing theory in new ways (Williams/Wynn 2018). Critical realism postulates that reality is stratified into three distinct domains: the empirical, the actual, and the real (Bhaskar 2008). Personal experiences are the domain of the empirical, while events, processes, and behavior constitute the "actual" and the underlying mechanisms represent the "real" (Gerrits/Verweij 2015). Critical realism, therefore, advocates that the "actual" are effects of the "real" that can be observed in the "empirical" (Easton 2010). It uses the language of causality and posits that it can explain how certain events lead to other events, how processes come into play, and how the mechanisms that control human behavior work (Gerrits/Verweij 2015). Unlike positivism, critical realism regards reality as an open system where the observed events, processes, or behaviors are caused by a combination of certain variables (Gerrits/Verweij 2015). Furthermore, it does not aim at identifying all the potential causal conditions for a certain outcome but focuses on unraveling selected core mechanisms that provide an efficient explanation of the observed events (Wynn/Williams 2012; Bemgal/Haggerty 2019).

The premise of critical realism implies causal complexity and equifinality regarding the relationship between causal conditions and outcomes (Henfridsson/Bygstad 2013). Equifinality, also called "multiple determination" by Bhaskar (2008), states that a specific state of a system can be reached by the means of different paths and initial conditions (Gresov/Drazin 1997). A configurational perspective is particularly suited to investigate problems of complex causality and equifinality since it enables the researcher to analyze the effect of possible configurations of causal conditions and relevant context variables on particular outcomes (Henfridsson/Bygstad 2013). Furthermore, configuration theory assumes that "organizational phenomena can best be understood by identifying distinct, internally consistent sets of firms and their relationships to the environment and performance outcomes" (Ketchen et al. 1997). While traditional theories based on variance advocate that conditions are both necessary and sufficient for an outcome, configuration-based theories postulate that the relationship between conditions and outcome may be asymmetric (El Sawy et al. 2010; Liu et al. 2015). Phenomena are seen as "clusters of interconnected elements that must be simultaneously understood as a holistic integrated pattern" and the resulting interplay can be illustrated through different combinations of configurations of conditions and outcomes (El Sawy et al. 2010, 838). A configurational perspective is particularly suited for building middle-range theories based on a more exploratory research design (El Sawy et al. 2010). Furthermore, configurational perspectives are regarded as a powerful approach to combine the assumptions of critical realism and the nature of social complexity (Gerrits/Verweij 2015). We assume that a configurational perspective is well-suited for exploring the concept of digital transformation due to the inherent causal and systemic complexity and its relatively recent emergence in both theory and practice. For this thesis, we chose QCA as a specific methodology to combine the assumptions of critical realism and complexity theory to get a holistic and systemic understanding of digital transformation.

3.2 Research Methods

Following a critical realist stance with a configurational strategy of inquiry, we use QCA as the main method of this thesis (P3-4, P6-7, P9). To collect the data needed for QCA, we conduct case studies (P5-7) and case surveys (P3-4, P9). Additionally, this thesis builds on a conceptual paper (P1) and two literature reviews (P2, P8) for the methodological and conceptual basis. Table 3 provides an overview of what research methods we used in the embedded publications.

Publication	Literature Review	Conceptual	Case Study	Case Survey	QCA
Combining the Case Survey Method and Qualitative Comparative Analysis for Information Systems Research (P1)		X			
On the Use of Qualitative Comparative Analysis in Information Systems Research - A Critical Review (P2)	X				
Reducing Socio-Technical Inertia During Digital Transformation – The Role of Dynamic Capabilities (P3)				X	X
The Role of Dynamic Capabilities in Overcoming Socio-Cognitive Inertia During Digital Transformation – A Configurational Perspective (P4)				X	X
Towards a Conceptualization of Capabilities for Innovating Business Models in the Industrial Internet of Things (P5)			X		
Pathways to Successful Business Model Innovation in the Context of Digital Transformation (P6)			X		X
Pathways to Digital Service Innovation: The Role of Digital Transformation Strategies in Established Organizations (P7)			X		X
Platform Openness: A Systematic Literature Review and Avenues for Future Research (P8)	X				
The Role of Openness and Extension Modularization in Value Capture for Platform-Based Digital Transformation (P9)				X	X

Table 3. Overview of Research Methods Applied in the Embedded Publications

3.2.1 Systematic Literature Review

Systematic literature reviews (SLRs) are an essential method for synthesizing and contributing to extant knowledge (Webster/Watson 2002). By conducting SLRs, researchers get an overview of the current state of the art of a specific field which they can use as a conceptual and theoretical foundation for their own research (Paré et al. 2015). Furthermore, SLRs help to identify research gaps (Paré et al. 2015).

There are different types of SLRs, depending on the scope and goal of the respective review: narrative reviews, descriptive, scoping/mapping reviews, meta-analyses, qualitative systematic reviews, umbrella reviews, theoretical reviews, realist reviews, and critical reviews (Paré et al. 2015). In the last decades, several guidelines and collections of best practices for conducting SLR have emerged. In particular, there are different guidelines for different disciplines. For this thesis, we followed recommendations from leading IS authors such as Webster/Watson (2002) and vom Brocke et al. (2009).

An SLR starts with defining the scope of the review. After that, the researcher needs to define a list of relevant outlets such as journals, conference proceedings, or books (Webster/Watson 2002). The list of outlets depends on the scope and goal of the review. For example, if the topic under investigation is relatively novel, the researcher should include recent conference proceedings since they may include knowledge that has not yet been published in journals. If the researcher wants to synthesize thoroughly reviewed literature, they may opt to include only journals in their list of outlets. The researcher may either use a database such as EBSCOhost or Web of Science (WoS) that covers the chosen outlets or search in each outlet individually (vom Brocke et al. 2009). For the search, the researcher defines a search term or a set of keywords that are used to gather an initial set of relevant publications (Webster/Watson 2002). The search term may then be further refined iteratively. Since the initial set may not contain all relevant papers due to missing keywords or outlets, researchers should conduct forward and backward searches (Webster/Watson 2002). For forward searches, the researcher finds all papers that cite a given paper from the result set through databases such as Wos. For backward searches, the researcher goes through articles that are cited by a given paper in the result set. To evaluate if a given paper is relevant to the SLR, including papers that were found through forward and backward search, the researcher first reads the title and abstract. If a paper cannot be included or discarded in the final result set based on these criteria, the researcher reads the full text to decide vom Brocke et al. (2009).

In the next step, the researcher codes the selected articles. For this, different techniques can be used, such as the grounded theory approach which is based on open, axial, and selective coding (Corbin/Strauss 1990; Bandara et al. 2015). Regarding the presentation of the results, Webster/Watson (2002) propose a concept-centric approach as opposed to an author-centric approach. While an author-centric approach structures the results based on the authors of the articles, a concept-centric approach is based on identifying common concepts that are repeatedly found in different articles. The results are then presented within a concept matrix that shows the concepts on the x axis and articles on the y axis. Thereby, the concept matrix helps highlighting the current state of scientific literature and to identify potential research gaps.

In the embedded publication “On the Use of Qualitative Comparative Analysis in Information Systems Research - A Critical Review” (Soto Setzke et al. 2020c), we conducted a critical review of the use of QCA in contemporary IS literature. As a result, we found that several important concepts of QCA are under- or even misused by scholars. This insight helped us to conduct thorough QCA studies throughout the remainder of this thesis. In particular, we conducted small-N analyses, which are not commonly used in IS research so far. Furthermore, in the embedded publication “Platform Openness: A Systematic Literature Review and Avenues for Future Research” (Soto Setzke et al. 2019a) we conducted a descriptive literature review. As a result, we identified platform openness and its characteristics as a potential success factor for platform-based digital transformation strategies. Besides, we conducted further theoretical reviews as a secondary research method in almost all of the remaining publications that are embedded in this thesis to ensure a thorough conceptual background.

3.2.2 Case Study

Case study research constitutes a methodological approach to investigate a contemporary phenomenon in depth and its real-world context (Yin 2017). It is particularly helpful if the boundaries between the phenomenon itself and its context are not evident and the phenomenon cannot be controlled (Yin 2017; Benbasat et al. 1987). Case study research is often used to investigate research questions that address “how” or “why” a certain phenomenon occurs in the real world (Yin 2017). To apply the case study research methodology in a structured manner, Yin (2017) developed an iterative six-step approach (see Figure 2).

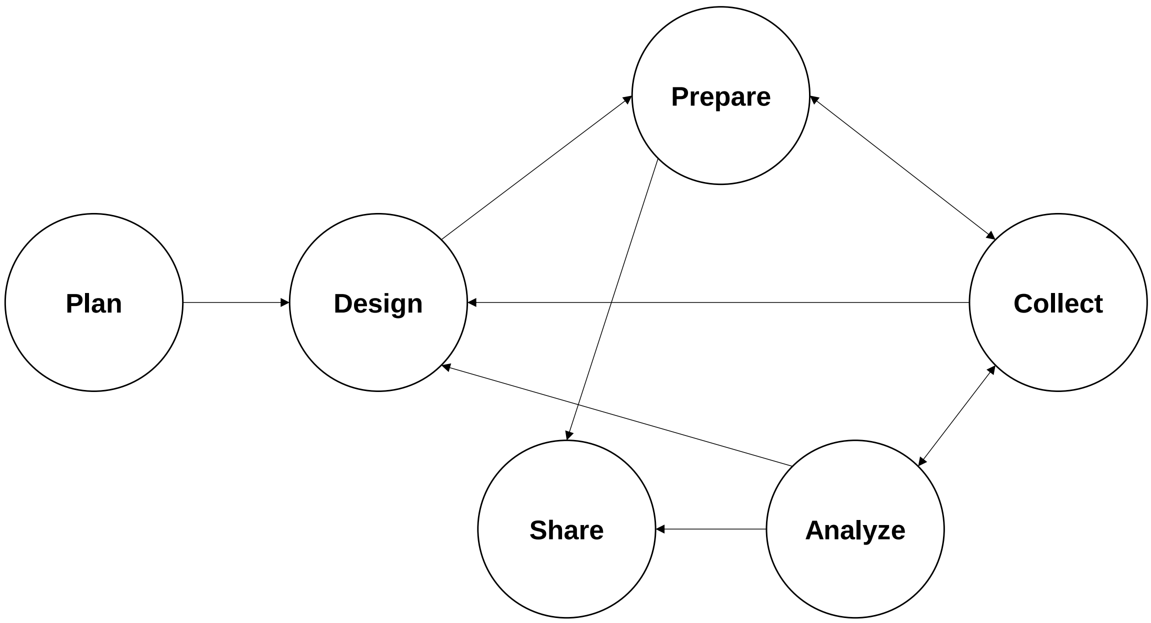

Figure 2. Case Study Approach (Based on Yin (2017))

In the planning phase, the researcher develops the research question and determines whether the case study approach is suitable for answering the chosen question. At this stage, the researcher should have a good overview of the theoretical and conceptual background of the phenomenon under investigation.

In the design phase, the researcher designs a research plan with the research questions as the starting and the conclusions as the ending point. The plan includes decisions regarding the number of cases and the unit of analysis. The researcher may choose between a holistic design, i.e. a single unit of analysis, or an embedded design, i.e. multiple units of analysis. Regarding the number of case studies, the researcher chooses between a single case or multiple cases. Figure 3 provides an overview of the four different case study designs that result from these decisions.

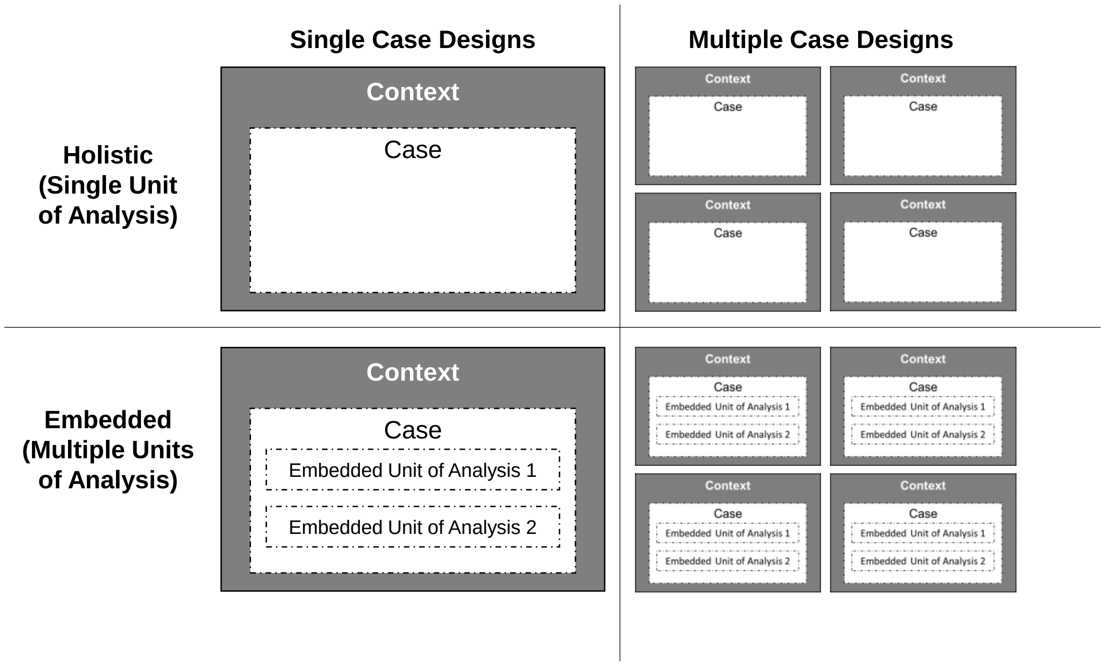

Figure 3. Case Study Design Options (Yin 2017)

In the preparation phase, the researcher defines the data sources for the case study. Depending on the data sources, the researcher develops a case study protocol and data collection guidelines, such as questionnaires for interviews (Yin 2017).

In the collection phase, the researchers conduct the case study with the help of the case study protocol (Yin 2017). To triangulate and to ensure construct validity, researchers should use a variety of data sources such as interviews, observations, archival data, or physical artifacts (Yin 2017). However, interviews are most commonly used to collect data (Eisenhardt/Graebner 2007). Interviews should be recorded and transcribed for easier access during the analysis phase.

In the analysis phase, the researcher investigates the collected data using different techniques such as categorization or coding (Yin 2017). Most commonly, researchers employ qualitative data analysis techniques such as qualitative content analysis (Mayring 1991), although quantitative approaches can be used as well. Yin (2017) proposes different analysis techniques to ensure high validity of the analysis phase, such as comparing the case study results with assumptions that were made before conducting the case study (pattern matching) or analyzing differences and similarities across different cases (cross-case synthesis).

In the sharing phase, the researcher identifies the target audience for the case study and prepares the form of presentation, e.g., a research paper. After publishing the results, the researcher receives feedback from case study participants and the audience.

In the embedded publication P5, we employ a holistic multiple-case design of different organizations engaging in IoT-based business model innovation. In the embedded publications P6-7 we use holistic multiple case designs of different digital transformation strategies in different organizations. The collected interview data is then analyzed using QCA.

3.2.3 Case Survey

The case survey method was first introduced by Lucas (1974, v) as a meta-analysis approach and an “inexpensive way to aggregate existing research”. So far, it has received rather limited attention in IS research (Jurisch et al. 2013). It assumes that case studies that have previously been published provide many potential interesting insights. It is difficult, however, to provide generalized insights based on only a small number of case studies. The case survey method provides a formalized approach to compare a larger number (> 50) of case studies to answer a certain research question. Thereby, “individually limited scientific contributions can be enhanced through systematic analysis of patterns across cases” (Larsson 1993, 1516).

Figure 4 shows the different stages and steps of the case survey method that were adapted for IS research by Jurisch et al. (2013). First, the researcher needs to formulate a research question grounded in theory. The question may be based on concrete hypotheses or more explorative. Most importantly, it should clearly explain the research gap. The next step comprises the selection of case studies that may be relevant to answer the given research question. To do so, the researcher first needs to define criteria that define whether a case should be included in the case study sample (so-called inclusion criteria) (Larsson 1993). Cases can be sourced from both scholarly and practice-oriented outlets from the field of IS or other fields, depending on the research question. For example, Henfridsson/Bygstad (2013) used articles from the field of medicine and development studies for their IS-oriented case survey. In any case, the identified case studies should provide sufficiently detailed narratives. One paper may provide multiple cases and different articles on the same case should be analyzed as one case (Rivard/Lapointe 2012; Bullock 1986). Having defined inclusion criteria, the researcher proceeds to search the literature for relevant case studies, aiming for a set that is as large as possible (Larsson 1993). Sometimes, the set of case studies may be too large to be analyzed with reasonable effort. In that case, the researcher may choose to use a random subset of cases for coding (Newig/Fritsch 2009). Since the case survey method allows the use of case studies with different epistemological foundations, it may also act as a bridge between these foundations (Larsson 1993). After having finalized the set of case studies, the researcher needs to use a coding scheme to quantify the qualitative data found in the cases (Bullock 1986). The coding scheme may either be based on concepts that are well-established in the extant literature or it could be completely open, based on the grounded theory approach (Corbin/Strauss 1990). In both cases, the researcher should stay open to surprises and create new codes when necessary (Newig/Fritsch 2009). It is advisable to create a scheme that is as comprehensive as possible since data can be excluded later, but including more data may only be possible with significant effort, i.e. recoding all cases.

Afterward, the researcher starts coding the cases based on the previously defined coding scheme. At least two trained coders should read and code each case study independently (Bullock 1986). This improves the robustness of the coding which can be measured, for example, with Krippendorff’s alpha (Krippendorff 2018). If the measured reliability does not meet a previously defined threshold, coders are encouraged to discuss discrepancies and resolve disagreements through oral discussion (Larsson 1993). Finally, the coded data can be used for analysis through techniques such as regression, structural equation modeling, or multivariate statistics (Larsson 1993; Bullock/Svyantek 1985; Larsson/Finkelstein 1999). Before conducting the analysis, however, coding and construct validity need to be assessed (Larsson 1993).

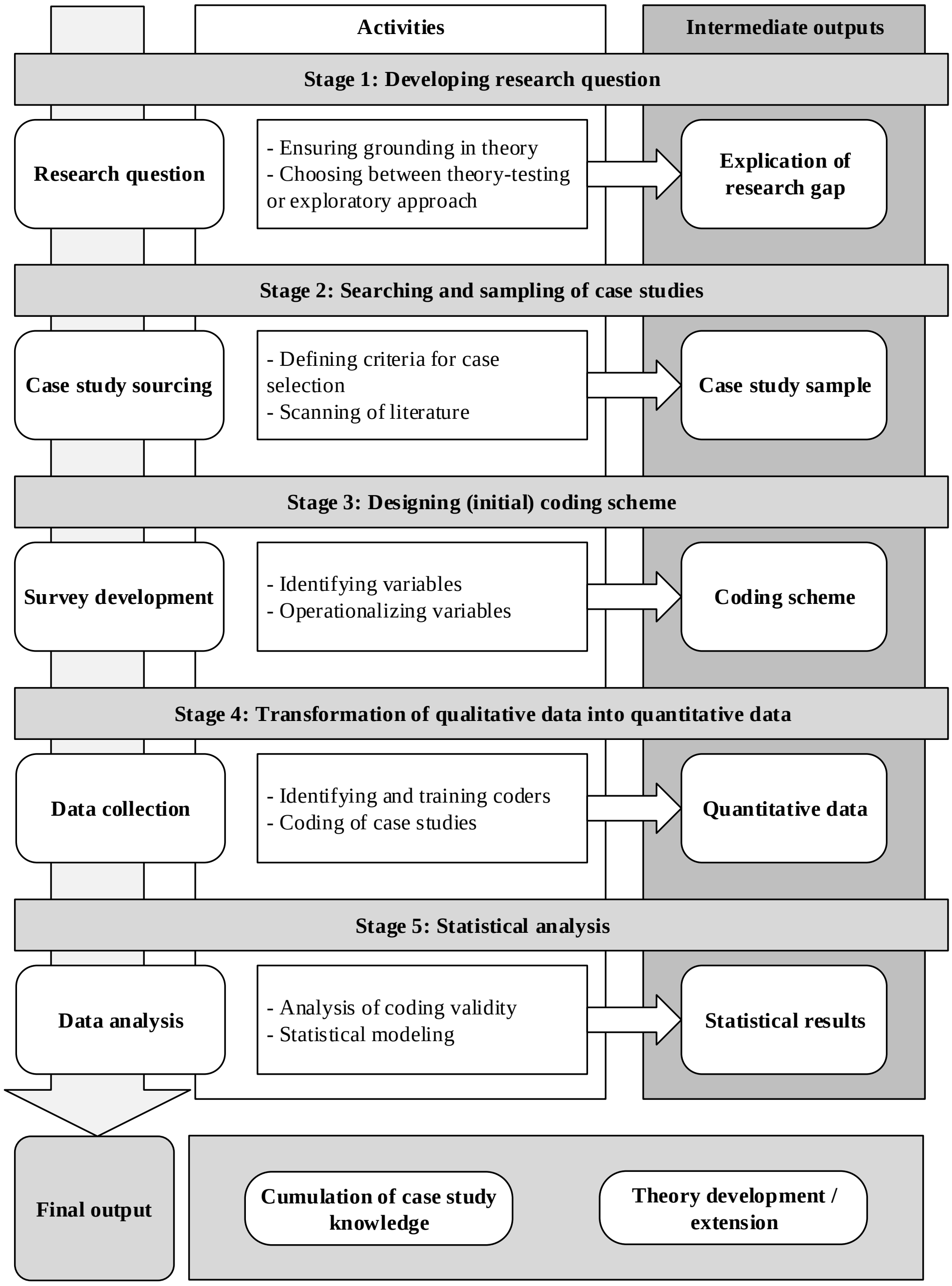

Figure 4. Case Survey Process (Based on Jurisch et al. (2013)

3.2.4 Qualitative Comparative Analysis

QCA enables researchers to infer configurational patterns based on conditions that lead to specific outcomes (Ragin 2009, 2008). Unlike traditional correlation-based methods such as regression analysis, which are built on symmetric linear relationships, QCA requires that the interaction of different conditions influences the value of the outcome. This allows the extraction of configurational patterns, where different configurations can lead to the same outcome. This concept is also known as equifinality. QCA thus supports the explanation of causalities and dynamics of complex systems by analyzing and comparing different cases with different outcomes. The method is particularly suitable for samples of small or medium size. In particular, QCA allows combining a detailed case study with a structured comparison of different cases. Furthermore, QCA considers the relationship between sufficient and necessary conditions to the outcome. Necessary conditions are conditions that must be present for the outcome to be present (Ragin 2008). In terms of set theory, instances of conditions are a superset of instances of the outcome. In turn, a sufficient condition or a sufficient combination of conditions can provide for the presence of the outcome (Ragin 2008). However, instances of the outcome can also be observed in which this condition or combination is absent. From a set theory perspective, this is a subset of the instances of the outcome (Leischnig et al. 2016).

QCA was first used in political science and has since attracted the attention of the social sciences as well. The methodology is preferably used when researchers assume complex causal mechanisms and the case set is too small for standard procedures of statistical analysis. In most cases, researchers have gathered prior knowledge about the population and use this knowledge to define, specify, and measure the core concepts for the study (Fiss 2011). Underlying QCA analysis is a case-based perspective that examines differences and similarities between different cases. The approach is based on set theory in that the analysis focuses on whether a variable is a superset or subset of another variable. In QCA, sets are dichotomous and each case is either "inside" or "outside" of the set, depending on the absence or presence of the set membership criterion in that case (Fedorowicz et al. 2018).

For example, the set of employed workers can be represented by a variable with two values: 1 (employed and "within" the set) or 0 (not employed and "outside" quantity). The concept of fuzzy sets allows for set membership between 0 (full non-membership) and 1 (full membership). In this example, a part-time employee would belong to the set "employed" with a value between 0 and 1. Fuzzy set affiliation means that an employee can be assigned a value that is neither fully employed (1) nor fully non-employed (0), and 0.5 would imply uncertainty about affiliation (Fedorowicz et al. 2018). It may be tempting to view affiliation as a continuous variable, but this is not advisable (Schneider/Wagemann 2010). Fuzzy set affiliation is the calibration of a degree of affiliation within a category. Calibration assigns a fuzzy set membership level to single or multiple variables. This represents both a qualitative and quantitative assessment of case characteristics (Ragin 2008). Determining set membership requires conceptual trade-offs based on the researcher's experience. Thus, QCA relies on substantial conceptual knowledge to enable meaningful calibration (Ragin 2000). There are also other variants of QCA that, instead of fuzzy values, use binary values (crisp-set QCA (Rihoux/de Meur 2009)) or even arbitrary values (multi-value QCA (Cronqvist/Berg-Schlosser 2009)). However, in this thesis, we focus on fsQCA since it allows for very fine-grained analyses (Greckhamer et al. 2018).

After calibration, a truth table is created, usually by software support. This contains 2^k rows, where k represents the set of conditions and the rows represent every possible combination of the conditions. The truth table is then refined using the measures of frequency and consistency (Ragin 2008). Frequency represents how many times a certain combination can be observed.

Consistency represents the degree to which the cases in a combination consistently produce the same outcome (Fiss 2011). According to Schneider/Wagemann (2010), consistency should be at least 0.75. The frequency should be at least 1, so combinations to be considered should be covered by at least one case (Liu et al. 2015). After determining these measures, the truth table is reduced so that only those rows remain that satisfy the respective measures of frequency and consistency.

The reduced truth table is now further simplified using Boolean algebra. QCA provides three different solution sets for this purpose: the complex, the parsimonious, and the intermediate solution set. Each solution set contains at least one solution term specifying combinations of conditions that lead to the observed outcome. To form the complex solution set, sufficient conditions are considered from the truth table and simplified with the application of set-theoretic operations such as the average, union, and difference. This application is mechanically supported by the Quine-McCluskey (QM) algorithm, which is incorporated in popular QCA software packages (Liu et al. 2015; Mendelson 1970, 86-88). However, the complex solution set may contain a large number of solution terms, which makes it difficult to interpret. Therefore, it is usually further simplified to the parsimonious and intermediate solution sets (Liu et al. 2015). The parsimonious solution set represents the solution terms with the minimum number of constraints. To form it, the QM algorithm uses those combinations that were eliminated by the frequency test. Since the process to form this set makes assumptions without considering necessary conditions or frequency, the parsimonious solution set is usually not discussed as the final solution set, but it is used to form the intermediate set by QCA software packages (Liu et al. 2015). After forming the three solution sets, conditions can be classified as core and peripheral conditions (Liu et al. 2015; Fiss 2011). Core conditions can be observed in both the parsimonious and the intermediate solution and are thus of greater importance. Peripheral conditions, on the other hand, are conditions that are only present in the intermediate solution and have been eliminated in the parsimonious solution.

In the final step of the analysis, the solutions are evaluated concerning various coverage measures. The term "coverage" refers to the proportion of the outcome that can be explained by a solution (Schneider/Wagemann 2010). Three coverage measures are distinguished:

- Solution coverage: proportion of the outcome that is explained by the entire solution set.
- Raw coverage: proportion of the outcome that is "explained by a particular alternative pathway" (Schneider/Wagemann 2010)
- Unique coverage: proportion of the outcome that is "explained exclusively by a particular alternative pathway" (Schneider/Wagemann 2010)

Table 4 shows the main concepts of a QCA analysis and their definitions. According to Liu et al. (2017), the process of QCA analysis can be summarized into the following four steps:

1. Calibration: expressions of the model variables are assigned degrees of membership in fuzzy sets by a membership measure.

2. Identification of the main configurations of conditions: Every possible combination of variables is evaluated for each case. The combinations that are observed often enough and are sufficiently consistent are selected for the next analysis steps.
3. Formation of solution sets: The previously determined configurations are simplified and combined by logical set operations. Three solution sets (complex, intermediate, and sparse) are identified.
4. Interpretation and evaluation of the solutions and solution sets: The conditions of the previously determined solutions are classified into core and peripheral conditions. Different coverage measures are used to determine the quality of the solutions and solution sets.

Concept	Definition
Configuration	Logical combinations of conditions
Frequency	Number of cases that can be assigned to a certain configuration
Consistency	Degree to which a certain combination is a sufficient condition for an outcome
Complex solutions	Solutions determined by simplification using logical set operations with sufficient frequency and consistency
Parsimonious solutions	Solutions determined by simplifying the complex solutions using information from the combinations eliminated by the frequency test.
Intermediate solutions	Solutions determined by using substantial knowledge in the form of the presence or absence of certain conditions
Core conditions	Conditions that are included in both the parsimonious and intermediate solutions (Fiss 2011)
Peripheral conditions	Conditions that are present in the intermediate solution but not in the parsimonious solution (Fiss 2011)
Solution coverage	Proportion of cases that can be explained by at least one configuration of a solution set (Ragin 2000)
Raw coverage	Proportion of cases that can be explained by the configuration (Ragin 2000)
Unique coverage	Proportion of cases that can be explained by one configuration from a solution set and no other configuration from that set (Ragin 2000)

Table 4. Definition of the Most Important Concepts of Qualitative Comparative Analysis

Part B

4 Combining the Case Survey Method and Qualitative Comparative Analysis for Information Systems Research (P1)

Title	Combining the Case Survey Method and Qualitative Comparative Analysis for Information Systems Research
Authors	Soto Setzke, David* (david.soto.setzke@tum.de) Böhm, Markus* (markus.boehm@tum.de) Krcmar, Helmut* (helmut.krcmar@tum.de) * Technische Universität München, Chair of Information Systems, Boltzmannstraße 3, 85748 Garching, Germany
Publication	Americas Conference on Information Systems, 2020
Status	Published
Contribution of first author	Literature review, problem definition, research design, data collection and analysis, interpretation, reporting

Table 5. Fact Sheet Publication P1

Abstract

The case survey method and qualitative comparative analysis (QCA) are two well-established research approaches in a number of research disciplines. They have recently made their way into information systems (IS) research. The case survey method is aimed at comparing previously published case studies, conventionally, using various statistical analysis methods. In turn, QCA relies on set theory, which allows deriving different configurations based on qualitative data corresponding to cases translated into set membership. Several authors have started to combine these two methods. However, so far there is no formalized approach that can easily be applied by other researchers. In this paper, we present a framework to integrate the two methods and demonstrate how this approach can be used to resolve several limitations intrinsic to these methods when being employed on their own. We furthermore discuss the potential of applying our approach for IS research and discuss the proposed approach's limitations.

Keywords: Qualitative comparative analysis, set-theoretic research, critical literature review

5 On the Use of Qualitative Comparative Analysis in Information Systems Research - A Critical Review (P2)

Title	On the Use of Qualitative Comparative Analysis in Information Systems Research - A Critical Review
Authors	Soto Setzke, David* (david.soto.setzke@tum.de) Kavılı, Merve Canan* (mervekavili@gmail.com) Böhm, Markus* (markus.boehm@tum.de) * Technische Universität München, Chair of Information Systems, Boltzmannstraße 3, 85748 Garching, Germany
Publication	European Conference on Information Systems, 2020
Status	Published
Contribution of first author	Problem definition, research design, data analysis, literature analysis, interpretation

Table 6. Fact Sheet Publication P2

Abstract

Qualitative Comparative Analysis (QCA) has increasingly become popular in Information Systems (IS) research. However, there are several pitfalls and bad practices when applying QCA. Therefore, we aim at providing an extensive overview of (1) how QCA has been applied so far in IS research and (2) how future QCA-based IS research can be improved. To do so, we review articles from IS journals and conferences using an extensive coding scheme based on methodological literature and QCA reviews from other research disciplines. First, our results show standards of reporting and justification, well established in other disciplines, are often not fulfilled. Second, we find that extant research is predominantly based on large-N analyses, which limits some of the key capabilities of QCA. Third, we show that necessity analysis is under- and sometimes even misused. Lastly, extant research suffers from low solution coverage values that are not adequately discussed and sensitivity analyses that are not employed frequently. Our findings represent the current state of QCA in IS research and highlight the potential for improvement in future QCA studies.

Keywords: Research methods, research commentary, qualitative comparative analysis, case survey, mixed methods

6 Reducing Socio-Technical Inertia During Digital Transformation – The Role of Dynamic Capabilities (P3)

Title	Reducing Socio-Technical Inertia During Digital Transformation – The Role of Dynamic Capabilities
Authors	Soto Setzke, David* (david.soto.setzke@tum.de) * Technische Universität München, Chair of Information Systems, Boltzmannstraße 3, 85748 Garching, Germany
Publication	European Conference on Information Systems, 2020
Status	Published
Contribution of first author	Literature review, problem definition, research design, data collection and analysis, interpretation, reporting

Table 7. Fact Sheet Publication P3

Abstract

Digital transformation promises various benefits for established companies such as increased revenue and competitiveness. However, a high number of digital transformation projects fail because companies are unable to adapt to changes induced through digital technologies. Socio-technical (ST) inertia plays a decisive role in the success or failure of these projects. Extant research proposes that dynamic capabilities can be used to effectively reduce ST inertia in DT projects. To further explore this proposition, I conducted a case survey on a set of DT case studies and apply fuzzy-set Qualitative Comparative Analysis on the results. This approach allows me to identify patterns of interactions between dynamic capabilities of a firm and its transformation project design that lead to the reduction of ST inertia. Preliminary results show that reconfiguration and, to some degree, sensing capabilities have a positive influence on the reduction of ST inertia. Seizing capabilities neither have a positive nor a negative impact. Furthermore, my findings show that ST inertia is also reduced through highly participative, centralized approaches.

Keywords: Digital transformation, dynamic capabilities, socio-technical inertia, governing agency

7 The Role of Dynamic Capabilities in Overcoming Socio-Cognitive Inertia During Digital Transformation – A Configurational Perspective (P4)

Title	The Role of Dynamic Capabilities in Overcoming Socio-Cognitive Inertia During Digital Transformation – A Configurational Perspective
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Publication	International Conference on Wirtschaftsinformatik, 2020
Status	Published
Contribution of first author	Literature review, problem definition, research design, data collection and analysis, interpretation, reporting

Table 8. Fact Sheet Publication P4

Abstract

Digital technologies are radically changing the way traditional companies interact in established markets. Although these technologies provide numerous benefits, many digital transformation projects fail because of companies' inability to adapt. Socio-cognitive inertia is an important factor inhibiting successful organizational transformation. Extant research suggests that, under specific conditions, dynamic capabilities are effective means of reducing socio-cognitive inertia. We combine a case survey and a fuzzy-set Qualitative Comparative Analysis approach to identify patterns of interactions between dynamic capabilities of a firm and its transformation project design that led to the reduction of socio-cognitive inertia. We show that sensing and, in particular, reconfiguration capabilities positively contribute to reducing socio-cognitive inertia when combined with a centralized governance approach. However, seizing capabilities neither have a positive nor a negative influence. Furthermore, we show that socio-cognitive inertia can also be reduced by ensuring high participation among employees, even in combination with decentralized governance approaches.

Keywords: Digital transformation, dynamic capabilities, socio-cognitive inertia, governing agency

8 Towards a Conceptualization of Capabilities for Innovating Business Models in the Industrial Internet of Things (P5)

Title	Towards a Conceptualization of Capabilities for Innovating Business Models in the Industrial Internet of Things
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Publication	International Conference on Wirtschaftsinformatik, 2019
Status	Published
Contribution of first author	Problem definition, research design, data analysis, interpretation

Table 9. Fact Sheet Publication P5

Abstract

The emergence of Internet of Things (IoT) technologies offers promising value potentials for industrial manufacturers based on the combination of smart products and data-driven services. At the same time, many incumbent firms experience a threat to their traditional value proposition and are challenged to innovate and reconfigure their existing business models. However, many of these traditional manufacturers lack or are unaware of the required capabilities for successfully reinventing their business model using IoT technologies. We therefore adopt the lens of dynamic and operational capabilities and conduct an empirical analysis of organizational capabilities required for successful IoT-enabled business model innovation (BMI). Through an exploratory, qualitative study based on interviews with decision makers in industrial manufacturing companies and experts in practice-oriented research institutions, we identify eleven distinct dynamic and operational capabilities. Our findings provide useful insights for research and practice and advance the understanding of enablers in IoT-enabled BMI.

Keywords: Digital transformation, industrial internet of things, dynamic capabilities, operational capabilities, business model innovation

9 Pathways to Successful Business Model Innovation in the Context of Digital Transformation (P6)

Title	Pathways to Successful Business Model Innovation in the Context of Digital Transformation
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Publication	Pacific Asia Conference on Information Systems, 2020
Status	Published
Contribution of first author	Problem definition, research design, data analysis, interpretation

Table 10. Fact Sheet Publication P6

Abstract

The process of digital transformation (DT) is driving established companies to innovatively modify existing business models. However, extant research provides very little insight into the determinative factors that contribute to successful business model innovation (BMI) in the context of DT. In this analysis, we draw on a resource-based view (RBV) by analyzing firms' dynamic and information technology (IT) capabilities by applying a configurational perspective to explore how companies can successfully transform their business models. To do so, we collected data of 15 established companies and employed fuzzy-set Qualitative Comparative Analysis (fsQCA) to derive the specific configurations that ultimately lead to success. We extend existing research on BMI in the context of DT and provide new insights regarding the combination of IT and dynamic capabilities.

Keywords: Digital transformation, business model innovation, fuzzy-set qualitative comparative analysis, IT capabilities, dynamic capabilities

10 Pathways to Digital Service Innovation: The Role of Digital Transformation Strategies in Established Organizations (P7)[1]

Title	Pathways to Digital Service Innovation: The Role of Digital Transformation Strategies in Established Organizations
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Publication	Information Systems Frontiers (2021, DOI: 10.1007/s10796-021-10112-0)
Status	Published
Contribution of first author	Literature review, problem definition, research design, data collection and analysis, interpretation, reporting

Table 11. Fact Sheet Publication P7

Abstract

Digital technologies are radically changing how established organizations design novel services. Digital transformation (DT) strategies are executed to manage the transition from product-centric to service-centric business models based on digital technologies. However, little is known about what configurations of DT strategies lead to successful digital service innovation (DSI) in established organizations. We employ fuzzy-set Qualitative Comparative Analysis on a set of 17 case studies of DT strategies from established organizations with different industry backgrounds. We identify several distinct configurations of DT strategies that lead to successful and unsuccessful DSI. Based on these configurations, we deduce that the threat of digital disruption negatively impacts an organization's innovation activities. Furthermore, we find that strategic partnerships can be leveraged by organizations that face an imminent threat of digital disruption while organizations with competitive advantages may rely on "do-it-yourself" approaches. Lastly, we find that the involvement of a C-level executive is a necessary requirement for successful DSI. Our results contribute to theory by integrating research on DSI and DT, providing a perspective on DSI failure, and employing a configurational research approach that allows us to highlight interdependencies between factors as well as insights into the individual factors. Furthermore, we provide actionable recommendations for executives.

Keywords: Digital transformation, digital service innovation, radical service innovation, digital transformation strategies, qualitative comparative analysis

11 Platform Openness: A Systematic Literature Review and Avenues for Future Research (P8)

Title	Platform Openness: A Systematic Literature Review and Avenues for Future Research
Authors	Soto Setzke, David* (david.soto.setzke@tum.de) Böhm, Markus* (markus.boehm@tum.de) Krcmar, Helmut* (helmut.krcmar@tum.de) * Technische Universität München, Chair of Information Systems, Boltzmannstraße 3, 85748 Garching, Germany
Publication	International Conference on Wirtschaftsinformatik, 2019
Status	Published
Contribution of first author	Literature review, problem definition, research design, data collection and analysis, interpretation, reporting

Table 12. Fact Sheet Publication P8

Abstract

Open platforms such as Facebook or Android have stimulated innovation and competition across industries. Information systems literature has analyzed platforms from a variety of perspectives. The aim of this paper is to synthesize and integrate extant interdisciplinary research on the concept of platform openness. Towards this end, we conducted a literature review and analyzed the results with deductive and inductive coding approaches. We identified five distinct themes: measurement frameworks, implementation mechanisms, drivers for opening and closing platforms, trade-offs in designing openness, and the impact of changing openness on ecosystems. We propose three avenues for future research: finding the optimal degree of platform openness, integrating perspectives on accessibility and transparency, and analyzing the influence of openness and other factors with configurational theories. This paper contributes to research on platforms by laying out the main themes and perspectives in the research stream of platform openness and by identifying areas for future research.

Keywords: Platform openness, digital platforms, platform ecosystems

12 The Role of Openness and Extension Modularization in Value Capture for Platform-Based Digital Transformation (P9)

Title	The Role of Openness and Extension Modularization in Value Capture for Platform-Based Digital Transformation
Authors	Soto Setzke, David* (david.soto.setzke@tum.de) Böhm, Markus* (markus.boehm@tum.de) Krcmar, Helmut* (helmut.krcmar@tum.de) * Technische Universität München, Chair of Information Systems, Boltzmannstraße 3, 85748 Garching, Germany
Publication	Business Information Systems, 2020
Status	Published
Contribution of first author	Literature review, problem definition, research design, data collection and analysis, interpretation, reporting

Table 13. Fact Sheet Publication P9

Abstract

Digital transformation is radically changing the way companies conduct business and compete in established markets. In particular, a growing number of companies are switching from predominantly product-focused to platform-based business models. However, it remains unclear how these platforms should be designed to enable platform owners to maximize value capture. In this study, we investigated the interactions between platform openness and extension modularization and their influence on value capture in the context of digital transformation. To do so, we combined a case survey strategy with a configurational approach using fuzzy-set Qualitative Comparative Analysis. We found that there is no single condition necessary to achieve a high degree of value capture. Furthermore, our results show the importance of closedness and tight coupling of platforms and their applications. Finally, we confirmed the importance of interface conformance to high value capture. In addition, our results contribute to both theory and practice and provide implications for future research into the role of digital platforms in digital transformation.

Keywords: Digital transformation, digital platforms, configuration theory

Part C

13 Summary of Results

We wrote nine publications to address the four research questions of this thesis. In the following chapter, we summarize our findings by outlining how each publication takes the respective research question into account.

RQ1: *How can configurational research methods inform research on success factors for digital transformation strategies?*

A formalized research approach combining the case survey method and qualitative comparative analysis. We introduced a formalized approach for combining the case survey methodology and QCA (P1). Our framework allows us to draw on already published research while still taking contextual richness into account. This is particularly useful when it may not be feasible to conduct new case studies due to limited resources or the novelty of the phenomenon under investigation. Research on digital transformation is an exemplary phenomenon where our approach may be useful. While conducting a sufficiently large set of case studies may not be feasible for most researchers, several high quality-cases have already been published and may thus be used with our approach.

Good and bad practices regarding the use of qualitative comparative analysis in information systems research. Based on a critical literature review, we provided an extensive overview of how QCA has been used in IS research and how future QCA-based IS research can be improved. We applaud the increased use of this set-theoretic methodology in our discipline but point out that its use in journals is still limited. Furthermore, we show that there are both severe issues and unused potentials in QCA applications for IS research which we summarize in four distinct themes: standards of reporting and transparency, the predominance of large N-studies, misuse of necessity analyses, low robustness of analyses, and absence of sensitivity tests.

RQ2**:** *What are configurations for reducing inertia in digital transformation projects?*

Configurations for reducing socio-technical inertia. Based on a literature review, we identified dynamic capabilities as a potential success factor for digital transformation. We then hypothesized that it may also be a decisive factor for reducing socio-technical inertia during digital transformation. We combined the case survey method and QCA (P1) to analyze 31 cases of digital transformation where socio-technical inertia occurred and identified successful and unsuccessful configurations of dynamic capabilities (P3). Our preliminary results show the importance of reconfiguring, the non-importance of seizing, and the positive impact of both centralized and participation-oriented approaches.

Configurations for reducing socio-cognitive inertia. We repeated the analysis from P3 to analyze 39 cases of digital transformation where socio-cognitive inertia occurred and identified successful and unsuccessful configurations of dynamic capabilities (P4). Our results show the importance of sensing and reconfiguring, the non-importance of seizing, and the positive impact of high participation among employees.

RQ3: *What configurations of digital transformation strategies lead to successful and unsuccessful innovation outcomes?*

Configurations for successful and unsuccessful business model innovation. To answer the third research question, we first identified dynamic capabilities as a potential success factor for business model innovation based on a literature review (P5). We then conducted case studies and subsequently analyzed them using QCA (P6). Based on 15 cases, we identified three configurations that lead to successful and unsuccessful business model innovation. Our results show the importance of IT capabilities for goods-oriented companies and the importance of combined IT and dynamic capabilities for digitally-enabled business models. We also show that the absence of IT capabilities may lead to failure for service-oriented firms.

Configurations for successful and unsuccessful digital service innovation. In a further QCA (P7), we analyzed 17 cases to identify configurations that lead to successful and unsuccessful digital service innovation. Our results show the negative impact of the threat of digital disruption as well as the importance of strategic partnerships for organizations that are experiencing threat. Organizations with competitive advantages, on the other hand, may rely on a "do-it-yourself" approach. Furthermore, we identify the involvement of a C-level executive as a requirement for success.

RQ4: *What are successful configurations for platform-based digital transformation strategies?*

Configurations for successful value capture. To answer the fourth and last research question, we first conducted a literature review (P8) and identified platform openness as a potential success factor for value capture. We then combined the case survey method and QCA to analyze 20 cases of platform-based digital transformation (P9). We identified three configurations for successful value capture. We found that there is no single condition necessary to achieve a high degree of value capture. Furthermore, our results show the importance of closedness and tight coupling of platforms and their applications. Finally, we confirmed the importance of interface conformance to a high degree of value capture.

Table 14 provides an overview of the key findings of this thesis.

P	RQ	Findings
P1	RQ1	▪ Development of a formalized approach that combines the case survey method and QCA ▪ Approach that allows drawing on already published research while still taking contextual richness into account ▪ Approach is especially useful for research on digital transformation projects due to a high amount of already published case studies
P2	RQ1	▪ Use of QCA in IS research has increased but use in journal articles is still limited ▪ Both severe issues and unused potential in QCA applications for IS research ▪ Established standards of reporting and transparency, such as publishing raw data matrices or truth tables and justifications of chosen thresholds are often not fulfilled ▪ Extant research relies mostly on large N-studies which neglects the analytical potential of small N research ▪ Use of random samples for large N studies is highly problematics and needs more reflection ▪ Necessity analyses are widely neglected and sometimes even misinterpreted ▪ Studies mostly show solid values for solution consistency but often report low values for solution coverage without adequate discussion ▪ Only few tests for sensitivity to varying thresholds of calibration and frequency conducted
P3	RQ2	▪ Dynamic capabilities can lead to reduction of socio-technical inertia in digital transformation projects ▪ Reconfiguring and, to some degree, sensing capabilities have a positive impact on the reduction of socio-technical inertia ▪ Seizing capabilities have neither a positive nor a negative impact ▪ Socio-technical inertia is also reduced through highly participative, centralized approaches
P4	RQ2	▪ Dynamic capabilities can lead to reduction of socio-cognitive inertia in digital transformation projects ▪ Sensing and, in particular, reconfiguring capabilities have a positive impact on the reduction of socio-cognitive inertia when combined with a centralized governance approach ▪ Seizing capabilities have neither a positive nor a negative impact ▪ Socio-cognitive inertia is also reduced by ensuring high participation among employees, even in combination with decentralized governance approaches
P5	RQ3	▪ Identification of dynamic capabilities as a potential success factor for business model innovation in the context of digital transformation
P6	RQ3	▪ Combination of dynamic and IT capabilities were identified as a success factor for digitally-enabled traditional business models ▪ IT capabilities are sufficient for successful digital business model innovation in goods-oriented firms ▪ Absence of IT capabilities was identified as a failure factor for service-oriented firms
P7	RQ3	▪ Threat of digital disruption negatively impacts an organization’s innovation activities ▪ Strategic partnerships can be leveraged by organizations that face an imminent threat of digital disruption while organizations with competitive advantages may rely on “do-it-yourself” approaches ▪ Involvement of a C-level executive is a necessary requirement for successful digital service innovation
P8	RQ4	▪ Identification of platform openness as a potential success factor for digital transformation
P9	RQ4	▪ No single condition necessary to achieve a high degree of value capture

		▪ Identification of three configurations that are sufficient for achieving a high degree of value capture in platform-based digital transformation ▪ Identification of the importance of closedness and tight coupling of platforms and their applications ▪ Confirmation of the importance of interface conformance to high value capture

Table 14. Overview of Key Results

14 Discussion

14.1 A Configurational Perspective on Digital Transformation

In their commentary, El Sawy et al. (2010) first proposed configurational research methods such as QCA as an appropriate lens for analyzing and understanding the influence of digital technologies on organizations and processes of organizational change. They provide an exemplary tutorial on how to apply the method and outline the advantages in a very detailed way. However, despite their methodological and conceptual groundwork, IS research has been adopting configurational thinking very slowly. As our embedded publication P2 shows, the use of QCA has been increasing modestly, but it is still far from becoming a mainstream method. This applies particularly to journals unlike in neighboring disciplines such as management research (Wagemann et al. 2016). Regarding digital transformation, extant research relies mostly on single or multiple case studies or quantitative research such as questionnaires and only a few studies employ configuration theory (Leonhardt et al. 2018).

In this thesis, we answer the call for research by El Sawy et al. (2010) and use configuration theory, in particular QCA, to explore the interdependencies of different potential success factors and their impact on the outcome of digital transformation strategies. As the results of this thesis show, QCA is an appropriate method to capture the complexity inherent to processes of organizational change based on digital technologies. In particular, it can be combined with the case survey method to investigate phenomena for which it may be costly to conduct many case studies (see P1). Therefore, it allows researchers to take advantage of the plethora of single and multiple case studies that are already available in scientific journals and conferences. On the other hand, it is also sufficient to conduct a reasonable number of case studies (such as 12 or more) to apply compact research models (see P7). Since QCA can be seen as a mixture of purely quantitative and qualitative approaches, it offers the advantage that it can be used with a smaller or medium number of cases. Furthermore, it allowed us to analyze the interplay between different potential success factors and therefore move beyond the analysis of purely symmetrical, net-effect-based relationships. For example, Rowe et al. (2017) analyzed the effects of dynamic capabilities on socio-technical inertia during organizational transformation. They used a traditional regression-based model and therefore analyzed, separately, the net effect of each dynamic capability (sensing, routinizing, and reconfiguring) on the outcome, i.e. socio-technical inertia. In our embedded publications on inertia (see P3-4), we employed QCA to move beyond analyzing of pure net effects and focused on the interplay of the three dynamic capabilities and their joint impact on inertia. Thereby, we were able to show the importance of combining sensing and reconfiguring and the smaller impact of seizing capabilities for reducing both socio-technical and socio-cognitive inertia. In the context of business model innovation (see P6), we were able to show the importance of combining IT and dynamic capabilities for digitally-enabled business models.

Furthermore, QCA enables the researcher to identify conditions that are necessary to achieve a certain outcome which has strong implications for both theory and practice. In P7, for example, we found that centralized decision-making qualifies as a necessary condition for successful digital service innovation and therefore should be a part of any service-based digital transformation strategy. Practitioners can apply these findings directly and take them into account when designing strategies. For them, configurations can service as recipes that represent different pathways to achieve the desired outcome. They can also serve to identify gaps between a momentarily failing and a successful strategy. If an organization's current strategy resembles a configuration leading to failure, the practitioner can use a successful configuration as a template and make changes. This shows that configuration theory is useful for both theory and practice and we invite scholars to further explore and apply it in their own research as well as to build upon our findings.

14.2 Identifying and Measuring the Outcome of Digital Transformation

Extant literature on digital transformation strategies has, until now, rarely explored the outcome and the effectiveness of certain strategies. In contrast, most scholars focus on how strategies are initiated and executed. This limitation of current research is also widely acknowledged by different scholars (Berghaus/Back 2017; Matt et al. 2015).

In this thesis, we contribute to the literature on digital transformation by adding an outcome-oriented perspective. Unlike previous research, we focus less on the process and the activities related to a digital transformation strategy, but rather explore the result and analyze the impact of different strategy building blocks. As outlined in the introduction of this thesis, startups are using digital technologies to attack markets once dominated by established organizations (Riasanow et al. 2019). Therefore, we first investigate the architectural redesign of a firm's overall business, which is also known as business model innovation (Vial 2019; Riasanow et al. 2019) (P6). Contrary to traditional, regression-oriented measurement instruments for business model innovation (see, for example, Clauss (2017)), we employ a qualitative perspective that focuses on customer acceptance of the newly introduced business model since ensuring said acceptance is often a challenge for established organizations (Riasanow 2020). Second, we explore digital service innovation as an outcome of digital transformation strategies (P7). While services may also be an example of an organization's business models, they have certain characteristics that distinguish them and warrant a proper analysis. Although scholars have highlighted the role of digital technologies for service innovation (Lusch/Nambisan 2015; Goduscheit/Faullant 2018; den Hertog 2000), extant research has not shed light on how the building blocks of digital transformation strategies impact the degree of innovation success. We close this gap by analyzing these building blocks as antecedents for digital service innovation. Third, we focused on platform-based digital transformation strategies. Similar to service innovation, digital platforms may represent a business model of a certain organization but due to the particular characteristics of platforms that distinguish them (Hein et al. 2020), we conducted a dedicated analysis. Regarding the outcome, we chose to measure how much co-created value could be captured on a certain platform since this mechanism has often been overlooked in IS research (Schreieck et al. 2017). Thereby, we answer calls for research from different scholars (de Reuver et al. 2018; El Sawy et al. 2010). However, this is only an initial exploration and future research could analyze different outcomes such as value creation. Although we also explore the reduction of inertia during digital transformation in our embedded publications, we do not consider this an outcome of transformation strategies. Rather, reducing inertia is an enabler or sometimes prerequisite for achieving business-related outcomes such as business model or digital service innovation. Lastly, our research provides a failure perspective on digital transformation. Extant literature focuses mostly on successful cases of digital transformation and neglects strategies that lead to failure. We close this gap by conducting failure case studies and including them in our QCA-based research models.

14.3 Reducing Inertia and Engaging in Innovation Through Dynamic Capabilities

The concept of dynamic capabilities has been introduced several decades ago by Teece et al. (1997) as an extension of the resource-based view (Eisenhardt/Martin 2000). They are processes that help managers to “integrate, build and reconfigure internal and external competencies to address rapidly changing environments” (Teece et al. 1997, 516). Recently, this concept has again drawn much attention to high potential explanatory value for research on digital transformation (Warner/Wäger 2019; Matarazzo et al. 2021; Magistretti et al. 2021). In the embedded publications of this thesis (P3-4), we use dynamic capabilities to explain how organizational inertia can be reduced during digital transformation. Due to the nature of higher-level routes, they may be able to “regulate and reconfigure lower-level capabilities and resources” (Rowe et al. 2017, 407). While Rowe et al. (2017) initially showed that each of the three dynamic capabilities significantly reduces inertia, we showed potential combinations and their effect on inertia.

Specifically, we can show that reconfiguring capabilities are particularly important for reducing both socio-cognitive and socio-technical inertia. We found that in organizations with centralized decision-making, decisions on the working environment and IT design may be very complex and managers may not always be able to predict the long-term effects of changes that are made today (Mocker/van Heck 2015). In these cases, reconfiguring capabilities enable organizations to effectively manage transformation through open and iterative approaches. Furthermore, in centralized settings, IT systems are often not aligned to the needs of the individual or sometimes isolated business units (Huang et al. 2010). Reconfiguring capabilities help organizations to adjust these systems even after having been introduced (Richet et al. 2016). Generally, centralized decision-making helps with making sure that the upper management can implement the planned changes (Mocker/van Heck 2015). Also, letting employees participate in the process of reconfiguring leads to better outcomes since this makes them feel taken seriously and gives them the impression that they can influence the outcome of the transformational process (Lapointe/Rivard 2005, 2007; Rivard et al. 2011). Apart from reconfiguring, sensing capabilities may also help reduce inertia. However, we identified them as peripheral conditions, which means that their causal link with the outcome is much weaker than reconfiguring. Sensing capabilities such as market scanning and innovation scouting are particularly helpful at the beginning of a transformation process and may, at a later stage, complement reconfiguring. Seizing capabilities, on the other hand, had neither a positive or a negative impact and were possibly overshadowed by the strong effect of reconfiguring capabilities.

Regarding business model innovation, we conceptualized dynamic capabilities that are needed for IoT-based business model innovation. Furthermore, we analyzed how dynamic capabilities need to be combined with IT capabilities to engage in successful business model innovation. Extant literature suggests that dynamic capabilities need to be deployed with other resources to fulfill their potential (Bharadwaj 2000; Wade/Hulland 2004; Chen et al. 2013). We partially confirm this view by showing that only the combination of dynamic and IT capabilities could potentially prevent the rejection of a business model innovation. Furthermore, we also show that organizations need to combine these capabilities to successfully engage in the innovation of digitally enabled traditional business models. However, this combination does not necessarily lead to successful innovation of digital business models, since we could not identify a corresponding configuration. Further research is required to analyze whether organizations need to deploy other capabilities in this context.

14.4 Centralized Decision-Making as a Key Success Factor

The role and different types of decision-making have received lots of attention in management as well as IS research (Mihalache et al. 2014; Cho et al. 2011). In our embedded publications, we found that decision-making plays a decisive role in reducing inertia as well as in engaging in digital service innovation (P7).

Regarding the reduction of inertia, we found that, as also discussed earlier, centralized decision-making has a strong causal link to the reduction of inertia, in particular when combined with strong reconfiguring capabilities. This is also in line with extant research (Weill/Ross 2004) Centralized decision-making through managers with detailed knowledge enables more aligned decisions and a more effective top-down implementation of the transformation plan (Kearns/Sabherwal 2006; Mocker/Ross 2018). However, we also found one potential success configuration for the reduction of socio-cognitive inertia that includes decentralized decision-making combined with a high degree of employee participation (P4). This could be explained by the potential wider reach of several decision-makers in a decentralized setting (Rezvani et al. 2017).

Regarding digital service innovation, we even identified centralized decision-making as a necessary condition. This shows that organizations need to, ideally, designate a C-level executive who is responsible for governing the digital transformation strategy. Alternatively, they can establish a digitalization committee where different higher-level managers or C-level executives jointly decide about the organization’s strategy. We found that in cases, where lower-level managers were responsible for governing the digital transformation strategy, higher levels of hierarchy were often not aware of the organization’s needs or potential new use cases. It proved difficult to convince the C-level of the importance of digital technologies. Therefore, we propose that to be successful, digital transformation strategies need to ensure top management attention and C-level governance, as also suggested by previous research (Park et al. 2017; Tronvoll et al. 2020).

In sum, we confirmed the relevance of extant research that demonstrates the effectiveness of centralized decision-making in organizational transformation. However, we also found that decentralized settings may be helpful in transformational settings with high socio-cognitive inertia.

15 Limitations

The publications that are embedded in this thesis are subject to several limitations. While each publication provides a section that presents its limitations, in this chapter, we discuss general limitations that apply to several publications.

Literature reviews (such as P2 and P8) are limited by the search and coding process. Regarding the search process, our reviews may have missed studies that are not covered by our choices of search terms and outlets. Alternative phrases for terms such as "platforms" or other outlets may yield additional articles. To mitigate this risk, we conducted forward and backward searches to find more articles to find further relevant articles that we may have missed (Webster/Watson 2002). In addition to journals, we also searched for articles in conference proceedings to ensure the inclusion of relatively novel insights which may have not been published in journals so far. Furthermore, our reviews are limited by the coding process. This applies particularly to P2, where we identified good and bad practices of the use of QCA. Therefore, two coders independently coded all the articles and afterward compared their results. Differences were then resolved in oral discussion.

In almost all of the remaining articles of this thesis, we used QCA combined with either the case survey methodology or case study research. An exception is P5 which is based only on case study research. The case survey methodology is limited by the processes of data collection and analysis (Jurisch et al. 2013). Regarding data collection, the limitations that we presented for literature reviews apply as well. For example, we have missed cases that are not covered by our choices regarding search terms and outlets. In addition to these limitations that were already presented, it should be noted that different case studies may be written based on different premises or different research gaps in mind which makes comparisons more difficult. Also, the extent of information provided by cases may vary. Therefore, we carefully defined appropriate inclusion and exclusion criteria to ensure comparability among different cases. Furthermore, selection bias in the chosen outlets is another limitation. Successful cases may have a higher probability of being published than failure cases (Kepes et al. 2018; Jurisch et al. 2013). Therefore, for some publications, we were able to provide results only for successful outcomes. Finally, the coding and analysis process is another limitation. To ensure the reliability of our coding, at least two people independently coded all of the cases and afterward resolved differences in oral discussion (Rivard/Lapointe 2012).

Three publications of this thesis use the case study method, either as a stand-alone methodology or in combination with QCA (P5-7). While case studies provide several advantages, such as rich in-depth insights, they are not free from limitations. First, they are limited regarding their generalizability. For example, in P7, we investigate 17 cases. However, compared with the real, total population of cases, this is a relatively small amount and the findings from our study may depend on certain conditions present in the investigated subset (Yin 2017). In P5, for example, all of our cases represent German firms. Certain behavior and values vary across different cultures which means that a set of cases with firms from other countries might have yielded slightly different results (Hofstede/Bond 1984). Furthermore, in most of our case studies, we conducted interviews and used the results as primary data. Interview data is subject to biases such as the retrospective sensemaking bias which can result in unreliable accounts of events (Eisenhardt/Graebner 2007). To mitigate this limitation, we interviewed different experts across different levels of hierarchy in all our case studies.

In five publications embedded in this thesis, we use QCA as a research method. Despite its advantages for studying complex phenomena such as digital transformation, it also implies certain methodological limitations. First, the number of cases in the analysis limits the number of conditions that should be used in the research model (Greckhamer et al. 2013; Greckhamer et al. 2018). Based on our literature review (P2), we decided to use small-N designs rather than large-N designs. Therefore, we used rather small sets of conditions and may have left out conditions that would have provided additional explanations. Still, values of consistency and coverages were relatively high in all of our analyses. Second, we used qualitative data for all our analyses which is not common in IS research (Soto Setzke et al. 2020c). Correctly and objectively calibrating data, especially from interviews to fuzzy sets may still raise concerns regarding the interpretability of the results. To mitigate this limitation, we followed established methodological guidelines provided by Basurto/Speer (2012) and de Block/Vis (2019). Furthermore, we accounted for interrater reliability and provided explanations of our coding scheme as well as decisions taken throughout the process of calibration and analysis.

16 Implications

The findings of our thesis have implications for both theory and practice which we are going to present and discuss in this section.

16.1 Implications for Theory

This thesis contributes to different theoretical concepts and literature streams in the context of digital transformation. First, we contribute to the literature on both dynamic capabilities and inertia by linking these concepts and investigating them using configuration theory. Our results show that, generally, dynamic capabilities contribute in a positive way to an organization's ability to overcome socio-cognitive and socio-technical inertia during digital transformation. The resulting configurations provide insights on which dynamic capabilities are particularly important and how they can be combined based on the governance-related decision in a particular digital transformation project. Furthermore, we provide further evidence pointing to the importance of participation among employees, which is already regarded as a success factor in IS and general change processes (Young/Jordan 2008; Erwin/Garman 2010). We also show that contrary to prior research, decentralized governance may not always be less effective than centralized governance for reducing inertia (Weill/Ross 2004).

Second, our findings contribute to the literature on innovation in digital transformation, in particular digital service and business model innovation. Regarding digital service innovation, our thesis is among the first studies to integrate this perspective with digital transformation and thus paints a more complete picture. Extant literature on digital service innovation focuses mostly on use cases, characteristics of innovation, or effective processes while we investigate building blocks of digital transformation strategies as antecedents of innovation (Goduscheit/Faullant 2018). Thereby, we add a new perspective explaining how organizations can successfully engage in digital service innovation. In particular, we provide further evidence for the importance of centralized-decision making (Tronvoll et al. 2020). Regarding business model innovation, we provide a conceptualization of eleven organizational capabilities that are required to successfully engage in IoT-enabled business model innovation. While the respective embedded publication focuses on IoT, the identified capabilities may also be transferred to other forms of business model innovation. Thereby, our results enhance the understanding of organizational antecedents and underlying processes of business model innovation. Furthermore, we introduce IT and dynamic capabilities as antecedents for business model innovation. Our findings show how these capabilities can be successfully combined, depending on the focus of the organization and the business model that is being transformed.

Third, the results contribute to the literature on digital platform ecosystems. Our embedded publications (P8-9) respond to a call for research regarding analyses of design choices for digital platforms (de Reuver et al. 2018). With a literature review, we identify platform openness as a potential success factor for digital platforms (P8). Based on this, we provide a first exploration of the interplay between value capture and design choices for platforms that are established as a building block of a digital transformation strategy. Using configuration theory, we show how platform openness and extension modularization influence the degree of value capture of a newly established platform. Thereby, our findings contribute to enhancing our understanding of how organizations can successfully design and maintain digital platforms that are part of a digital transformation strategy.

Fourth, our results contribute to an outcome-oriented perspective on digital transformation. Extant literature on digital transformation focuses on different building blocks of digital transformation strategies but only rarely investigates the effectiveness of these strategies and their influence on specific outcomes (Berghaus/Back 2017; Matt et al. 2015). Digital transformation strategies are often called successful if their implementation went according to the original plan, but without measuring tangible results (Singh/Hess 2017; Hess et al. 2016). Our findings provide several potential outcomes for digital transformation strategies that help to assess their effectiveness: digital service innovation (P7), business model innovation (P6), and, in the case of platform-based digital transformation, value capture (P9). Thereby, we answer calls for research that focuses on "comparing digital transformation strategies across different industries […] in order to increase success rates" (Matt et al. 2015, 342). Furthermore, we provide a perspective on how digital transformation may fail while extant literature focuses mostly on successful cases of digital transformation (Hess et al. 2016; Sebastian et al. 2017).

Fourth, our thesis provides methodological contributions. We employed a configurational research approach for answering most of our research questions (RQ2, RQ3, and RQ4). Thereby, we answer several calls for research from IS scholars (Riasanow et al. 2019; El Sawy et al. 2010). By using configuration theory, we enhance our understanding of the interplay of different building blocks of digital transformation strategy and their impact on innovation-related outcomes. It also allows us to investigate individual strategy elements and contribute to the literature on each of the building blocks, such as centralized decision-making. We also contribute to methodological variety in IS literature. Studies based on configuration theory are slowly becoming more popular, but smaller sample sizes are still not used frequently despite their many advantages (Greckhamer et al. 2013). In our embedded publications, we show how researchers can use QCA to calibrate qualitative data from, for example, semi-structured interviews to investigate relatively novel phenomena (P3-4, P6-7, and P9). Furthermore, we introduce a formalized approach to combine the case survey methodology and QCA (P1). While several authors have already started to combine these methods (Henfridsson/Bygstad 2013; Rivard/Lapointe 2012), allowing them to draw on already published research while still taking contextual richness into account. However, extant literature provides no guidelines on how to design and conduct similar studies. This gap is closed by our approach and provides scholars with new methodological tools.

16.2 Implications for Practice

This thesis provides several implications for practice that firms can apply when designing and executing their digital transformation strategies. First, all the configurations that were identified in this thesis can be used as templates by executives. They represent different pathways that lead to a specific outcome and can be used as a basis for strategic planning depending on the specific context. Each configuration represents a different choice that leads to an outcome of interest. This way, executives can also identify gaps between a currently failing and a potentially succeeding strategy.

Second, practitioners can use the findings of this thesis to reduce inertia in their organization, in particular socio-technical and socio-cognitive inertia. Our results show that both sensing and, in particular, reconfiguring capabilities are associated with a reduction of inertia. Therefore, when faced with inertia, executives should build up or extend dynamic capabilities in the firm. Our configurations (P3-4) show how capabilities can be combined, depending on the context of the digital transformation initiative at hand.

Third, our findings illustrate how organizations can successfully engage in innovation activities. Regarding business model innovation, executives can use our configurations to identify which capabilities should be built up or extended in the organization, depending on the degree of digitalization of the business model. Regarding digital service innovation, we show that centralization of decision-making is a decisive success factor. Organizations should thus ensure that their digital transformation initiatives are steered by a C-level executive or a committee consisting of multiple executives or managers. Furthermore, organizations with a lot of resources may rely on a do-it-yourself approach while smaller or medium-sized organizations should engage in strategic partnerships to ensure successful innovation activities.

Finally, the thesis provides practical insights for successful platform-based digital transformation strategies. Practitioners can use the configurations to adjust the degrees of platform openness, loose coupling, and interface conformance to maximize value capture.

17 Future Research

In the following section, we present and discuss several topics and research questions that have emerged during our work on this thesis but could not be addressed in the embedded publications. We encourage other scholars to pursue research on this topic to broaden and deepen our understanding of digital transformation strategies.

Investigating different facets of centralized decision-making. We identified centralized decision-making as a necessary condition for successfully engaging in digital service innovation (P7) and a success factor for reducing socio-cognitive inertia (P4). However, due to the relatively low number of potential conditions in a QCA study, we could not further differentiate this condition and its effect on the success of digital transformation. For example, we did not investigate the influence of different leadership styles such as transactional or transformational leadership (Bass 1990). Furthermore, in the case of CDOs, the focus and role of the CDO in the organization could also influence the effectiveness of decision-making (Tumbas et al. 2017; Haffke et al. 2016). Future research could focus on and investigate different facets of centralized decision-making and their impact on digital transformation. As in this thesis, configuration theory could be used to identify different configurations of elements to investigate whether, for example, organizations should appoint CDOs or Chief Information Officers (CIOs).

Investigate other forms of inertia. In this thesis, we focus on socio-technical and socio-cognitive inertia in the context of digital transformation since they are particularly relevant for the socio-material aspect of digital transformation. Future research could explore other forms of inertia such as political, economic, and negative psychology inertia (Besson/Rowe 2012). Thereby, researchers could paint a more complete picture of the role of inertia in digital transformation and how to successfully reduce it, depending on the specific type of inertia. Furthermore, these studies could also include additional or other conditions besides dynamic capabilities.

Measure and analyze other outcomes of digital transformation. Extant research rarely observes and analyzes the outcome of digital transformation strategies (Berghaus/Back 2017). In this thesis, we used the degree of digital service innovation, business model innovation, and value capture to measure the said outcome. Future research could explore other concepts to measure the outcome and compare their results with ours. From a theoretical point of view, this could enhance our understanding of the concept of digital transformation and its interdependencies with other concepts. For practitioners, further research in this area could provide additional and more concrete recommendations depending on the goal that organizations aim to achieve with their digital transformation strategy.

Validation of the QCA-based case survey method. Our approach for combining the case survey method and QCA (P1) has proven useful in several of our embedded publications. However, to further investigate its usefulness and to further improve it, we encourage other scholars to apply and test this method with other research questions. Future research could also be conducted to design and execute workshops or semi-structured interviews with other researchers to test the applicability of the approach and gather feedback for further improvement.

Cross-validation of results with other research methods. We applied a configurational perspective in several of our embedded publications. We used a relatively small sample of cases in these publications which leads to limited generalizability of the findings, also known as “modest generalization” (Berg-Schlosser et al. 2009). While this approach may be more robust than generalizing from multiple-case studies with even smaller samples, it is also more limited than the approach applied in regression-based methods. For this thesis, we aimed at providing a first theoretical exploration of the relationships that we investigated by analyzing rich, in-depth qualitative data which means that QCA is an appropriate research method. Future research, however, could validate our findings by using regression analysis on larger, representative samples. This could provide more generalizable contributions to the relatively young research area of digital transformation.

18 Conclusion

Digital technologies are radically changing how established organizations compete and interact in traditional markets. Digital transformation strategies are formulated executed to integrate digital technologies in business models and processes and to ensure competitiveness against a rising number of start-ups. However, many digital transformation strategies fail due to different reasons and little is known about the respective success and failure factors. Therefore, this thesis aims at developing an empirical understanding of success factors for digital transformation strategies of established organizations by taking a configurational perspective into account. We develop a formalized approach that enables the use of QCA combined with the case study approach and we conduct a critical review on the use of QCA in IS research that highlights good and bad practices. We highlight different paths to reduce inertia during digital transformation and illustrate the importance and usefulness of dynamic capabilities. Furthermore, we analyze different types of digital transformation strategies and derive success and failure configurations. Our results contribute to the literature on digital transformation as well as digital service and business model innovation and digital platform ecosystems. For practice, we derive guidelines that firms can apply when designing and executing their digital transformation strategies. Future research may analyze other outcomes of digital transformation strategies, investigate different types of inertia, and explore the mechanisms related to centralize decision-making.

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Appendix. Published Articles in Original Format

Appendix A. Combining the Case Survey Method and Qualitative Comparative Analysis for Information Systems Research (P1)

Combining the Case Survey Method and Qualitative Comparative Analysis for Information Systems Research

Completed Research

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Abstract

The case survey method and qualitative comparative analysis (QCA) are two well-established research approaches in a number of research disciplines. They have recently made their way into information systems (IS) research. The case survey method is aimed at comparing previously published case studies, conventionally, using various statistical analysis methods. In turn, QCA relies on set theory, which allows deriving different configurations based on qualitative data corresponding to cases translated into set membership. Several authors have started to combine these two methods. However, so far there is no formalized approach that can easily be applied by other researchers. In this paper, we present a framework to integrate the two methods and demonstrate how this approach can be used to resolve several limitations intrinsic to these methods when being employed on their own. We furthermore discuss the potential of applying our approach for IS research and discuss the proposed approach's limitations.

Keywords

Research methods, research commentary, qualitative comparative analysis, case survey, mixed methods.

Introduction

While conducting research, information systems (IS) scholars have a variety of research methods at their disposal. A major challenge lies in selecting an appropriate method for the research purpose (Galliers and Land 1987). IS scholars have argued that combining different research methods, even originated from distinct paradigms, allows establishing more targeted research as well as obtaining more reliable and relevant results (Mingers 2001). Recently, researchers have started to combine two methods that have been introduced into IS research recently: the case survey method and qualitative comparative analysis (QCA).

The case survey method was originally introduced as a meta-analysis approach aimed to investigate cases obtained from extant literature (Lucas 1974). In this way, it uses the vast amount of already published single and multiple case studies, similar to other comparison-based research methods such as meta-analysis (Jurisch et al. 2013). Using the case survey method, a researcher first constructs a sample of case studies along with a coding scheme, which is then used by two or more coders. Afterward, the resulting data can be analyzed, most commonly, by applying conventional statistical analysis tools.

In turn, QCA is based on set theory and was first introduced by Ragin (1987). QCA allows the researcher to operate in terms of configurations instead of symmetric, net effect-based predictor-outcome relationships (Liu et al. 2015). Similar to the case survey method, it is a case-based approach, which can be applied to any type of underlying datasets, such as interviews, archival data, or questionnaire-based survey results. Through the calibration process, a researcher assigns set memberships to each case according to different conditions defined in the research model. These set memberships are then used to compute solution formulas, which are combinations of conditions, reliably resulting in a specific outcome.

Both research methods have certain limitations. For example, the case survey method is limited by the fact that a rather large sample of case studies is needed when using traditional statistics-based approaches. QCA, on the other hand, works well when using an intermediate-sized set of diverse cases, but conducting these cases may not always be feasible. We argue that these and other limitations can be overcome when combining the case survey method and QCA, as can be seen in extant literature. However, so far there is no formalized approach that can be applied by other researchers. Therefore, in this paper, we propose an approach to combine the case survey method and QCA to provide new potential for IS research. First, we briefly introduce the case survey method and QCA by outlining their concepts and individual strengths. Afterward, we review exemplary applications that combined both methods. Then, we describe the proposed integrated approach and highlight its potential compared with employing the two considered research methods separately. Finally, we discuss limitations that arise with regard to the proposed approach and conclude the paper.

Case Survey Method

The case survey method was first formally introduced by Lucas (1974, p. v) as an "inexpensive way to aggregate existing research." So far, it, surprisingly, received only scarce attention in IS research (see, for example, Henfridsson and Bygstad (2013); Jurisch et al. (2013); Rivard and Lapointe (2012)). The concept of the case survey method relies on the assumption that there is a growing amount of empirical insights provided by single or multiple case studies. However, it is difficult to deduce generalized insights based on single case studies or even small N-case research works. The case survey method represents a formalized technique to compare a relatively large number (> 50) of case studies. Therefore, with regard to the case studies, their "individually limited scientific contributions can be enhanced through systematic analysis of patterns across cases" (Larsson 1993, p. 1516).

Figure 1 illustrates the case survey method's stages and steps. This process model is based mostly on the work of Jurisch et al. (2013), which introduced a variant of the case survey method adapted for IS research purposes. The process begins with formulating a fitting research question, which needs to be grounded in theory (**Stage 1**). The research question may correspond to a theory based on concrete hypotheses, or it may also be of a rather exploratory nature. In any case, it should clearly outline the identified research gap.

Afterward, a suitable sample of case studies needs to be defined (**Stage 2**). The sampling process should be reliable and reproducible and rely on inclusion and rejection criteria (Jurisch et al. 2013). Depending on the research question, cases can be selected from both scholarly and practice-oriented sources (Larsson and Finkelstein 1999). Furthermore, the cases suitable for answering the considered research question may be found not only in IS but also in other domains. For example, the study by Henfridsson and Bygstad (2013) on digital infrastructure evolution included domains such as medicine or development studies since suitable cases on digital infrastructure could be found there as well. However, it is important to ensure that each case contains a sufficiently detailed narrative so it can be used later in coding. Different articles on the same case should be regarded as a single entity rather than several cases (Bullock 1986). On the other hand, one paper may also comprise several cases (Rivard and Lapointe 2012).

Having selected a case study sample, the researcher needs to convert the qualitative information contained in the cases into quantitative data. To this end, a coding scheme should be defined (**Stage 3**), which can either be based on concepts from extant literature or be completely open and adaptable to the grounded theory-based approach. However, in any case, the researcher should remain ready to create new codes when appropriate. To avoid biases, meta-information about the case study (such as information about authors or outlets) should also be coded (Jurisch et al. 2013). Generally, it is recommended to create a rather comprehensive coding scheme since single variables can also be excluded later, if necessary. Ideally, more than two people who are unfamiliar with the underlying research question should do the coding to avoid introducing biases (**Stage 4**). Involving multiple coders also enables the researcher to calculate the degree of inter-rater reliability and, therefore, ensure the coding's robustness, for example, by using Krippendorff's alpha (Krippendorff 2018). If inter-rater reliability does not exceed a certain threshold (for example, 0.8 in the case of Krippendorff's alpha), the coders can use the consensus approach to analyze discrepancies and reconcile disagreements (Larsson 1993).

Thereafter, the coded data can be used for further analysis (**Stage 5**). Commonly used techniques in case survey-based research are, for example, structural equation modeling (Jurisch et al. 2013), bivariate statistics (Bullock and Svyantek 1985), and multivariate statistics (Bullock and Tubbs 1990). In the case of statistical analysis, it is also important to assess construct validity (Larsson and Finkelstein 1999). According to the main argument of the present paper, it is also possible to employ QCA as an analysis technique (Henfridsson and Bygstad 2013; Rivard and Lapointe 2012). However, as we further explain in the section describing exemplary applications in IS research, this analytical option is still rarely used.

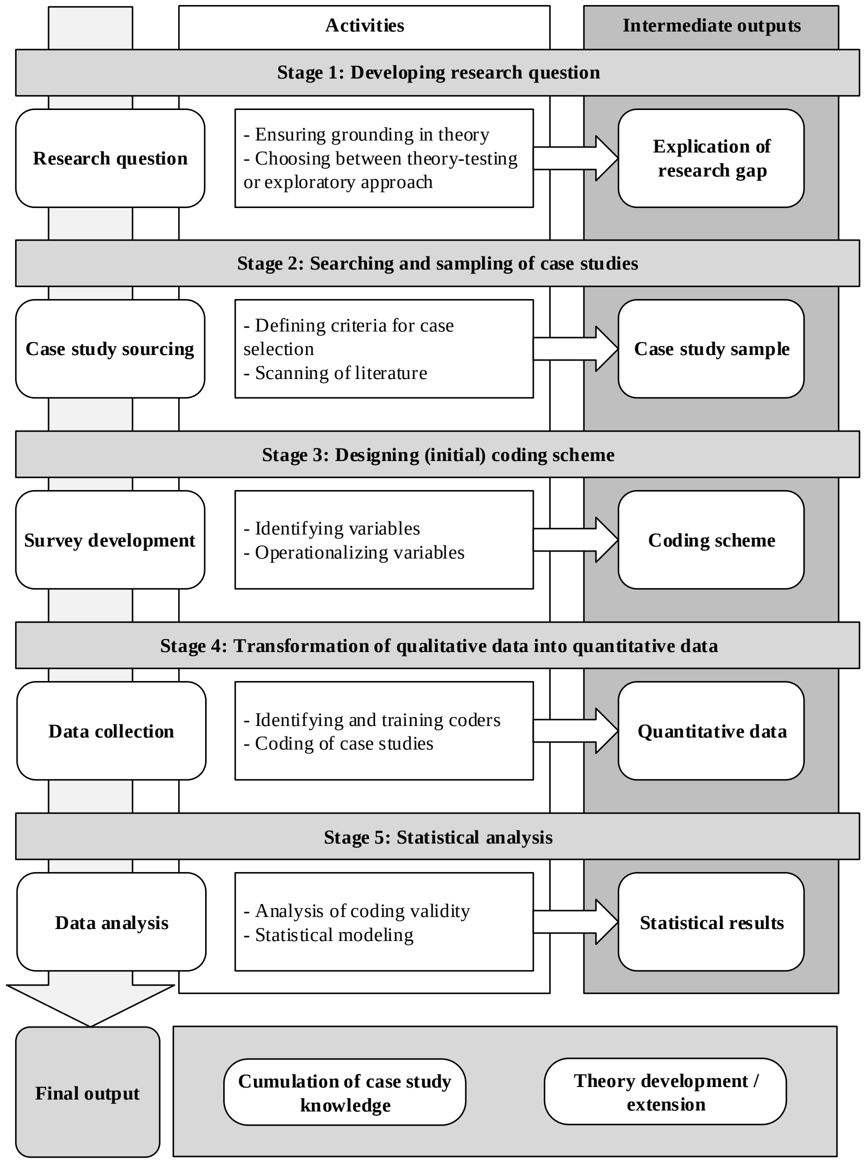

Figure 1. Stages and Steps of the Case Survey Method (adopted from Jurisch et al. (2013))

Qualitative Comparative Analysis

QCA represents a novel research paradigm, often described as a combination of qualitative and quantitative research methodologies. One of the most important properties that distinguish QCA from other research methodologies is the way it interconnects the predictor and outcome variables. Traditional, regression-based models (RBM) assume that a researcher can calculate each predictor's net effect on an outcome variable. Furthermore, RBMs assume that the relationship between predictors and outcomes is always symmetrical. This means that a predictor X needs to be both sufficient and necessary to obtain a certain outcome Y. QCA is novel in terms of assuming that, instead of net effects, it is possible to identify different combinations of predictor values that allow obtaining a required outcome. Furthermore, QCA facilitates considering asymmetrical relationships: while the presence of a predictor may lead to obtaining an outcome, its absence does not necessarily implicate the absence of the outcome. Moreover, it could possibly lead to obtaining an outcome when it is combined with certain other predictors. Therefore, predictors can be either sufficient or necessary or both to obtain an outcome. To represent this differentiating factor also in a verbal way, we note that predictors are usually called "conditions" in QCA-based research. This approach's advantages are as follows: QCA enables analyzing complex, cause-and-effect relationships that cannot be represented by means of traditional RBMs. Furthermore, it can be applied to qualitative data as well. Below, we describe the different steps of the QCA methodology and summarize them in Figure 2, similar to the description provided for the case survey method.

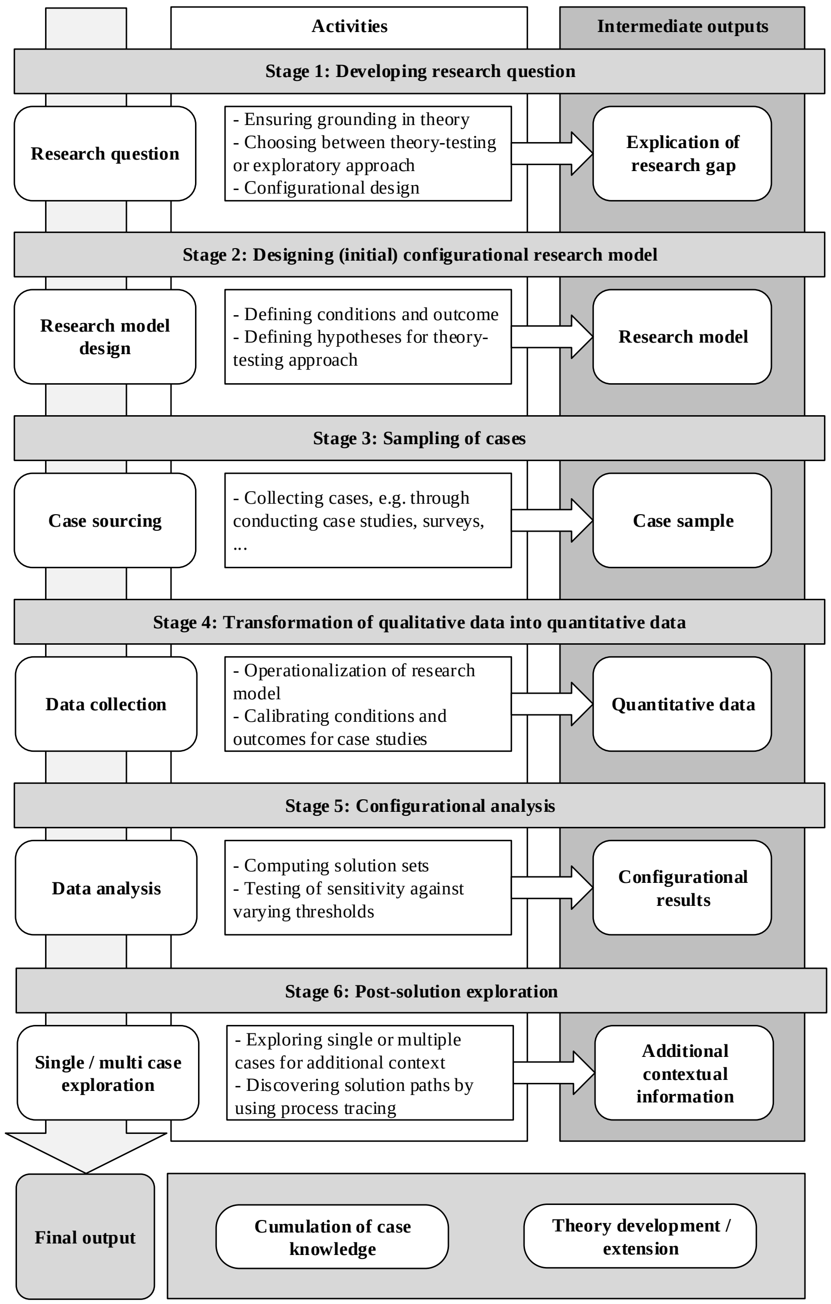

Figure 2. Stages and Steps of the QCA method

Just as in the case of the case survey method, the researcher first needs to formulate a fitting research question that may either be of theory-testing or exploratory nature (**Stage 1**). Then, the researcher has to construct a fitting configurational research model (**Stage 2**) (Greckhamer et al. 2018). Unlike the traditional, regression-based research methods, QCA can be based on various conditions that have an impact on a certain outcome. The number of conditions should be selected depending on the number of available cases. While it is often stated that QCA's advantage lies in its compatibility with small or medium datasets (namely, 12–50 cases), it can also be applied to larger data sets, with no limit on the maximum number of cases (Greckhamer et al. 2013). Since QCA derives combinations of conditions, the maximum number of possible combinations grows exponentially by adding new conditions to the research model. The cases themselves, however, might not provide the empirical data for each potential combination, leading to a problem known as limited diversity (Seawright 2014).

Researchers can use different types of data to perform QCA (**Stage 3**). For example, extant research works employ archival data (Stanko 2016), questionnaire-based surveys (Tan et al. 2016), and interview data (Iannacci and Cornford 2018). Moreover, the data relevant to cases can include datasets from different sources and correspond to various data types. At the next step, the researcher needs to assign a value for each dimension to each case, in other words, to perform calibration (**Stage 4**). The values that can be assigned depend on the selected variation of QCA. The crisp-set QCA allows setting only 0 or 1 as the possible values, while in the case of the fuzzy-set QCA, cases can be assigned any value between 0 and 1. In turn, multi-value QCA allows assigning arbitrary values. Calibration depends on the researcher's substantive and theoretical knowledge. Therefore, the rationale behind the assigned values should always be explained in depth along with providing replicable examples.

For analytical purposes, the researcher needs to define a truth table depicting all potential configurations (**Stage 5**). Each case is then assigned to a table row, along with the degree to which the particular case corresponds to its assigned row. Afterward, the table is reduced by using thresholds for the measures of frequency and consistency. Frequency is used to indicate how many cases are assigned to a single row. Therefore, the researcher can specify that only the truth table rows, with the minimum number of cases that empirically support them, are retained in the table. In turn, consistency indicates the degree to which the cases empirically support the given truth table row. Similar to frequency, the researcher can define the minimum consistency so that all rows that do not exceed this threshold will be deleted. Based on the selected thresholds, the truth table is then further reduced to different sets of solution formulas with regard to various degrees of complexity. It is recommended to use the so-called parsimonious solution with an intermediate degree of complexity. The solution set consists of formulas, namely, configurations of conditions leading to the required outcome. The researcher has different means of evaluating the quality of the resulting solution set. First, measures of consistency and coverage can be analyzed to assess how consistently the configurations lead to the outcome and to what extent they explain the observed variance in the outcome. Low values of these measures may indicate that the research model or the considered cases do not adequately match the defined research question. Furthermore, there are several techniques that can be used to test the solution sensitivity to adjusted thresholds of frequency, consistency, and calibration. If changes in these thresholds do not significantly alter the resulting solution sets, they can be regarded as sufficiently robust.

Stage 7 includes further exploration of the configurations after the actual analysis. Although this step is skipped by many QCA studies, it may provide additional valuable insights. For example, the researcher can use the insights from the configurations and explore the selected cases that fit these configurations to further explore the underlying causal mechanisms and estimate the extent to which they are influenced by certain contextual factors. Furthermore, additional research methods, such as process tracing, can be used to obtain a better understanding of which ways, and under which circumstances, certain configurations emerge.

Exemplary Combined Applications in IS Research

To find relevant applications of the case survey method combined with QCA, we conducted a literature review, focusing on renowned IS journals and conferences. We included journals from the AIS Scholar's Basket of Eight, as well as the ones that received at least "B" ranking according to the VHBJOURQUAL 3 ranking system. Additionally, we included the well-known IS conferences, such as ICIS, ECIS, PACIS, AMCIS, HICSS, and WI. Considering the case survey method was employed in the field of IS for a longer time period compared with QCA, we used the following search term: (*qca OR "qualitative comparative" OR "configurational analysis" OR "configurational approach"). This query resulted in yielding a set of 64 articles. However, as a result of the thorough inspection conducted by two authors, we found only three articles that implied combining the case survey and QCA. Two were published in the MIS Quarterly journal by Henfridsson and Bygstad (2013) and Rivard and Lapointe (2012) while the third one was presented at the WI conference by Ertl et al. (2020). Below, we present the results of analyzing the examples.

Henfridsson and Bygstad (2013) analyzed generative mechanisms of digital infrastructures, namely, the "causal powers that explain why such infrastructure evolves over time" (Henfridsson and Bygstad 2013, p. 907). To develop the configurational research model, the authors first conducted an in-depth case study which allowed them to derive distinct key mechanisms and contextual conditions. Afterwards, they collected data from 41 case studies from different outlets. These were coded using a crisp-set approach and then analyzed using QCA. To further explore these mechanisms, the authors then described several exemplary cases matching the identified configurations and thoroughly explained the influence of the contextual conditions that could be observed. Therefore, the authors could leverage the contextual and narrative richness of the cases while conducting a case survey with a rather large number of cases. Combining the case survey method and QCA was particularly helpful in terms of generating valuable insights since the in-depth case study represented one of the resulting configurations and the case survey revealed the possibility of using alternative configurations to achieve success under specific conditions.

Rivard and Lapointe (2012) focused on analyzing how IT implementers reacted to resistance during IT implementation and how users responded in turn. The authors developed an initial coding scheme based on literature and applied it to a set of 89 cases from diverse scholarly sources. During the coding process, additional codes were created. The authors then followed the iterative approach: after the first round of set-theoretic analysis based on selected conditions, they identified the further candidate conditions applicable to resolve contradictions encountered in the first round. After presenting the final results of the second round of analysis, the authors did not perform further analysis of selected cases but instead investigated extant literature to provide explanations for the identified causal mechanisms. However, we note that the combination of the case survey method and QCA proved to be useful in this study since the selected cases' comprehensiveness enabled the researchers to identify additional candidate conditions required for the analysis. If the authors had used, for example, the case survey method only, such detailed and context-rich analysis would likely have been impossible.

Ertl et al. (2020) investigated how dynamic capabilities helped to reduce socio-cognitive inertia in digital transformation (DT) projects. The authors collected data from 39 cases of DT projects. They built a coding scheme based on extant literature and applied it on the cases using a fuzzy-set QCA approach. The results show that certain dynamic capabilities were more crucial than others, in particular when combined. Extant research that was presented in this paper used questionnaire-based surveys and could only demonstrate the effect of each dynamic capability on its own. By using the case survey method and QCA, Ertl et al. (2020) were able to identify different pathways to success based on previously published case studies.

Potential of Combining the Case Survey Method and QCA

Having introduced the case survey method and QCA along with exemplary applications, we can now describe the proposed approach that implies combining these two methodologies. This approach is summarized and illustrated in Figure 3. The first two stages are the same as in the QCA approach: first, a research question needs to be formulated and, on this basis, a preliminary configurational research model is designed. The next two steps are adopted and extended from the process model of the case survey method: instead of collecting the data corresponding to any type of case, the proposed approach suggests focusing on collecting case studies from the related literature to construct a case study sample. Since QCA can be used with any kind of source, it is possible to further specify this step, in our case with cases from extant literature. Afterward, an initial coding scheme is developed based on the configurational research model. At this step, the variables are operationalized, and the researcher defines how they should be measured based on extant literature and theory. First, the measurement can be realized using Likert scales, similar to the traditional case survey method process, which are then translated to fuzzy values by defining thresholds for set memberships. Secondly, researchers may also use a set theory-driven approach by employing qualitatively interpretative guidelines, such as the generic membership evaluation template introduced by Tóth et al. (2017), or the theoretical ideal approach presented by Basurto and Speer (2012).

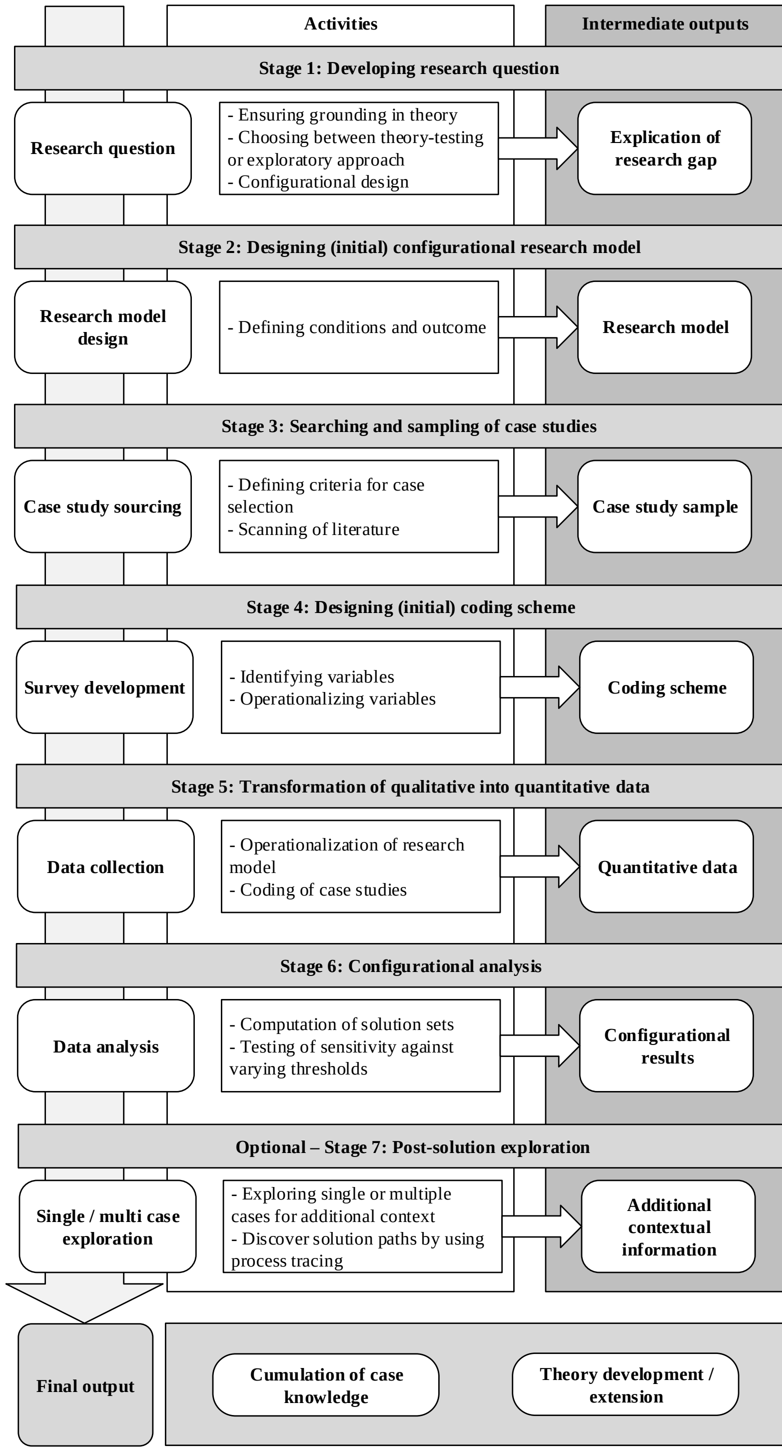

Figure 3. Stages and steps of the proposed methodology combining case survey and QCA

Both approaches are equally valid in QCA. Nevertheless, the transformation step should be executed by at least two experienced coders so that inter-rater reliability can be calculated accordingly. Then, the resulting quantitative data is analyzed by selecting one flavor of QCA, depending on the approach used to define the set membership. Afterward, the researcher can conduct a post-solution exploration by reconsidering the cases identified in the case study sourcing step. The proposed approach enables several possible applications to IS research and allows overcoming particular limitations intrinsic to the two methods when applied on their own. Below, we describe and discuss these potential applications and limitations.

Possibility to Use Small Sample Sizes

The case survey method is usually combined with traditional statistical analysis. A limitation of this approach is that a considerably large sample is required to deduce relevant insights. However, sufficient data may not always be readily available. First, this may occur when researchers are investigating relatively novel phenomena, such as DT strategies or blockchain implementation projects, and only a limited number of case studies have been published on this subject. Second, this issue may also arise for the case subjects in which the total population is relatively small, such as countries within a specific region. However, in the case of combining the case survey method with QCA, this issue becomes irrelevant since QCA is applicable to small-sized case samples, depending on the number of conditions. The study by Iannacci and Cornford (2018), for example, makes a relevant theoretical contribution by applying QCA on a sample of merely seven cases.

Contextual Richness

A central limitation and critique of the case survey method are related to its way of simplifying case studies by assigning numbers to qualitative, contextually rich data. Although iteratively designing a comprehensive coding scheme that considers a multitude of factors is recommended, the nature of statistical analysis allows using only a limited number of predictor variables if a researcher wants to obtain reliable results. The number of potential predictors or conditions does not vary significantly in the case of employing QCA due to the aforementioned limited diversity problem. Furthermore, the proposed approach is based on a transformation of qualitative data to quantitative data. However, we consider that the two aspects of the proposed model would enable researchers to make use of context comprehensiveness. However, QCA's configurational nature is particularly sensitive to context: the presence of a contextual variable may change resulting configurations drastically. Therefore, the importance of including contextual variables has been highlighted multiple times in the methodological literature (Denk and Lehtinen 2013; Schneider 2019). Furthermore, stage 7 of the proposed method, denoted as post-solution exploration, allows researchers to revisit the selected cases and, therefore, use the information to obtain additional insights into the mechanisms of how certain configurations emerge. These causal mechanisms are difficult to explore when applying the case survey method using traditional statistical analysis.

Covering and Showcasing Diverse Pathways

Traditional statistical analysis is sensitive to outliers. When analyzing a rather small sample size, a single outlier may have a large impact on a regression line which could drastically change the results in particular cases (see, for example, Berg-Schlosser and Quenter (1996)). QCA is more robust in this regard since it is based on set theory, identifying subsets of the considered data (Liu et al. 2015). Therefore, the cases that would be regarded as outliers in regression analysis merely lead to one or more new configurations, with little or no impact on other configurations. This allows ensuring theoretically relevant cases, which may not be represented by a high amount of cases, are considered and included in the solution set.

Limitations of the Proposed Approach

While combining the two considered research methods allows mitigating several intrinsic limitations, others may still be in place and new ones may arise as well. In particular, we note that case studies are typically written with different purposes and research problems in mind, which may cause difficulty comparing them. The extent of information comprehensiveness that is expected and that is actually provided by a particular case may vary considerably among different cases. Therefore, it is important to define adequate inclusion and exclusion criteria, aiming to ensure that all cases included in the case survey provide sufficient information for researchers. In addition, selection bias among the compared studies constitutes another potential limitation: successful cases are likely to be published more frequently than failure ones (Kepes et al. 2018). According to Jurisch et al. (2013), this makes generalization more difficult to establish since the considered cases may not cover an adequate part of the total population. Specifically, in QCA research, this issue further limits generalizability since it is usually recommended for analyzing both the outcome and negation of the outcome (namely, success and failure). However, when only a limited number of unsuccessful cases are available for analysis, insufficient relevant information may be available to deduce configurational solutions. Furthermore, the problem of limited diversity in QCA remains, possibly even when using large sample sizes. Limited diversity is encountered if the cases within the sample in question do not adequately represent the set of possible configurations based on the selected conditions. Even for large samples, there may be several cases assigned to the same truth table rows, leaving other table rows empty. Considering that limited diversity is a well-known problem related to QCA-based research, there are several guidelines and strategies on how to mitigate this issue. Finally, the approach presented in this paper has not been validated so far. The authors plan on conducting workshops and qualitative interviews to test its applicability.

Conclusion

The present article's aim was to introduce a formalized approach for combining the case survey methodology and QCA, as well as to discuss its potential for IS-related research purposes. To this end, we briefly introduced both research methods, discussed articles that combine them, and presented a formalized framework aimed to facilitate their joint usage. Our framework contributes to methodological literature and IS research by allowing scholar to combine the best of both worlds. When it is not feasible to conduct new case studies due to limited resources or the newness of the phenomenon under investigation, our approach allows to draw on already published research while still taking contextual richness into account. Recent developments provide plenty of exemplary phenomena where our proposed approach may be useful: first, research on DT projects may benefit. Conducting a sufficiently large set of case studies on DT may not be feasible for most researchers. However, several high-quality case studies have already been published and may thus be used with our approach (Sebastian et al. 2017). Additionally, the success of DT projects is highly dependent on context: strategies that work for large multinational companies may not be applicable to smaller, family-owned businesses. The currently ongoing COVID-19 crisis provides another example that extends even beyond the IS context. There are various case studies on the effects of COVID-19 on organizations, human behavior, and learning practices (Guo and Li 2020; Li et al. 2020). All of them involve different interconnected factors while their relationships may not be clear at this point. In both examples, case survey combined with QCA allows to draw on extant research while taking context into account and embracing the complexity of these phenomenon. We therefore encourage researchers to explore these and similar phenomenon using our proposed approach to strengthen both theoretical and practical contributions in IS.

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Appendix B. On the Use of Qualitative Comparative Analysis in Information Systems Research - A Critical Review (P2)

ON THE USE OF QUALITATIVE COMPARATIVE ANALYSIS IN INFORMATION SYSTEMS RESEARCH – A CRITICAL REVIEW

Research paper

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Abstract

Qualitative Comparative Analysis (QCA) has increasingly become popular in Information Systems (IS) research. However, there are several pitfalls and bad practices when applying QCA. Therefore, we aim at providing an extensive overview of (1) how QCA has been applied so far in IS research and (2) how future QCA-based IS research can be improved. To do so, we review articles from IS journals and conferences using an extensive coding scheme based on methodological literature and QCA reviews from other research disciplines. First, our results show standards of reporting and justification, well established in other disciplines, are often not fulfilled. Second, we find that extant research is predominantly based on large-N analyses, which limits some of the key capabilities of QCA. Third, we show that necessity analysis is under- and sometimes even misused. Lastly, extant research suffers from low solution coverage values that are not adequately discussed and sensitivity analyses that are not employed frequently. Our findings represent the current state of QCA in IS research and highlight the potential for improvement in future QCA studies.

Keywords: Qualitative comparative analysis, set-theoretic research, critical literature review.

1 Introduction

Scientific methods shape our way of thinking and the way we conduct research. Qualitative Comparative Analysis (QCA) has emerged as a novel paradigm, located between qualitative and quantitative approaches (Ragin, 2009). As a research methodology, it has three distinct features. First, it allows for conjunctural causation in the form of configurations. This means that it is assumed that the combination of distinct factors accounts for the occurrence of a specific outcome, unlike traditional regression-based models (RBMs) where the net effect of each factor on the outcome in question is analyzed (Fiss, Sharapov, and Cronqvist, 2013). Second, QCA embraces the concept of equifinality, i.e., a variety of different configurations can lead to the same outcome (Berg-Schlosser et al., 2009). Third, it is assumed that relationships between factors and outcomes are not necessarily symmetrical (Woodside, 2013). This means that a factor X may be a sufficient or a necessary condition for an outcome Y, while traditional RBMs assume that X is both a sufficient and necessary condition (Y. Liu et al., 2015).

QCA was first introduced by Ragin (1987) in his book “The Comparative Method” and has since been developed further by Ragin himself (see, e.g., Ragin (2000) or Ragin (2008)) as well as other scholars, mostly from the field of sociology. Through its distinct features, QCA has been gaining popularity in diverse fields such as public policy analysis (Rihoux, Rezsöhazy, and Bol, 2011), spatial planning research (Verweij and Trell, 2019), and business and management research (Wagemann, Buche, and Siewert, 2016). Over the past ten years, QCA has also been gaining traction in Information Systems (IS) research. As a research approach, it is particularly useful for our discipline since it can help to capture the inherent complexity of, for example, digital ecosystem dynamics and strategies (El Sawy et al., 2010) or behavioral research by allowing for equifinality and asymmetry (Y. Liu et al., 2015). So far, scholars have used QCA to shed light on diverse topics such as digital innovation governance (Leonhardt et al., 2018), mechanisms for digital infrastructure evolution (Henfridsson and Bygstad, 2013), or remixing in online innovation communities (Stanko, 2016).

From its inception, QCA has faced criticism from different groups of scholars (Goldthorpe, 1997; Tanner, 2014). Qualitative researchers are discouraged by the formal mechanisms and rather strict guidelines to be followed when applying the method. Quantitative scholars have noted the differences between traditional RBM-based approaches, such as the absence of standardized tests for significance (Wagemann et al., 2016). Addressing these critiques is important: QCA is no silver bullet and should be seen as a supplemental research approach that is suitable under certain circumstances. It does not replace nor eliminate the value of traditional RBM-based approaches nor those of qualitative research designs but allows for new types of insights through its distinctive features (Y. Liu et al., 2015). While different sets of good practices and pitfalls to avoid are already well-established in other disciplines, these may not as well-known in IS research as in other disciplines such as IS. QCA has emerged rather recently in IS research but has already been employed in several papers in high-quality outlets. In this paper, we conduct a critical review of the IS literature to see how QCA has been employed so far and how its application in our discipline can be improved.

As a result, the research questions that guide our literature review are as follows:

RQ1: *How is QCA used in IS research?*

RQ2: *How can future applications of QCA in IS research be enhanced?*

To the best of the authors' knowledge, there are, so far, no comprehensive reviews of the application of QCA in IS research. However, aside from empirical articles, several calls for research, as well as methodological contributions, have been published. While some of these articles use empirical data along with a QCA analysis (Y. Liu et al., 2015), the main contribution of these articles is the demonstration of the QCA methodology and its usefulness for IS research (see, for example, El Sawy et al. (2010); Lasrado, Vatrapu, and Andersen (2016); Y. Liu et al. (2015); Wendler, Bukvova, and Leupold (2013). There are both descriptive and critical literature reviews on the use of QCA in other disciplines (see e.g., Jordan et al. (2011); Verweij and Trell (2019); Wagemann et al. (2016)). We used these articles to gather inspiration for our approach and the coding scheme.

2 The QCA Methodology

Due to space limitations, we will not explain the QCA methodology in detail but rather, provide a broad overview along with the steps of analysis. For a detailed tutorial of the QCA methodology, we refer to the excellent handbooks written by Rihoux and Ragin (2009) and Schneider and Wagemann (2012).

At the beginning of a QCA study, a sound configurational research model needs to be built (Greckhamer et al., 2018). In QCA, combinations of **conditions** influence a certain **outcome**. Thus, QCA studies should also outline the configurational rationale behind the research model and explain why QCA is an appropriate methodology for answering the research question (Rihoux and Ragin, 2009). The research model should comprise a moderate number of conditions, depending on the number of cases. While there is no formal minimum or maximum limit for the number of conditions, the sample size should be used as a reference. A higher number of conditions increase the number of potential configurations, which leads to the problem of **limited diversity**, i.e., configurations with no empirical cases in the dataset. As Marx and Dusa (2011) show, a low ratio of conditions to cases can lead to seemingly sound results even with completely random data.

QCA can be used with small to medium-sized samples (n = 12 to 50) as well as with larger samples with virtually no upper limit (Cooper and Glaesser, 2016; Greckhamer, Misangyi, and Fiss, 2013). For all **sample sizes**, cases should be selected purposively based on the outcome under investigation. Thus, samples should be theoretically defined (Rihoux and Ragin, 2009). This means that for small samples, cases should either constitute or be representative of the entire population, or be comprised of a combination of both positive and negative cases (Greckhamer et al., 2018). For large samples, cases should either represent the entire population or a stratified sample. In particular, a random sample may not be useful since it may not include relevant, rare configurations (Greckhamer et al., 2018).

Diverse kinds of data can be used to perform QCA, such as questionnaires (Park, El Sawy, and Fiss, 2017), archival data (Dawson, Denford, and Desouza, 2016), or qualitative interviews (Iannacci and Cornford, 2018). To assign values to the dimensions for each case, data from the used sources need to be calibrated. **Calibration** depends on the chosen flavor of QCA: for crisp-set QCA (**csQCA**), only values of 0 and 1 are allowed. Fuzzy-set QCA (**fsQCA**) supports values on a continuum from 0 to 1. Multi-value QCA (**mvQCA**) allows for arbitrary values. Since there are no fixed rules for calibration, the researcher needs to base their decision on substantive theoretical grounds and explain the reasoning behind their calibration.

After calibrating the data, the researcher proceeds to the analysis. For this, a **truth table** is constructed which contains all possible configurations, thus, the table contains 2^k rows where k denotes the number of conditions included in the research model. Afterward, for each row, the degree to which a given case supports it can be calculated. The truth table can then be further reduced by specifying thresholds for **frequency** and **consistency**. The frequency threshold specifies the minimum number of cases that are needed to support a given truth table row. Rows that are supported by fewer cases are then dropped from the table. Consistency refers to how consistently a given row is a sufficient condition for the outcome under investigation, thus, the consistency threshold indicates a minimum consistency that needs to be reached to keep a given row in the truth table. Thresholds for frequency and consistency should be chosen carefully. The frequency threshold should depend on the number of cases in a given dataset: for small to medium-sized samples, a threshold of one is sufficient, while for larger samples, a threshold of at least two should be used. Consistency thresholds should be selected independently of the sample size and should be, according to a well-established recommendation, at least above 0.75 (Rihoux and Ragin, 2009). Based on the reduced truth table, the resulting configurations can be obtained. To ensure replicability, researchers should provide the truth table or even the complete **raw data matrix** (Schneider and Wagemann, 2010). It is recommended to analyze both the presence and the absence of an outcome separately. Since QCA assumes potential asymmetry between conditions and outcomes, the presence of an outcome may be caused by different configurations rather than its absence (Greckhamer et al., 2018; Schneider and Wagemann, 2010). The truth table can then be reduced to three different types of solutions (**complex**, **intermediate**, and **parsimonious**), depending on how **logical remainders** in the truth table were handled by the researcher.

There are different ways to report the results and steps of a QCA. Over the years, different visualizations such as XY plots (Schneider and Wagemann, 2010), configuration charts (Fiss, 2011), or simple Boolean formulas (Schneider and Wagemann, 2010) have emerged. Each of them can be used to highlight different aspects of a study (Rubinson, 2019; Schneider and Grofman, 2006). Configuration charts, for example, are especially well-suited to highlight different **core** and **peripheral conditions** (Fiss, 2011) while XY plots can be used to visualize the consistency of sufficient conditions in fsQCA applications (Schneider and Grofman, 2006). When interpreting the results, it is recommended to use the case data to explain the results and also build theory by conducting further analyses on a case level. For small-N studies, additional case data is readily available for most cases (for example, see Iannacci and Cornford (2018)) and also for large-N analyses, there are guidelines on how to select cases for complementing the preceding QCA (Dwivedi, Joshi, and Misangyi, 2018; Greckhamer et al., 2018).

After having identified the solution sets, there are different ways to measure their quality. First, the solution as a whole, as well as each configuration that is part of a solution, can be assessed regarding its **coverage**. This refers to the "proportion of the sum of the membership values of supporting cases for a combination" and is comparable to the R^2 measure in regression-based methods. Thus, coverage explains the proportion of cases for a certain outcome that is "covered" by a certain solution set or configuration. A low solution coverage value may indicate that the chosen research model does not contribute much to explaining the presence or absence of the outcome (Ragin, 2009). Second, there are several ways to test the results for **sensitivity** by adjusting the thresholds for frequency, consistency, and, in the case of fsQCA, calibration. While these changes might result in slightly different values for solution consistency and coverage, they should not significantly alter the resulting configurations (Cooper and Glaesser, 2016; Skaaning, 2011).

3 Methodology

We carried out a critical review of IS studies applying QCA (Paré et al., 2015). As outlined by Paré et al. (2015, p. 189), this type of review aims to "critically analyze the extant literature on a broad topic to reveal weaknesses, contradictions, controversies, or inconsistencies" and thus "can constructively inform other scholars and strengthen knowledge development". As outlets, we included all journals from the AIS Scholar's Basket of Eight as well as journals ranked as B according to VHBJOURQUAL 3. Furthermore, we included articles from well-known IS conferences. In the end, our set of outlets consisted of 6 conferences and 36 journals in total. Afterward, we used the Scopus online database to compile a set of all articles in our selected outlets that apply QCA either as the main or supplemental research method. Table 1 shows the search terms that we used to search in journals and conferences. Since conferences usually have a higher yearly output of articles than journals, we used more restrictive search terms. We iteratively refined our search terms. Our first search term did not include the keywords "configurational" (for journals) nor "configurational analysis" and "configurational approach" (conference) nor "set-theoretic" (journals and conferences). However, we added these keywords after several rounds of literature search since several articles known by the authors beforehand could not be found using the initial search term. This is because these articles, although they apply QCA, do not explicitly mention the methodology in their titles nor their abstracts but rather, use descriptive terms such as "a configurational perspective" (Henfridsson and Bygstad, 2013, p. 907) or "a set-theoretical approach" (Bui, Leo, and Adelakun, 2019b, p. 330). Furthermore, we used the online database COMPASS which contains a large collection of QCA studies of different fields to identify any other relevant QCA studies we might have overlooked (see http://compasss.org). After the last round of article search with the modified search term, we examined all the articles and included all the articles that apply QCA either as its main or supplemental methodology. We rejected articles for further review if they apply QCA to mainly demonstrate its usefulness in IS research (for example Y. Liu et al. (2015)) or if they constitute a methodological contribution to QCA (for example Lasrado et al. (2016)). We included work-in-progress papers only if they presented at least preliminary results using QCA. We then conducted a forward and backward search following Webster and Watson (2002) to identify more articles that we have not found during our main search due to the restrictiveness of our search terms. For each of the articles during this step, we applied the already mentioned criteria to determine its relevance. Having completed a forward and backward search, we were left with a final set of 64 articles. The search process started in August 2019. After we started the process, we optimized our selection criteria and search queries a few times and this search and elimination process was completed in November 2019. The relevant outlets and their number of articles are summarized in Table 1. All articles that were part of our review can be found in the bibliography and are marked with an asterisk in the reference list ("*").

As a next step, two of the authors systematically coded the articles using a pre-defined coding scheme. We derived the codes from existing reviews of QCA research in other disciplines (see e.g., Roig-Tierno, Gonzalez-Cruz, and Llopis-Martinez (2017); Verweij and Trell (2019); Emmenegger, Kvist, and Skaaning (2013); Seny Kan et al. (2016); Rihoux et al. (2013)) and from methodological literature on QCA.

	Outlet	***Search***	***Relevant Articles***
Journals	The Journal of Strategic Information Systems (JSIS)	**qca OR "qualitative comparative" OR "configurational"* in Title | Abstract | Keywords	3
	MIS Quarterly (MISQ)		3
	Information Systems Research (ISR)		1
	Journal of the Association of Information Systems (JAIS)		1
	Journal of Information Technology (JIT)		1
	Information Systems Journal (ISJ)		1
	Journal of Management Information Systems (JMIS)		1
	Decision Support Systems (DSS)		1
	Information & Management (I&M)		1
	Decision Sciences (DS)		2
	IEEE Transactions on Engineering Management (IEEE-TEM)		1
Conferences	International Conference on Information Systems (ICIS)	**qca OR "qualitative comparative" OR "configurational analysis" OR "configurational approach"* in Full Text	7
	European Conference on Information Systems (ECIS)		10
	Pacific Asia Conference on Information Systems (PACIS)		2
	International Conference on Wirtschaftsinformatik (WI)		2
	Hawaii International Conference on System Sciences (HICSS)		14
	Americas Conference on Information Systems (AMCIS)		13
Total			**64**

Table 1. Summary of the articles identified for analysis

A table of the coding scheme including more information on the involved aspects can be found in the appendix (see Table 3). We compiled a descriptive overview of all articles to provide a “bird’s eye view” of QCA research and thus answer our first research question. This comprised dimensions such as the number of cases and conditions or the variety of data sources used. To answer our second research question, we conducted an in-depth methodological analysis on 33 of our selected papers, which were published in the AIS Basket of Eight, journals classified as B according to VHBJOURQUAL 3, and ICIS and ECIS. Since these outlets are usually considered the top outlets in the field of IS, we assume that articles published in these outlets should follow most of the good practices of a certain methodology. The elements we measured by in-depth analysis are indicated with a boldface text in the coding scheme. We compiled our set of good practices based on the methodological groundwork of Schneider and Wagemann (2010) and Greckhamer et al. (2018). We then analyzed whether our selected articles follow these practices and identified patterns of bad practice and potential for future applications. As we will discuss in the next section, a large portion of QCA articles have been written by a small set of authors. In identifying good and bad practices, we made sure that these do not apply exclusively to this small set of articles but can be found in articles by other authors as well. This way, we avoided that a few authors set the tone for QCA applications in IS research. It should be noted that, due to limited space, we only present and discuss categories from the coding scheme that we deemed particularly interesting for our analysis. For reasons of transparency, we still included the complete coding scheme in the appendix.

4 Results and discussion

4.1 A bird's eye view of QCA in IS research

Prevalence in the field of IS. QCA has become a mainstream methodology in some fields but is still considered an emerging method in the field of IS. This becomes more obvious as we consider the publication years of the articles we have explored. Especially in recent years, we can observe a significant increase in the method's popularity (see Figure 1). The first appearance of QCA in the sources reviewed was in 2009, much later than its inception by Ragin in 1987. Considering that we searched in 42 outlets, the number of articles is very small, especially in journals. Most of the outlets did not even provide any QCA articles, while others had just a few compared to their total article tally.

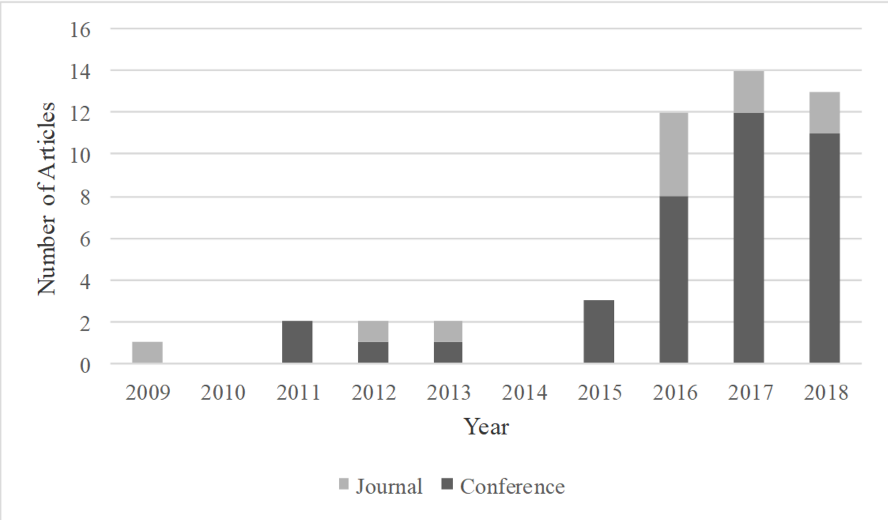

Figure 1. Number of QCA-based articles in examined outlets by year

Further interesting observations are made when looking at the authors who write QCA articles. The majority (74 %) of the 112 individual authors in our sample have written only one QCA article, either as first author or co-author. Among the 29 authors who have published more than one article, it should be noted that a large part of the article sample is written by these authors. More specifically, the four authors who published the most articles are responsible for 25 % of all the QCA articles. One first author (Illias Pappas) is even responsible for 8 % of the articles. This shows that QCA is extensively used by a small group of researchers. A list of authors with a lot of QCA articles can be found in the appendix (see Table 4). Among closer inspection, we were unable to find any good or bad practices that apply exclusively to the works of these authors.

Study design. Based on the classification of units of analysis by Rihoux et al. (2011), 67 % of our articles are on the meso level and focusing mostly on organizations and projects (Koo et al., 2019; Tuo, Feng, and Sarpong, 2019; Wiedemann, Weeger, and Gewald, 2015). 30 % of the articles conducted their analyses on a micro level, which means that they focused on individuals or small groups and topics such as social media avoidance, intention to download mobile applications (Mattke, Müller, and Maier, 2018; Pappas, Mikalef, Kourouthanassis, et al., 2017). Lastly, the remaining 3 % are macro-level articles that base their analysis on, for example, entire countries (Iannacci and Cornford, 2018). Another aspect to take into consideration is the data source. Applying QCA on questionnaire-based survey data is the leading approach adopted by more than 77 % of the articles. Archival data is the second most common at 14 % (e.g., Duarte and Picoto (2016)) and further data sources are not popular. Two articles used case surveys (Henfridsson and Bygstad, 2013; Rivard and Lapointe, 2012) and only 11 % collected data through observation or interviews (Beerepoot et al., 2019; Islam, Buxmann, and Ding, 2017; H. Wang and Doong, 2017). fsQCA and csQCA have been adopted by the majority of the studies (70 % and 25 % each and 3 % used both methods). There is only one instance of mvQCA (H.-Y. Liu, Subramanian, and Hang, 2019). Additionally, the QCA approach was used as the only method in 88 % of the articles, whereas the rest used QCA in conjunction with other methods, such as structural equation modeling (Nikou, Brännback, and Widén, 2019; Pappas and Papavlasopoulou, 2019).

Research model design. The number of cases and conditions varied over a wide range. As for the number of cases, Poon et al. (2011) had the lowest number by restricting the analysis to only five case studies, while Hajek and Stejskal (2017) focused on a data set of 2183 companies, the highest number among our examined articles. The number of conditions varied from three conditions (Beerepoot et al., 2019; Levallet and Chan, 2015, 2016) to a maximum of 13 conditions (Hajek and Stejskal, 2017). The ratio of cases to conditions may cause problems if the number of conditions is too high and the number of cases is too low. A high number of conditions yield a large truth table with lots of potential configurations. If only a few cases were used, this leads to a high number of logical remainders. While it may be easy to handle logical remainders that are, for example, theoretically impossible, it is advised to not exceed a certain ratio of cases to conditions. Otherwise, there may be too many logical remainders to be analyzed. Building on the work of Rihoux et al. (2013), we categorized articles having more than 20 cases as "many cases" and articles with fewer than or equal to 20 cases as "few cases". Similarly, articles with more than four conditions were classified as "many conditions"; others are labeled as "few conditions". Since our results did not differ as we considered each truth table analysis separately, we only show the statistics of one truth table analysis from each article. We also excluded articles that did not provide information about the number of cases. As illustrated in Table 2, there is only one instance of bad practice concerning the ratio of cases and conditions (Bardaki et al., 2013). Since the referred study has seven conditions, the truth table has 128 rows. Yet the study only has eight cases and therefore we might assume that there are 120 empty rows at best. Nevertheless, by comparing these results to the results from Verweij and Trell (2019), which employs the same approach in the field of spatial planning research and related disciplines (SPARD), we can see that the situation in IS research is much better since our study only has only 2 % instances of bad practices compared to SPARD's 21 % instances of bad practices.

		Conditions		
		Few (≤ 4)	Many (> 4)	Total
Cases	Few (≤ 20)	1 application (2%)	**1 application (2%)**	2 applications (4%)
	Many (> 20)	8 applications (14%)	47 applications (82%)	55 applications (96%)
	Total	9 applications (16%)	48 applications (84%)	57 applications (100%)

Table 2. Comparison of the ratio of cases and conditions

Solution computation and illustration. Regarding the software that is used to compute the solutions, the most popular application is the fs/QCA software (Ragin and Davey, 2016). It is utilized in 61 % of the studies, while R (Duşa, 2019) was only used in 5 %. Although, it is important to note that a considerable number of articles (31 %) did not provide the information about the applied software in their full texts. In terms of solution types that the software produces, Schneider and Wagemann (2010) state that the process of dealing with logical remainders should be explained well. In our articles, 70 % adhered to this good practice and, as for the rest, it is unclear how the researchers handled the phenomenon of limited diversity. Among the articles containing this information, the most common solution type is the intermediate solution at 93 %. Regarding visualization types, we adopted the classification of Rubinson (2019). Among the visualization types like XY plots, Venn diagrams, Fiss table charts, Tosmana diagrams, etc., the most common type is the Fiss chart, introduced by Ragin and Fiss (2008). The authors of almost 81 % of the articles chose to visualize their results with a Fiss chart. Also, some authors chose to use more than one visualization type. For instance, Iannacci and Cornford (2018) used Fiss charts and truth tables, as well as a Boolean formula, to visualize their QCA results.

4.2 Critical issues in QCA applications in IS research

4.2.1 Reporting and transparency

To provide transparency and ensure reproducibility, any study should provide details about the underlying data set and decisions that were made when conducting an analysis (National Academies of Sciences and Medicine, 2019). For QCA studies, this can be achieved by publishing the raw data matrix and the truth table before minimization and providing the cut-off values that were used for setting thresholds for consistency and frequency (Schneider and Wagemann, 2010). Most of the studies nicely describe the process of collecting and calibrating data and building and minimizing truth tables to derive sufficient configurations and sometimes also necessary conditions. However, a striking 67 % of articles in our data set do not provide the raw data matrix nor the truth table. While this understandable for conference papers due to the abbreviated format, journals usually provide plenty of space to include these data in the appendix. However, our review shows that even some journal articles with an appendix provide neither the data matrix underlying their analyses nor the truth table, as can be seen in the case of Stanko (2016) and Bui et al. (2019b). Two examples of good practice can be found in the studies by Fedorowicz, Sawyer, and Tomasino (2018) and Iannacci and Cornford (2018). Iannacci and Cornford (2018) used a relatively small sample of just seven cases and provided both the raw data matrix as well as the minimized truth table, along with a detailed explanation and justification of the coding protocol, including examples for selected fuzzy values. This also applies to Fedorowicz et al. (2018) who included the truth table in the appendix as well as detailed explanations of how fuzzy score values were computed.

Most of our analyzed articles disclose the applied thresholds for consistency and frequency and their reasoning for justifying these decisions (for notable exceptions, see Dawson et al. (2017); Dawson et al. (2016)). These articles refer predominantly to the thresholds established by Ragin (2008) and Schneider and Wagemann (2010). While we applaud the fact that authors make their decisions transparent and refer to well-known methodological groundwork, the authors of that groundwork also note that their recommendations are “rather guidelines”, which “should not be implemented mechanically” (Wagemann et al., 2016, p. 5). Schneider and Wagemann (2010, p. 10) explicitly note that “rather than justifying thresholds by referring to alleged conventions, thresholds must be explicitly justified.” Otherwise, these established thresholds risk reaching a “doctrine-like status” which negatively affects the researcher’s ability to correctly estimate effects, similar to the ongoing discussions on the arbitrariness of significance levels in regression analyses (Gerber and Malhotra, 2008; Schneider and Wagemann, 2010, p. 10). One such practice that goes beyond just referring to established thresholds is to look at gaps between resulting consistency scores (Wagemann et al., 2016). However, we acknowledge that existing methodological work on QCA provides little guidance on how to choose thresholds and since even journal articles mostly only refer to other authors, aspiring QCA researchers have few resources to look at.

4.2.2 Predominance of large-N studies

Large-N (50+) analyses based on questionnaires are by far the predominant type of QCA studies in IS research. This leads us to two potential problems. First, a lot of articles with large samples make use of random samples (see e.g., Tan, Benbasat, and Cenfetelli (2016) or Leonhardt et al. (2018). However, this practice is problematic for two reasons, as explained by Greckhamer et al. (2018) and Greckhamer et al. (2013). On the one hand, while it is common to generalize based on random samples in traditional regression analysis, this practice makes use of properties such as central tendency, variability, and sampling distributions and their shapes. Since these properties do not apply to any of the QCA variants, researchers may only safely generalize from their findings if they are confident that their random sample is representative of the entire population. Second, random samples are inappropriate for analyzing diversity among cases since a random sample is likely to represent only limited diversity. Thus, theoretically relevant, but rare configurations are likely not included in a random sample. Regression analyses typically treat these rare configurations as outliers, while QCA, as described before, usually includes them in the results if they pass the chosen thresholds for consistency and frequency. Researchers who are interested in generalizing from their results of adequately representing the diversity of cases should, therefore, opt for analyzing the entire population of cases (see Stanko (2016) or a representative sample that reflects the diversity of the population (see Nikou et al. (2019)) (Greckhamer et al., 2018).

Furthermore, while the appropriateness and usefulness of QCA for large-N studies have been widely acknowledged by different scholars (Cooper and Glaesser, 2016; Emmenegger, Schraff, and Walter, 2014; Greckhamer et al., 2013), QCA loses one of its key strengths through the application on large datasets: its orientation on in-depth case knowledge (Emmenegger et al., 2014). Fewer cases, and thus, intimate knowledge provides four main advantages. First, this knowledge reduces the risk of ex-ante measurement errors (Schneider and Wagemann, 2012). Second, the issue of limited diversity may be approached by using in-depth case knowledge when performing counterfactual reasoning (Thomann and Maggetti, 2017). Third, a small-N approach is highly suitable for "exploring underresearched or undertheorized phenomena, illuminating causal mechanisms, suggesting alternative theoretical explanations, and extending or refining existing knowledge" (Thomann and Maggetti, 2017, p. 19). Lastly, small-N approaches allow for using in-depth knowledge after the initial analysis. For example, it may be used after the actual QCA for interpreting single configurations by illustrating examples from the cases (see Iannacci and Cornford (2018) for an example using the process tracing technique). Furthermore, it may constitute the basis for an iterative approach involving more or different conditions, drawing on complementary data available from the cases (Ragin, 2009). This data may not be readily available or even retrievable in the case of large-N analyses based on (often randomized) surveys. Still, our goal is not to argue that the large-N approach is preferable over the small-N approach but rather, that both approaches have distinct strengths and weaknesses that play out in different research designs (for an in-depth discussion of the differences, see Greckhamer et al. (2013) and Thomann and Maggetti (2017)). We observe that currently, small-N analyses are underused which means that QCA-based IS research does not benefit from the advantages that this type of analysis offers.

4.2.3 Under- and misuse of necessity analysis

Only 39 % of the articles in our dataset mention the use of an analysis of necessary conditions. This is highly problematic since the results of a necessity analysis can have an impact on the results of the sufficiency analysis. Any truth table rows that do not include a necessary condition can be excluded from the minimization process. Furthermore, it eliminates the risk of mistaking a condition that appears in every sufficient configuration for a necessary condition (Schneider and Wagemann, 2012, p. 220). An example of this fallacy can be found in the article by Bui et al. (2019b) which was recently published in JSIS. In their article, Bui et al. (2019b) use governance and capability theory to identify configurations of outcomes of Information Technology outsourcing (ITO). The abstract claims that the authors identified detailed contracts as a necessary condition for achieving cost reduction. However, a closer look reveals that the authors did not conduct a necessity analysis, but rather, find that "all three ITO configurations include detailed contracts" and that "[t]his suggests that having detailed contracts is a necessary condition for cost reduction in ITO configurations". Thereby, they derive the presence of necessary conditions from their sufficiency analysis. While it is theoretically possible that detailed contracts are a necessary condition, the authors would have needed to conduct a necessity analysis to prove this assumption. Unfortunately, the article does not provide any data which would make it possible for other researchers to confirm or disconfirm the nature of detailed contracts as a necessary condition.

An article written by Iannacci and Cornford (2018), which was recently published in ISJ, falls into a similar, but somewhat different trap: the authors seem to mistake core conditions (as opposed to peripheral conditions) for necessary conditions. This is not a mere issue of cluttered nomenclature since the authors base their reasoning on the article by Fiss (2011), who introduced the concept of core and peripheral conditions and later in the paper, it is clear that the authors are aware of the distinction between necessary and sufficient conditions. However, according to Fiss (2011), core elements are merely “those causal conditions for which the evidence indicates a strong causal relationship with the outcome of interest” (Fiss, 2011, p. 398). More specifically, “core conditions are those that are part of both parsimonious and intermediate solutions, and peripheral conditions are those that are eliminated in the parsimonious solution and thus only appear in the intermediate solution” (Fiss, 2011, p. 403). The author even illustrates this with an example of core and peripheral conditions, noting that the model contains “likely no necessary condition” (Fiss, 2011, p. 409). Giving Iannacci and Cornford (2018) the benefit of the doubt, we replicated their analysis using the provided raw data matrix (see Table 5 in the appendix). We used the commonly used fs/QCA software (Ragin and Davey, 2016) to conduct a necessity analysis for both the outcome and the negation of the outcome. For the positive outcome, we found that the four core conditions are indeed necessary conditions, with a consistency of 1.00. However, we also find that “Automation”, which has not been marked as a core condition, does exceed the commonly used threshold of 0.9. Since the authors do not disclose the applied threshold for necessity, it is not possible to determine whether they have employed a stricter approach and thus, have dismissed “Automation”. However, the replication of the negative outcome shows that none of the three conditions that were marked as necessary conditions reach the recommended consistency threshold of 0.9. In fact, most do not even exceed a threshold of 0.8. Therefore, the study cannot claim to have identified any necessary conditions for the negative outcome and for the positive outcome, at least doubts remain.

4.2.4 Analysis robustness

When analyzing the robustness and reliability of the articles in our data set, several issues come to mind. QCA uses parameters of fit, i.e. consistency and coverage to indicate the quality of identified solutions. The overall solution consistency of the analyzed articles is, in general (and if reported), relatively good: the values are, with a few exceptions, mostly in the range from 0.75 to 1.00, as recommended by Ragin (2008). We noted that only a few papers make use of PRI consistency (see e.g., Park et al. (2017) or Papert, Pflaum, and Leischnig (2017)). Introduced by Schneider and Wagemann (2012), PRI consistency considerably strengthens the quality of analyses by eliminating the influence of cases that are subsets of both the outcome and its negation. Solution coverage is often surprisingly low, for example, a mere 18 % for Stanko (2016), 38 % for Tan et al. (2016), and 46 % for Park et al. (2017). Both Stanko (2016) and Park et al. (2017) do not even discuss these low values and how they impact the reliability of their results, while Tan et al. (2016) even state that the coverage lends support to the related proposition. Exceptionally low coverage values can be found in the article by Bui et al. (2019b): the five solutions have coverage values of 33 %, 18 %, 5 %, and 8 %, respectively. Again, these low values are barely discussed. The explanatory power of QCA solutions is significantly reduced since large shares of the observed outcome cannot be explained by the chosen analytical model. Low coverage values can be due to various reasons, such as decisions regarding calibration, missing dimensions in the analytical model, or skewness and heterogeneity in the set membership values (Wagemann et al., 2016). Authors should at least mention and discuss these issues when presenting solutions with low coverage.

As described before, methodological works on QCA have outlined several ways to verify the robustness of a solution through sensitivity testing. However, our review shows that these are not used frequently. For notable exceptions, see, for example, Bui et al. (2019b), Stanko (2016), and Mattke, Müller, et al. (2018) who replicated their analyses with varying calibration thresholds, or Mattke, Maier, et al. (2018) and Müller et al. (2017) who tested for sensitivity to different frequency thresholds. Understandably, these approaches have not been used in QCA articles that have appeared relatively early in IS research (such as Rivard and Lapointe (2012)) since groundwork articles on sensitivity tests have appeared relatively late as well (see Skaaning (2011)). However, it is alarming that even recently published articles in high-quality outlets such as MISQ or JSIS are still not making use of these tests (see Tan et al. (2016) or Dawson et al. (2016)). This applies even to articles partly or mainly intended to demonstrate the use and best practice of QCA (see, respectively, Park et al. (2017) and Y. Liu et al. (2015)).

5 Conclusion

In this paper, we present a critical literature review on the use of QCA in IS research. While QCA has already been extensively used in other disciplines, it is slowly gaining traction in IS research. We aimed to provide an extensive overview of (1) how QCA has been used in IS research and (2) how future QCA-based IS research can be improved. To do so, we have reviewed articles from IS journals and conferences using an extensive coding scheme based on methodological literature and QCA reviews from other research disciplines. We provide a bird's eye view of the use of QCA in all articles and conducted an in-depth methodological analysis of articles published in high-quality outlets. We applaud the increased use of this set-theoretic methodology in our discipline but point out that its use in journals is still limited. Furthermore, we show that there are both severe issues and unused potentials in QCA applications for IS research which we summarize in four distinct themes. First, we recommend following established standards of reporting and transparency, such as publishing raw data matrices or truth tables and justifying decisions for choosing thresholds. Second, we show that extant research relies predominantly on large-N studies, neglecting the analytical potential of small-N research. Additionally, the use of random samples for large-N studies is problematic and needs more reflection from researchers. Third, extant studies largely neglect necessity analyses and, partly, even misinterpret the concept of necessary conditions. Fourth, regarding the robustness of analyses, studies mostly show solid values for solution consistency but often report low values for solution coverage without adequately discussing these. Lastly, we find that only a few articles test their results for sensitivity to varying thresholds of calibration and frequency.

As with any research endeavor, our study is not free from limitations. In particular, our review is limited by our choice of outlets. While we believe that our selected journals and conferences adequately represent the diversity of IS research, we did not analyze all IS-affiliated conferences and excluded journals that have a ranking of C or lower according to VHB JOURQUAL3. Future research could take these omitted outlets into account and extend our review. Second, our coding scheme is focused on methodological features and decisions regarding QCA and neglects other aspects of ongoing discussions about theory in IS research. However, our review provides a first step to understanding the use of QCA in IS research and thus lays the groundwork for future research to explore other issues. This could also include aspects such as citation analyses to identify influential QCA papers. Third, our coding may be limited by subjectivity and the fact that authors may have applied further steps in their analyses which were not documented in the articles. Necessity analyses, for example, typically occupy a lot of space. If the analysis revealed that there were no necessary conditions present, it is possible that the authors did not mention this due to space limitations. Therefore, future research could examine this aspect further and provide the articles' authors the opportunity to give feedback to the coding process of this review. Also, future research may build on our finding that a small group of authors is responsible for the majority of QCA articles in IS research by conducting a bibliometric analysis (for example in another field, see Roig-Tierno et al. (2017)). Furthermore, in light of the low number of QCA articles in journals, future research could study the reasons behind this phenomenon and develop an updated version of the methodological tutorials published by El Sawy et al. (2010) and Y. Liu et al. (2015). This update could take recent methodological developments and collections of best practices into account.

In conclusion, the potential of QCA for IS research has been recognized but the methodology is still underused and there is potential for improvement. Our critical review sheds light on these issues and provides recommendations for future use of QCA in IS research.

Appendix

	Category (Source)	**Examples**
Study Design	**Objective for the use of QCA (Berg-Schlosser et al., 2009)**	Summarizing the data, Developing a new argument, Checking coherence, Checking an existing theory, Testing conjectures
	Data source (Authors' own)	Archival data, Case survey, Interview, Observation, Survey
	Case selection strategy (Greckhamer et al., 2018)	Large-N entire population, Large-N random sample, Large-N stratified sample, Small-N entire population, Small-N representative sample, Small-N positive/negative cases
	Condition selection strategy (Yamasaki and Rihoux, 2009)	Comprehensive, Perspective, Significance, Second look, Conjunctural, Inductive
	Unit of analysis (Rihoux et al., 2011)	Micro, Meso, Macro
General analysis	QCA variant (Rihoux and Ragin, 2009)	csQCA, fsQCA, mvQCA
	Number of cases (Schneider and Wagemann, 2012)	(a number)
	Number of conditions (Schneider and Wagemann, 2012)	(a number)
	Number of analyses (Authors' own)	(a number)
	QCA used with other analysis methods (Authors' own)	Yes/No
	Software (Schneider and Wagemann, 2012)	Fs/QCA, R, Tosmana, Other
	Calibration cross-over point adjusted to 0.5 (Wagemann et al., 2016)	Yes/No
	Necessity analysis conducted (Schneider and Wagemann, 2010)	Yes/No
	Consistency threshold of the necessity analysis (Schneider and Wagemann, 2010)	(a number)
	Frequency threshold (Rihoux and Ragin, 2009)	(a number)
	Raw consistency threshold (Rihoux and Ragin, 2009)	(a number)
	PRI consistency threshold (Schneider and Wagemann, 2012)	(a number)
	Solution coverage (Schneider and Wagemann, 2010)	(a number)
	Solution consistency (Schneider and Wagemann, 2010)	(a number)
Reporting	Solutions reported (Schneider and Wagemann, 2010)	Complex, intermediate, parsimonious
	Raw data matrix provided (Schneider and Wagemann, 2010)	Yes/No
	Dichotomization/Calibration process justified (Schneider and Wagemann, 2010)	Yes/No
	Visualization type (Rubinson, 2019)	Boolean formula, Fiss chart, Tosmana diagram, Tree Map, Truth table, XY Plot

	Motivations/Advantages of the method explained (Rihoux et al., 2013)	Yes/No
Sensitivity & Post-analyses	**Returned to cases (Schneider and Wagemann, 2010)**	Yes/No
	Robustness test (Maggetti and Levi-Faur, 2013; Skaaning, 2011)	Variation of the calibration threshold, Variation of the frequency threshold, Variation of the consistency threshold
Note. The boldface categories are examined within the in-depth analysis.		

Table 3. Coding scheme

Author	**Papers as first author (percentage of article sample)**	**Papers as first or co-author (percentage of article sample)**
Gregory S. Dawson	2 (3 %)	**5 (8 %)**
James S. Denford	2 (3 %)	**5 (8 %)**
Kevin C. Desouza	0 (0 %)	**5 (8 %)**
Michail N. Giannakos	0 (0 %)	**5 (8 %)**
Panos E. Kourouthanassis	2 (3 %)	**5 (8 %)**
Christian Maier	0 (0 %)	**6 (9 %)**
Jens Mattke	3 (5 %)	**6 (9 %)**
Patrick Mikalef	2 (3 %)	**8 (12 %)**
Lea Müller	2 (3 %)	**5 (8 %)**
Ilias O. Pappas	**5 (8%)**	**7 (11 %)**
YoungKi Park	3 (5 %)	**5 (8 %)**

Table 4. Authors who are listed as first author or co-author on a high number (> 3) of QCA papers

Condition	**Impact**		**~ Impact**	
	Consistency	Coverage	Consistency	Coverage
Comprehensiveness	1.00	0.67	0.81	0.72
~Comprehensiveness	0.59	0.69	0.63	1.00
Consistency	0.75	0.82	0.50	0.73
~Consistency	0.75	0.53	0.88	0.83
Currency	1.00	0.72	0.69	0.65
~Currency	0.50	0.54	0.69	1.00
Compatibility	1.00	0.81	0.68	0.73
~Compatibility	0.67	0.60	0.82	1.00
Reliability	1.00	0.80	0.56	0.60
~Reliability	0.50	0.46	0.81	1.00
Automation	0.91	0.85	0.62	0.77
~Automation	0.75	0.59	0.88	0.93
~: Logical negation; commonly used necessity consistency threshold: 0.9 (Schneider and Wagemann, 2012)				

Table 5. Replicated necessity analysis based on Iannacci and Cornford (2018)

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Appendix C. Reducing Socio-Technical Inertia During Digital Transformation – The Role of Dynamic Capabilities (P3)

REDUCING SOCIO-TECHNICAL INERTIA DURING DIGITAL TRANSFORMATION – THE ROLE OF DYNAMIC CAPABILITIES

Research in Progress

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Abstract

Digital transformation promises various benefits for established companies such as increased revenue and competitiveness. However, a high number of digital transformation projects fail because companies are unable to adapt to changes induced through digital technologies. Socio-technical (ST) inertia plays a decisive role in the success or failure of these projects. Extant research proposes that dynamic capabilities can be used to effectively reduce ST inertia in DT projects. To further explore this proposition, I conducted a case survey on a set of DT case studies and apply fuzzy-set Qualitative Comparative Analysis on the results. This approach allows me to identify patterns of interactions between dynamic capabilities of a firm and its transformation project design that lead to the reduction of ST inertia. Preliminary results show that reconfiguration and, to some degree, sensing capabilities have a positive influence on the reduction of ST inertia. Seizing capabilities neither have a positive nor a negative impact. Furthermore, my findings show that ST inertia is also reduced through highly participative, centralized approaches.

Keywords: Digital transformation, dynamic capabilities, socio-technical inertia, governing agency.

1 Introduction

Digital transformation (DT) is on everyone's minds and has become a highly fashionable topic in both research and practice. Organizations of all sizes and from every industry are launching large-scale transformation projects to adopt digital technologies into their processes and business models (Matt, Hess, and Benlian, 2015). These projects are often characterized by their speed and their uncertainty in execution (Dobbs, Manyika, and Woetzel, 2015). The low success rate of just under 30 % shows that organizations are still struggling when transforming themselves through digital technologies (La Boutetière, Montagner, and Reich, 2018). One of the factors inhibiting successful organizational transformation is organizational inertia (Besson and Rowe, 2012). Different factors such as organization size, age, or technological foundations have been identified as origins of inertia (Schmid, 2019). In IS literature, scholars have recently begun to emphasize that in DT research, organizational inertia needs to be analyzed considering a socio-technical perspective (Besson and Rowe, 2012; Schmid, 2019; Schmid, Recker, and vom Brocke, 2017). As Schmid (2019, p. 12) notes, inertia is an "integral part of transformation that cannot be overcome but only counterbalanced". Despite its importance for the success of DT projects, socio-technical (ST) inertia is a phenomenon that has been neglected by IS research so far. Specifically, few research efforts have been made to explore ways to counterbalance ST inertia. Rowe, Besson, and Hemon (2017) propose that dynamic capabilities are an effective way to reduce ST inertia in organizational transformation.

To verify this proposition in the context of DT, I set out to answer the research question: *How can dynamic capabilities overcome ST inertia in DT projects?* To explore this question, I adopt a configurational theory approach since I assume that various paths to success may exist. I conduct a case survey on cases of DT projects found in literature and analyze the results using fuzzy-set Qualitative Comparative Analysis (fsQCA) (Larsson, 1993; Ragin, 2009). Thus, I identify distinct paths that lead to success, considering the role of project governance. My preliminary results reveal the importance of reconfiguration capabilities along with centralized and participative governance approaches. Furthermore, I show that sensing capabilities fulfill a supporting role while seizing capabilities do not have a positive nor a negative influence. The identified patterns of the interplay between dynamic capabilities and governing agency provide implications for both theory and practice and reveal several avenues for future research. Still, since this is an ongoing research effort and the four configurations represent only preliminary results. As future research, I plan to search for and include further cases into my case database to refine and recalibrate the used causal conditions and to provide evidence-based, in-depth explanations for the configurations. Furthermore, I plan to extend my preliminary results to cases where ST inertia could not be reduced.

The rest of this paper is structured as follows. I present a review of my conceptual background in section 2. In section 3, I outline my methodological approach, specifically the collection, coding, and analysis of cases. I present my preliminary results in section 4 and conclude my paper with section 5. There, I discuss the results and limitations of this research and outline my plans for future research.

2 Conceptual Background

2.1 DT, ST Inertia, and Dynamic Capabilities

DT has become a frequently discussed topic in both theory and practice (Vial, 2019). The advent of easily accessible digital technologies has considerably impacted organizations' business models and processes. Over the last years, different scholars from the fields of information systems (IS) and business and management literature have put considerable efforts in defining and demystifying the meaning behind the buzzword (see, for example, Matt et al. (2015), Kutzner, Schoormann, and Knackstedt (2018), Bockshecker, Hackstein, and Baumöl (2018), Riasanow et al. (2019), and Vial (2019), among others). For the remainder of this paper, I will employ the definition proposed by Vial (2019, p. 118), who understands DT as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies". For my research, I look at DT of single organizations (as opposed to societies or industries) and consider projects that trigger the mentioned changes as my unit of analysis. DT promises various benefits such as increased revenue and competitiveness, but organizations are confronted with different barriers when transforming themselves (Vogelsang et al., 2019; Zhu et al., 2006). Also, the low success rate (< 30 %) shows that organizations are still struggling with these barriers (La Boutetière et al., 2018). As in any organizational transformation process, inertia plays a critical role (Besson and Rowe, 2012). Organizational inertia is defined as an "organizations' ability to sustain reliable and accountable performance in turbulent environments" (Schmid, 2019, p. 3) and, in my context, reflects the stickiness of the organization under transformation (Besson and Rowe, 2012). While inertia used to be considered an advantage for organizations, increasing their survival in uncertain periods or environments, it is nowadays considered a threat (Amburgey, Kelly, and Barnett, 1993; D. Miller and Friesen, 1980; Schmid, 2019). This perception is caused by the increased speed of changes induced through digital technologies and the loss of competitive leverage of some companies that do not adapt to these changes. In some cases, this inertia may be driven by a company's inability to adapt due to missing resources, while it may also be caused by economic, cultural, or political factors, such as the desire to preserve certain routines or a certain way of life (see, for example, Collinson and Wilson (2006), Cooper (1994), Danny Miller and Chen (1994), or Datta (2020)). In particular, Besson and Rowe (2012) have identified and conceptualized five distinct dimensions of organizational inertia: negative psychology, socio-cognitive, socio-technical, economic, and political. In this paper, I focus on ST inertia, since this type of inertia depends on ST capabilities which lie at the core of DT (Rowe et al., 2017). In particular, ST inertia is based on technological and ST path dependencies and therefore stems from employees who are not able to or unwilling to work with new technology or newly introduced processes (Besson and Rowe, 2012). Surprisingly, ST inertia remains an understudied phenomenon, in particular in the context of DT, despite its importance and negative influence on the success of DT (Besson and Rowe, 2012; Rowe et al., 2017; Schmid, 2019).

A recent article by Rowe et al. (2017) proposes the idea that dynamic capabilities are a suitable concept to explain how organizational inertia in organizational transformation can be reduced. I will now briefly explain this concept and its origins before I explain the reasoning that links it with organizational, and in particular, ST inertia. The concept of dynamic capabilities was originally introduced to account for the highly volatile nature of today's markets (Teece, Pisano, and Shuen, 1997; Winter, 2003). Mezger (2014, p. 430) described them as "higher-order organizational capabilities", allow incumbent companies to reorganize their existing organizational structures, capabilities, and cultures (Lavie, 2006; Leih, Linden, and Teece, 2015). Teece (2007) classified dynamic capabilities according to the three dimensions of sensing, seizing, and reconfiguring. Sensing capabilities describe an organization's ability to discover opportunities that are related to technological developments and changes in customer requirements (Eriksson, 2014; Teece, 2007). They enable an organization to explore technological possibilities, to probe markets, and to integrate input from customers (Leih et al., 2015). Seizing capabilities requires large organizational investments because they mainly comprise processes related to organizational value generation, new product development, or service innovation (Teece, 2007). They capture a firm's product architectures, business models, and organizational boundaries (Eriksson, 2014). Lastly, reconfiguration capabilities describe processes for aligning and realigning organizational assets to meet changed or new requirements (Teece, 2007). Reconfiguration capabilities address issues such as decentralization or co-specialization and critical processes related to organizational knowledge management (Eriksson, 2014; Teece, 2007). Moreover, they enable organizations to redesign existing routines, product offerings, and organizational structures (Teece, 2007). Over the years, several researchers have proposed theoretical arguments that dynamic capabilities are a useful means to overcome rigidities in organizational transformation (Huff, Huff, and Thomas, 1992; Leonard, 1992; Schreyögg and Kliesch-Eberl, 2007). Since they are higher-level routines, they may be able to "regulate and reconfigure lower-level capabilities and resources", thereby reducing inherent organizational inertia (Rowe et al., 2017, p. 407). Rowe et al. (2017) empirically tested this theoretical idea with a quantitative study design and showed that each of the three dynamic capabilities (sensing, seizing, and reconfiguring) significantly reduced ST inertia in organizational transformation. In particular, the effect of reconfiguring was amplified in uncertain environments. While this study provided first empirical insights supporting the idea that dynamic capabilities can counterbalance ST inertia, it needs further empirical validation and exploration. In particular, Rowe et al. (2017) employed a net-effects model, isolating the effects of each dynamic capability on the others. However, related research on dynamic capabilities has shown that in specific situations, certain dynamic capabilities or certain combinations are more effective than others (see, for example, the articles of Jantunen et al. (2018), Gelhard, von Delft, and Gudergan (2016), or Razmdoost, Alinaghian, and Linder (2019)). I argue that configuration theory is a suitable lens to investigate these interdependencies and different contexts. As Wilden, Devinney, and Dowling (2017) posit, there may be multiple, equally effective configurations of dynamic capabilities. It should also be noted that there is a second school of thought that proposes that the presence or absence of ST inertia hinders or favors the development of dynamic capabilities rather than vice-versa (see, for example, Mikalef, van de Wetering, and Krogstie (2019)). For this paper, I focused on the reverse relationship.

Returning to the argument outlined by Rowe et al. (2017), they show that the effectiveness of dynamic capabilities in reducing inertia may also depend on other environmental or project-related factors. My literature review identified two factors that influence the success of DT projects and, as I argue, therefore also the level of inherent ST inertia: governing agency (G-agency) and participation of employees. G-agency refers to the "design, planning and control of IS-enabled OT" (Besson and Rowe, 2012, p. 107). It can either be centralized or decentralized. A centralized G-agency is characterized by a high centralization of decision-making, represented by a single person who leads the organizational transformation process, for example, the CEO or CIO (Brown and Grant, 2005). In a decentralized G-agency, on the other hand, involves several people through organizational structures such as steering committees (Besson and Rowe, 2012). The two options should be seen as two ends of a continuum, where organizations can also adopt a hybrid approach. Extant research shows that a centralized approach allows for a higher degree of global control over IT systems (Brown and Grant, 2005). Thus, this also reduces uncertainty through earlier planning without involving several decision-makers or following overly complex decision processes (Reynolds, Thorogood, and Yetton, 2010). On the other hand, a centralized G-agency enables a higher degree of local control over IT systems, which may favor flexibility over standardization, such as in the case of adapting information systems to specific needs of employees and departments (Huang, Zmud, and Price, 2010). I argue that both approaches may either favor or hinder the reduction of inertia, depending on the circumstances. Also sometimes questioned, a high degree of participation is usually considered a success factor of both IS projects and organizational transformation (Besson and Rowe, 2012; Young and Jordan, 2008). Participative project approaches enable a positive attitude of employees towards change programs and thus bear the potential for effectively reducing inertia at an early stage of an organizational transformation (Erwin and Garman, 2010; Oreg, Vakola, and Armenakis, 2011).

2.2 Research Model

In this paper, I focus on explaining how dynamic capabilities can reduce ST inertia in DT projects. I argue that due to the inherent complexity of DT, there may be different paths to success. Therefore, I adopt a configurational viewpoint, allowing for equifinality and asymmetry by identifying different patterns that produce a certain outcome. In my case, this outcome is represented by the **reduction of ST inertia**. As explanatory factors, I include dynamic capabilities and draw upon extant research by diving them into three subcategories: **sensing**, **seizing**, and **reconfiguring**. Furthermore, I assert that I need to include other factors that explain successful DT to make my contribution as specific and actionable as possible. Therefore, I also include, as mentioned in my conceptual background, two project-related factors: **G-agency** and **participation**. These five explanatory factors comprise my research model for explaining the reduction of ST inertia. Figure 1 summarizes the research model building on a Venn diagram which is commonly used for illustrating configurational research designs.

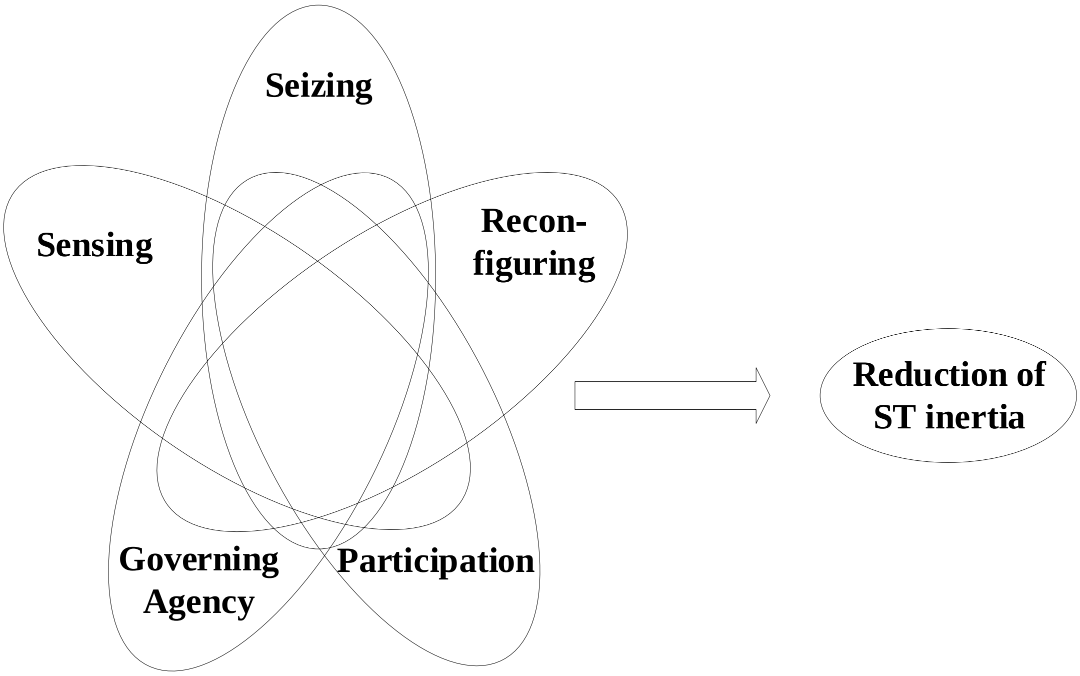

Figure 1. Configurational research model for exploring pathways to reducing ST inertia in DT projects

3 Methodology

3.1 Data collection

We argue that an in-depth perspective, offered typically by case studies should be adopted to investigate my research question. Since extant IS literature provides us with a high number of high-quality cases on DT, I chose a case survey approach (Larsson, 1993). Furthermore, I integrate a configurational perspective into my research by adopting configuration theory as a methodological lens. Specifically, I use fsQCA to analyze the finding of my initial case survey. To do so, I designed a coding scheme comprised of fuzzy values that I then used to conduct the case survey. The resulting fuzzy value matrix was then analyzed with fsQCA. I built an extensive collection of case studies regarding DT from several scholarly sources. I included cases if (1) they described a DT project that matched the definition presented in the theoretical background, (2) their narrative provided rich descriptions of the project's events, and (3) the case reported evidence of ST inertia during the project. Cases that did not meet these criteria were excluded. To identify cases, I used the Scopus database to search for articles in different journals. This included the fields of IS (the AIS „Basket of Eight“) as well as entrepreneurship (i.e., Journal of Business Venturing, Strategic Entrepreneurship Journal, Research Policy, Entrepreneurship: Theory and Practice) and strategic management and organization research (specifically: Academy of Management Review, Academy of Management Journal, Strategic Management Journal, Journal of Management). I first searched for publications that mention the term "case study" in the abstract. Afterward, I performed a full-text search with the search term *"(resist* OR inertia) AND (transform* OR chang*)."* I then included more cases from textbooks and other journals. I constantly refined my sample using the already mentioned criteria. In some instances, I found multiple articles describing a single case and articles describing multiple cases. Notably, the initial sample also included cases that reported instances of other types of inertia, such as socio-cognitive or psychological inertia. However, since the focus of my research lies in ST inertia, I excluded these cases. In total, I selected 31 cases for my analysis. These cases described projects from distinct industries such as manufacturing, finance, or healthcare. I included all cases that were used in this paper's bibliography and marked them with an asterisk ("*").

3.2 Coding

We developed a coding scheme that included the following main categories derived in the conceptual background: dynamic capabilities (sensing, seizing, and reconfiguring), project-related factors (G-agency and participation), and reduction of ST inertia. I derived a "theoretical ideal" for each dimension which reflects the best imaginable case that was possible considering logical and social bounds. This is following the recommendations of Basurto and Speer (2012) and Iannacci and Cornford (2018) regarding the use of qualitative data for Qualitative Comparative Analysis (QCA). To facilitate coding, I designed individual vignettes for each case. Each case was then coded against each theoretical ideal using a fuzzy 5-value scheme (see Table 1). According to this scheme, introduced by Ragin (2009), each dimension can be assigned, for each case, to 0, 0.25, 0.51, 0.75, or 1. This approach is recommended when data may be "too weak to support fine-grained distinctions" (Iannacci and Cornford, 2018)". I and a Master student then independently coded each case with the fuzzy 5-value scheme and the theoretical ideals and completed a coding report along with information about the case, the attributed fuzzy values, and excerpts of the case that justified the chosen values. In case of disagreements, both coders reread the respective case and reached a consensus through discussion. Due to space constraints, a complete list of the case vignettes is available from the authors upon request.

Dimension/ Fuzzy value	Sensing/ Seizing/ Reconfiguring (SSR)	G-agency	Participation	Reduction of ST inertia
0 (fully out)	The company exhibits no SSR capabilities	The project was governed through a decentralized approach	The DT project did not follow a participative approach	ST inertia could not be reduced at all
0.25 (more out than in)	The company exhibits poor or under-developed SSR capabilities	The DT project was governed using a rather decentralized approach	The DT project followed a rather non-participative approach	ST inertia could only be reduced to a small degree
0.51 (borderline)	The company exhibits moderately developed SSR capabilities	The DT project was governed using a mix of a centralized and decentralized approach	The DT project followed a mix of a participative and non-participative approach	ST inertia could only be reduced partially
0.75 (more in than out)	The company exhibits well-developed SSR capabilities	The DT project was governed using a rather centralized approach	The DT project followed a rather participative approach	ST inertia could mostly be reduced
1 (fully in)	The company exhibits very well-developed SSR capabilities	The DT project was governed using a centralized approach	The DT project followed a highly participative approach	ST inertia could be reduced to a high degree

Table 1. Fuzzy 5-value scheme used in the coding procedure

3.3 Analysis

Having completed the coding procedure, I went on to apply fsQCA on the resulting fuzzy values. Configuration theory distinguishes between necessity and sufficiency, as well as between single conditions and configurations of conditions (Ragin, 2009). If a condition is necessary for a certain outcome, then the outcome cannot occur if the condition cannot be observed as well. If a condition is sufficient for an outcome, then the outcome will always be observed if the condition is observed. A condition may be either necessary or sufficient or both. Using fsQCA, researchers usually first evaluate whether any condition or its negation is necessary for a certain outcome (Schneider and Wagemann, 2010). Afterward, the analysis proceeds to identify sufficient configurations (or combinations) of conditions that produce the outcome (Ragin, 2009). To conduct necessity and sufficiency analyses, I used a popular R library developed by Duşa (2019). fsQCA provides two parameters of fit that are used to evaluate solutions: consistency and coverage. Consistency indicates how “consistently” a certain outcome is produced by a condition or a configuration (Ragin, 2009). Coverage indicates the percentage of cases of a certain outcome that is explained by a condition or a configuration (Ragin, 2009). Thus, its explanatory power is comparable to the well-known R^2 measure in traditional regression analysis.

We used the R library to first conduct a necessity analysis on all of my conditions, using a threshold of 0.9, which is commonly accepted in QCA research (Schneider and Wagemann, 2012). Afterward, I built a truth table that consists of all potential configurations. Each case was then assigned to a table row by the R library, along with a consistency measure of how well the row represents the given case. Afterward, the truth table was reduced through Boolean algebra. Therefore, the researcher specifies thresholds of consistency and frequency that need to be met. I applied a consistency threshold of 0.9 which is above the commonly accepted lower bound of 0.75 (Park, El Sawy, and Fiss, 2017). This means that rows are kept in the table only if they show a consistency level of at least 0.9. Furthermore, I applied a frequency threshold of one, which is commonly recommended for medium-sized samples (Greckhamer et al., 2018). This means that rows are kept in the table only if they are represented by at least one case in the data set. After having removed rows that do not meet the specified criteria, the R library applied the Quine-McCluskey algorithm to further simply the remaining table (Ragin, 2009). Afterward, I derived the intermediate and parsimonious solution, as recommended by (Schneider and Wagemann, 2010). I used these two solutions to identify core and peripheral conditions. Core conditions represent conditions “for which the evidence indicates a strong causal relationship with the outcome of interest” (Fiss, 2011, p. 398). Peripheral conditions, on the other hand, are conditions that “may surround the core causal condition” and for “which the evidence for a causal relationship with the outcome is weaker” (Fiss, 2011, p. 398). These two types of conditions can be identified by comparing intermediate and parsimonious solutions: conditions or combinations of conditions that appear in both solutions are core conditions, while conditions that disappear in the parsimonious solution are considered peripheral (Fiss, 2011). Lastly, it is recommended to report the intermediate solution and visually distinguish core and peripheral conditions (Fiss, 2011; Greckhamer et al., 2018).

4 Preliminary Results

Our necessary condition analysis shows that no single condition passes the commonly accepted threshold of 0.9. This means that no single dynamic capability alone is necessary to overcome ST inertia. Furthermore, it also means that neither centralized/decentralized nor participative/non-participative agency approaches are necessary on its own. Therefore, I proceed to the sufficiency analysis. Sufficiency analysis reveals an intermediate solution with four configurations for overcoming ST inertia (see Table 2). With 0.98, my solution shows an excellent consistency level, exceeding the commonly accepted threshold of 0.8 (Ragin, 2008). Also, the coverage value of 0.65 shows that the identified configurations explain a considerable share of the outcome. The first configuration (C1) depicts projects where a centralized governing agency was combined with a participative approach. Furthermore, sensing capabilities are present as a peripheral condition, indicating a minor role. The second configuration (C2) comprises similar elements as C1, but instead of sensing as a peripheral condition, I can observe reconfiguring as a core condition. The third (C3a) and fourth (C3b) configurations are permutations of each other since they share the same core conditions but partly differ regarding the peripheral condition (Fiss, 2011). In both configurations, reconfiguring appears as a core condition along with sensing as a peripheral condition. Additionally, C3a reflects projects with a centralized G-agency where C3b is based on a participative approach instead. It should be noted that the unique coverage of the individual configurations is rather low. This suggests a certain overlap, especially in the case of C1. Nevertheless, configurations with a low unique coverage can still be interesting from a theoretical point of view (Grofman and Schneider, 2009).

Conditions	**Reduction of ST inertia**			
	C1	C2	C3a	C3b
Dynamic Capabilities				
Sensing	•		•	•
Seizing				
Reconfiguring		⬤	⬤	⬤
Project Factors				
G-agency (centralized)	⬤	⬤	•	
Participation	⬤	⬤		•
Raw consistency	0.97	1.00	1.00	1.00
Raw coverage	0.41	0.46	0.45	0.44
Unique coverage	0.04	0.09	0.09	0.08
Solution consistency	0.98			
Solution coverage	0.65			
Black circle = Presence of a condition; Crossed-out circle = Absence of a condition; Empty row = may be either present or absent; Large circle = Core condition; Small circle: Peripheral condition; Raw consistency threshold: 0.9; PRI threshold: 0.8; Frequency threshold: 1.				

Table 2. Sufficient configurations for reduction of ST inertia

5 Discussion and Conclusion

Our preliminary findings support the idea that dynamic capabilities have a positive influence on the reduction of ST inertia, thus confirming the results presented by Rowe et al. (2017) and applying a configurational perspective. However, my results differ regarding the importance of single dynamic capabilities and their combination. There are several interesting observations across the identified patterns. Most striking is the importance of reconfiguring for reducing ST inertia. In combination with a centralized G-agency, this could be explained by the need for adjusting new IT systems after the initial implementation due to a centralized planning approach. Furthermore, seizing capabilities seem to have neither a positive nor a negative influence on the reduction of ST inertia. This may mean that seizing is either not relevant at all or that its effect is overshadowed by strong reconfiguration capabilities. Furthermore, both centralized and participation-oriented approaches have a positive influence. When combined, their causal link to reduced ST inertia is even larger than the link of sensing capabilities (see C1). This is particularly interesting since one may suspect that centralized approaches are accompanied by a lower degree of participation. However, these are only preliminary results that need further validation through more cases and further explanation through in-depth analyses of the cases.

Our approach is subject to limitations. First, due to the limited number of conditions that can be used in a QCA research model, I could not include other concepts that may have further explanatory power (such as personal traits or social network theory (Lehrig and Krancher, 2018; Phelps, Heidl, and Wadhwa, 2012)). Second, the coding procedure may be subject to bias from authors of the case studies and their interpretations. Furthermore, the coding procedure and assignment of dimensions to the fuzzy 5-value scheme may be subject to subjectivity as well. However, I attempted to reduce this bias by having two people code the cases. This approach is in line with similar approaches documented in articles in high-quality journals (see, for example, Henfridsson and Bygstad (2013) or Rivard and Lapointe (2012)). Third, the use of a different coding scheme as opposed to the fuzzy 5-value scheme might have led to slightly different results. Therefore, after including further cases, a sensitivity analysis as proposed by Skaaning (2011) should be conducted to test the robustness of the results. Fourth, in this study I propose dynamic capabilities as a means to reduce socio-technical inertia, building on previous work by, among others, Rowe et al. (2017) and Schreyögg and Kliesch-Eberl (2007). However, as I mentioned before, there is also a different school of thought that proposes that it is rather ST inertia that predicts the development of dynamic capabilities. While I decided to focus on the reverse relationship for this paper, I encourage future research to consider this direction as well, for example with a configurational research model. Lastly, most of the cases were successful which is why my dataset does not exhibit enough explanatory power to explain a negative outcome, i.e. situations where ST inertia could not be reduced.

In this paper, I presented preliminary results that are part of a larger research project. Although I already analyzed 31 cases of DT projects where ST inertia was present, I plan to include further cases. This may also increase the unique coverage of the individual configurations and more clearly delineate their empirical relevance. Based on additional data, I will recalibrate my casual conditions and the outcome and conduct additional necessity and sufficiency analyses which will either confirm or extend the preliminary results of this study. I will also attempt to include enough cases to be able to explain the negation of the outcome as well. This will also allow me to provide more contextual information to the individual configurations and therefore deduce concrete recommendations for practitioners. Furthermore, I plan to conduct case-based post-hoc analyses such as process tracing to better explain the configurations and the resulting contributions to theory and practice (Schneider and Rohlfing, 2013).

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Appendix D. The Role of Dynamic Capabilities in Over-coming Socio-Cognitive Inertia During Digital Transformation – A Configurational Perspective (P4)

The Role of Dynamic Capabilities in Overcoming Socio-Cognitive Inertia During Digital Transformation – A Configurational Perspective

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Abstract. Digital technologies are radically changing the way traditional companies interact in established markets. Although these technologies provide numerous benefits, many digital transformation projects fail because of companies' inability to adapt. Socio-cognitive inertia is an important factor inhibiting successful organizational transformation. Extant research suggests that, under specific conditions, dynamic capabilities are effective means of reducing socio-cognitive inertia. We combine a case survey and a fuzzy-set Qualitative Comparative Analysis approach to identify patterns of interactions between dynamic capabilities of a firm and its transformation project design that led to the reduction of socio-cognitive inertia. We show that sensing and, in particular, reconfiguration capabilities positively contribute to reducing socio-cognitive inertia when combined with a centralized governance approach. However, seizing capabilities neither have a positive nor a negative influence. Furthermore, we show that socio-cognitive inertia can also be reduced by ensuring high participation among employees, even in combination with de-centralized governance approaches.

Keywords: Digital Transformation, Dynamic Capabilities, Socio-Cognitive Inertia, Governing Agency

1 Introduction

Trends, such as digital transformation (DT) and globalization, have shaped our economic era with rapid changes and uncertainties as primary characteristics [1]. Adaption to these new circumstances is critical for the survival of established companies [2]. The low success rate (<30%) of organizational transformations [3] shows that is still uncertain how traditional companies can leverage opportunities coming from DT. An important challenge faced by organizations during transformation is overcoming legacy processes, routines, and patterns [4]. Resistance to realignment causes inertia at various levels. Not only do legacy business processes have to be realigned, employees must also embrace the changes [4]. Socio-cognitive inertia specifically stems from extant organizational norms and values affecting employee actions [4]. Research has often brought this into context with the failure of transformation projects in established companies [5] and as a major factor hindering the success of information technology (IT) projects [6]. Overcoming socio-cognitive inertia and motivating employees to actually use new information systems (IS) is a decisive success factor of successful organizational transformation [6]. Dynamic capabilities are rooted in organizational routines and the actions of managers and employees [7]. Therefore, these variables are suitable for explaining successful transformation in the context of socio-cognitive inertia [7-9]. Furthermore, the way in which DT is managed has a strong impact on the reduction of inertia. These decisions include active employee involvement with centralized or decentralized decision-making [4, 10-12].

In this paper, we explore requisite dynamic capabilities and other contextual factors (e.g., participation and project governance) that allow established organizations to overcome socio-cognitive inertia during their DT. For this purpose, we adopt a configurational approach to identify different pathways to success and further explore the role of project governance. We draw on a large knowledge base by conducting a case survey of DT studies using fuzzy-set Qualitative Comparative Analysis (fsQCA) [13, 14]. To apply a configurational perspective allowing for different combinations of capabilities depending on context, we employ the methods developed by [15]. We show that sensing and, in particular, reconfiguration capabilities positively contribute to reducing socio-cognitive inertia when combined with a centralized governance approach. Interestingly, the seizing capabilities neither have a positive nor a negative influence. Furthermore, we show that socio-cognitive inertia can also be reduced by ensuring high participation among employees, even in combination with de-centralized governance approaches.

The rest of the paper is structured as follows. In section 2, we review our conceptual background on DT, dynamic capabilities, socio-cognitive inertia, governance types, and the interaction of these concepts. Section 3 describes our methodological approach, including how we collected, coded, and analyzed our data. In Section 4, we present a descriptive account of our results. We reveal and explain patterns that can be observed across configurations in Section 5. Then, we discuss the results in Section 6, integrating them with extant theoretical knowledge to derive recommendations for practitioners. Section 7 concludes our paper.

2 Conceptual Background

2.1 Digital Transformation

DT has attracted considerable attention in both theory and practice. Extant literature provides many different definitions of DT [16]. In this paper, we draw on the definition posed by Vial [16], who described DT as a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies [16]. For this paper, we consider the DT of single organizations, and we focus on projects that trigger the described significant changes through combinations of technologies. Significant changes may refer to the creation of new value propositions that rely increasingly on the provision of services [16]. Although DT is not only "old wine in new bottles" [17], several learnings from earlier IT-based organizational transformation still apply. Participation, for example, is a factor that is continuously found to positively influence change processes [10] and IS projects [18]. Participation allows firms to address resistance and inertia at an early stage. The execution of any transformation process needs to be designed in some fashion. Besson and Rowe [4] referred to a so-called governing agency, which can be either centralized or decentralized [4].

2.2 Dynamic Capabilities

Dynamic capabilities describe how a firm's competencies can be transformed to fit new environmental circumstances [7]. They are described as higher-order organizational capabilities that support companies in adapting their organizational structures, processes, and company cultures [19-21]. They are rooted in the routines of an organization and the actions of managers and employees [7]. In contrast to ordinary capabilities, dynamic capabilities represent an organization's ability to transform [22] and to have a positive influence on performance [23]. Dynamic capabilities are seen as enablers of DT [8]. They can be classified into three dimensions: sensing, seizing, and reconfiguring. Sensing capabilities help organizations excel at finding new and fitting markets for their existing products, correctly identifying their customer's needs, and recognizing opportunities for innovation [21]. Seizing capabilities allow organizations to build up new structure, policies, and incentives that enable organizational value generation or service and product innovation [21]. Reconfiguration capabilities are concerned with aligning and realigning organizational assets to meet new requirements in new circumstances [21].

2.3 Socio-Cognitive Inertia

Inertia describes the first level of analysis of organizational transformation in that it characterizes the degree of stickiness of the organization being transformed and defines the effort required to propel IS-enabled organizational transformation [4]. It is also a barrier of DT, especially in organizations where existing resources act as resistors to change [16]. Extant literature has identified five dimensions of inertia: negative psychology, socio-cognitive, socio-technical, economic, and political [4]. In this paper, we focus on socio-cognitive inertia. At an organizational level, socio-cognitive inertia is caused by routines that are embedded in an organization. Extant research has shown that this type of inertia is likely stronger when the routines have been in place for a long period of time [24]. Individuals feel comfortable with familiar situations, and, because employees learn from the past, they tend to think of solutions that have proven useful in the past rather than new ideas [24]. Socio-cognitive inertia assumes that people act based on their existing values as they have done in the past.

2.4 Research Model

Recently, dynamic capabilities have been identified as a suitable concept to explain how inertia can be reduced [9]. Although there are different conceptualizations of dynamic capabilities, the three dimensions of sensing, seizing, and reconfiguring have proven useful in many contexts and are employed in the present study [25]. Their importance as dynamic capabilities explaining DT stems from the fact that DT is characterized by high uncertainty and fast changes [1]. Therefore, having capabilities that support change is crucial, such as sensing new business opportunities or reconfiguring an organization.

Extant research on inertia in the context of DT has focused on socio-technical inertia thus far [4]. In this paper, we focus on explaining how dynamic capabilities can be used to reduce socio-cognitive inertia. We assert that the relationship between the mentioned concepts is dependent upon other factors and that there may not be a "one-size-fits-all" solution [26]. Thus, we adopt a configurational model for explaining this complex relationship. We assert that, to provide specific explanations, we must include other factors that have been proven useful for explaining DT, especially those regarding the governing agency [4]. Governance of a DT project relates to structures, decision rights, and accountability to ensure the appropriate use of digital technologies [12]. Furthermore, governance can either be centralized or decentralized [27]. A centralized agency refers to organizations led by a single manager or leader. However, a decentralized agency delegates governance to several people or organizations [4]. Although a centralized governance approach allows for more IT control [27], decentralized governance allows for more local control, which can increase the flexibility of adapting ISs to specific needs of customers and departments [28]. Furthermore, we include the degree of participation of employees in our research model, because it is an important factor for driving change and reducing inertia [10]. Participation reduces inertia by enabling a more positive attitude toward change processes [10] and better prepares employees for an organizational transformation [29]. Because of the fact that extant research does not agree on an ideal governance type or an optimal degree of participation of employees, our argument that there may be several roads to success is supported [11, 27]. In summary, we investigate the dynamic capabilities that are known to be useful to reduce socio-cognitive inertia in DT projects, considering the effects of centralized or decentralized governing agencies and the degree of employee participation.

3 Research Approach

The objective of our study is to identify how dynamic capabilities can be used in DT projects to overcome socio-cognitive inertia. The in-depth perspectives offered by case studies are appropriate to answer our research question. However, we target a large sample of case studies, which is difficult to conduct because of resource constraints. Therefore, we followed a case-survey approach, making use of the vast availability of case studies in ISs and business research [13]. Because we assume that specific combinations of dynamic capabilities might be more effective for certain kinds of DT projects, we further adopted a configurational perspective. Configuration theory posits that organizational phenomena can best be understood by identifying distinct and internally consistent sets of firms and their relationships to the environment and to performance outcomes [30]. In particular, this accounts for the concept of equifinality, which implies that a system can take different paths from initial conditions to reach a specific state [31]. To apply configurational thinking to our study, we draw on fsQSA to analyze our findings from the case survey [14]. Furthermore, we designed and applied a coding scheme based on fuzzy values for our research design based on both case survey and fsQCA. In the following, we explain our approach for collecting the case studies, coding them with fuzzy values, and applying fsQCA to the coded cases.

Data Collection. Following the approaches realized by Rivard and Lapointe [32] and Henfridsson and Bygstad [33], we collected a large sample of DT cases from scholarly sources. To identify these, we first performed a search on a diverse set of journals from the fields of IS (the scholarly Basket of Eight), entrepreneurship (Entrepreneurship: Theory and Practice, Journal of Business Venturing, Research Policy, Strategic Entrepreneurship Journal), and strategic management and organization research (Academy of Management Journal, Academy of Management Review, Strategic Management Journal, Journal of Management). Furthermore, we included the European and the International Conference on IS (ECIS and ICIS). We searched for articles using the term "case study" in their abstract and performed a full-text search using the search string, "(resist* OR inertia) AND (transform* OR chang*)." After an initial screening, we included cases from relevant textbooks and other journals. We then refined our initial sample based on inclusion and exclusion criteria and coded the remaining cases using the dimensions of our research model. From our initial sample, we included cases where the case represented a DT project according to our understanding presented earlier, where it reported evidence of socio-cognitive inertia and where the case narrative provided a rich description of events. We then excluded cases having no evidence of inertia or whose narrative was not sufficiently detailed. We selected a total of 39 cases from journals, conference proceedings, and a book. The cases covered different sectors, including healthcare, manufacturing, and finance. A complete list of the cases is available upon request from the authors.

Coding. We designed a coding scheme focusing on three main elements described in our conceptual background: dynamic capabilities, a transformation's governing agency, and the reduction of socio-cognitive inertia. Regarding dynamic capabilities, we further differentiated between sensing, seizing, and reconfiguring. Regarding the governing agency, we investigated their degrees of centralization and participation. Regarding socio-cognitive inertia, we determined whether the cases provided evidence that socio-cognitive inertia could be overcome at the end of the project. For each dimension, we derived a "theoretical ideal" representing the best imaginable case in the context of the study that was logically and socially possible [34]. Following Basurto and Speer [34], Iannacci and Cornford [35], we coded our cases against each "theoretical ideal". We created individual summary statements for each case and employed a fuzzy 5-value scheme that is recommended when data might be "too weak to support fine-grained distinctions" [35].

Table 1. Fuzzy 5-value coding scheme

Fuzzy-set value/Dimension	0 (fully out)	0.25 (more out than in)	0.51 (borderline)	0.75 (more in than out)	1 (fully in)
Sensing/Seizing/Reconfiguring (SSR)	The company exhibits no SSR capabilities	The company exhibits under-developed SSR capabilities	The company exhibits moderately-developed SSR capabilities	The company exhibits well-developed SSR capabilities	The company exhibits very well-developed SSR capabilities
Centralization	The DT project was governed using a decentralized approach	The DT project was governed using a rather decentralized approach	The DT project was governed using a mix of a centralized and decentralized approach	The DT project was governed using a rather centralized approach	The DT project was governed using a centralized approach
Participation	The DT project did not follow a participative approach	The DT project followed a rather non-participative approach	The DT project followed a mix of a participative and non-participative approach	The DT project followed a rather participative approach	The DT project followed a highly participative approach
Reduction of socio-cognitive inertia	Socio-cognitive inertia could not be reduced at all	Socio-cognitive inertia could only be reduced to a small degree	Socio-cognitive inertia could only be reduced partially	Socio-cognitive inertia could mostly be overcome	Socio-cognitive inertia could completely be overcome

Owing to space constraints, we provide only selected examples for our coding procedure. For example, we coded the following article excerpt as evidence of having overcome socio-cognitive inertia. It stated, “after some initial apprehension about their new responsibilities and unfamiliar tasks, users accepted and embraced these changes and soon welcomed them” [36]. Regarding dynamic capabilities, we coded the following excerpt as exhibiting high sensing capabilities: “[…] Philips launched Jovia Health […]. Over time, Philips believed that similar solutions would help to shift industry focus from treatment to prevention […]” [37]. On the contrary, we interpreted the following excerpt as an evidence of low reconfiguration capabilities: “[…] they were still struggling with the old projects and their consequences […]” [38]. Regarding governing agency, we coded the following statement as an example of decentralized agency: “the Bakery implemented dedicated project teams that succeeded in implementing the e-commerce initiative” [39]. We interpreted the following statement as an evidence of a low degree of participation: “[…] the focus groups’ responses were ignored in the pilot system design […]” [40].

Based on the summary statements and the fuzzy-value scheme, two authors independently coded all 39 cases from the sample. When disagreements arose during coding, the coders reread the case and discussed their results until consensus was reached. Table 1 provides an overview of our coding scheme comprising the criteria used to assign fuzzy values to cases and their dimensions.

Analysis. After having coded all cases, we proceeded to conduct both a necessary conditions analysis and a sufficiency analysis. Necessary condition analysis reveals single conditions that can be observed in every case exhibiting the outcome. To be considered necessary, a condition needed to exceed a threshold of 0.9 [41]. Consistency measures the extent to which cases with the same conditions share the same outcome [14]. However, necessary conditions could also be present if the outcome could not be observed which is why we also analyzed sufficient configurations. This type of analysis reveals combinations of conditions that guarantee a specific outcome [14]. First, we built a truth table consisting of all potential configurations of conditions. We then further reduced the table rows by setting thresholds for case frequency, raw consistency and proportional reduction in inconsistency (PRI). Aligning to previous QCA research, we applied a frequency threshold of 1, because we used a sample of medium size. This reflects only configurations represented by a minimum of one case study in the truth table. We applied a consistency threshold of 0.9 and a PRI consistency threshold of 0.8. These exceeded the conservative thresholds of 0.75 for both raw and PRI consistency [42]. After reducing the truth table, we applied the Quine–McCluskey algorithm to simplify the remaining table [14]. This led to our final set of configurations.

4 Results

Necessary condition analysis. The results of our necessary condition analysis revealed that none of the conditions pass the required threshold of 0.9. Thus, we concluded that there were no conditions always present in all cases exhibiting the outcome.

Sufficiency analysis. Our sufficiency analysis yielded an intermediate solution having four distinct configurations that explained the reduction of socio-cognitive inertia (see Table 2). Our solution shows an excellent consistency level of 0.97, which is well above the level of 0.8 that is considered acceptable in QCA research [14]. Additionally, the solution coverage value of 0.77 demonstrates that the solutions were able to explain the majority of outcomes. Coverage assesses the empirical relevance of a solution and each single configuration and refers to the percentage of cases exhibiting a certain outcome that can be explained with a solution or a single configuration [14]. Furthermore, raw and PRI consistency values of all single configurations were higher than 0.96 which demonstrates that they all led reliably to the outcome in question [14]. The first configuration (S1) represents DT projects in which a decentralized governing agency was combined with a highly participative approach. Dynamic capabilities were not relevant in this configuration. The second configuration (S2) depicts projects in which sensing capabilities were present in combination with a participative approach. In this configuration, it did not matter whether the governing agency was centralized or decentralized. The third configuration (S3) shows participative approaches combined with reconfiguration capabilities. The last configuration (S4) depicts projects in which both sensing and reconfiguring were present, combined with a centralized governance approach.

Table 2. Configurations for reduction of socio-cognitive inertia

Conditions	Reduction of socio-cognitive inertia			
	S1	S2	S3	S4
Dynamic capabilities				
Sensing		●		●
Seizing				
Reconfiguring			⬤	⬤
Governing agency				
Centralization	⊗			●
Participation	⬤	⬤	⬤	
Raw consistency	1.00	0.98	1.00	0.98
Raw coverage	0.37	0.52	0.62	0.52
Unique coverage	0.01	0.03	0.12	0.09
Solution consistency	0.97			
Solution coverage	0.77			

Black circle = presence of a condition; Crossed-out circle = absence of a condition; Empty row = may be either present or absent; Large circle = core condition; Small circle: peripheral condition; Raw consistency threshold: 0.9; PRI threshold: 0.8; Frequency threshold: 1.

5 Discussion

5.1 Cross-Configurational Patterns

Building upon our descriptive analysis of the identified configurations, we now discuss distinct cross-configurational patterns by comparing them to extant literature and integrating empirical observations from the cases forming parts of our analysis.

Decentralized governance is successful when combined with high participation. Typically, centralized governance designs are deemed to be more successful [12]. Therefore, having a decentralized governing agency as part of a successful configuration is surprising. A potential explanation could be derived from the fact that a project having a decentralized agency includes different types of people, because a team of business and IT professionals is needed to overcome inertia [43]. Furthermore, social relationships between a change agent, supports, and adversaries are important for DT [44]. A widespread de-centralized agency can possibly reach more people within an organization [45]. A decentralized governance approach allows decision makers to better reach the employees using the system. Therefore, it can be determined how these interact and whether they accept new processes. Furthermore, it helped those organizations gain insights from the IT and business departments. Although this served to surpass most hurdles, when necessary, the administration and higher management intervened and supported the transformation process.

Centralized governance is successful when combined with sensing or reconfiguration capabilities. The success of overcoming socio-cognitive inertia using a centralized governing agency is congruent with the findings of Weill and Ross [12], who found decentralized IT governance types having many decision-makers to be less effective than others. A centralized governing agency allows managers making the actual decisions to be more knowledgeable about planning in all areas. Having business managers with detailed knowledge about the plans of IT departments and its managers, having detailed knowledge about the plans, allows for better and more aligned decisions [46]. A possible explanation of why participation was not relevant in configuration S4 is that the centralized agency was led by a leader who guided and pushed the transformation in a top-down manner. This was the case at Royal Philips, where the chief information officer led the transformation and pulled lower management areas on board [37, 47]. Although this type of central governance is sometimes helpful, it is not always sufficient, because the current environment and IT decisions are very complex, and participants are not always able to understand what things will look like 5 years from now [37]. Therefore, reconfiguring is very helpful. This was achieved by some of the case organizations, because they adapted their project management methods using open and iterative approaches [36, 37, 47]. Although reconfiguration capabilities can help find the right foci for digitalization or lessons learned from failures, sensing capabilities are also helpful. An example is the innovation project of Audi-City, where a manager saw an opportunity to leverage a semi-virtual sales room and was so confident about it that he pursued it without informing managers [48]. At Audi, this sensing capability complemented the reconfiguring capability that allowed organizations to adapt the new circumstances without major hurdles. However, the centralized governance helped ensure the necessary authority to push through changes [48].

Participation leads to success. Participation is often mentioned as a success factor in DT [16]. It is also important for the general success of change and for reducing employee resistance [49]. In their literature review, Ali, Zhou, Miller and Ieromonachou [50] stated that researchers proposed a participative approach to overcome resistance during IT implementation. This agrees with the demonstrated high importance of participation found in our results. One explanation for this high success of participation was proposed by Bartunek, Rousseau, Rudolph and DePalma [51], who found that participation allowed employees to interact and make sense of changes together. We found that this also applied to other cases (Beiersdorf [36] and Lego [36, 52-55]). As explained earlier, participation supports a more positive attitude toward change [10]. We also observed this in the case of Hummels [56], who worked on adapting their culture with a major transformation. The argument of Oreg, Vakola and Armenakis [29] stated that participation allowed for a higher readiness toward change. This applied to our cases. An example is that of Sentara, where developing prototypes and employees empowerment to use systems at an early stage with a smaller scope was beneficial in preparing them to accept transformation [57]. Furthermore, for a large-scale transformation, knowledge from different business functions is often necessary. A high degree of participation secures this. This helped with the success of the introduction of SAP at Lego when they included diverse new business functions (e.g., sales, logistics, and IT) [52-55]. In summary, different types of dynamic capabilities with participation seems to lead to success in overcoming socio-cognitive inertia. This fits with the concept of equifinality, in which different path and the configuration of factors can lead to similar outcomes [58]. A possible explanation for this is that, for different types of environmental uncertainty, complex strategies (e.g., planning vs. trial-and-error learning) are efficient [59]. A high degree of sensing supports strategic planning, whereas reconfiguring supports trial-and-error learning. Therefore, differences in what capability has proven successful for a given company could arise because of differences in their project management approaches.

Reconfiguration capabilities as core conditions. In our results, reconfiguration capabilities appeared as core conditions, whereas sensing capabilities appeared only as peripheral conditions. Seizing capabilities did not appear at all. A reason why reconfiguration capabilities were important could be related to the fact that most of our cases exhibited a centralized governance. Compared to de-centralized governance approaches, centralized approaches were not suitable for customizing a system for specific needs [28]. Therefore, reconfiguration capabilities were needed later to adjust the system to the specific needs of employees. For example, at SFTR Telecommunications Group [40], a new IT system did not fit at all needs of the employees. This changed as soon as IT-related decisions were adapted to the actual needs because of top-management intervention. Reconfiguring and adaptations also made employees feel positive about their new IT system, because they felt taken seriously [60-62] and able to influence the transformation outcome. Therefore, they felt more in control and not as insecure. Additionally, they gained more ownership of the whole process. This type of ownership helps with reducing inertia [29]. Generally, a key difference between cases exhibiting sensing or reconfiguring capabilities is that, with reconfiguring, employees showed new and innovative ways of using technologies. Therefore, they increased their usage and adoption of IT and new processes even after implementation [63, 64]. Sensing capabilities are useful at the beginning to establish an initial project trajectory. However, they are also useful later on when new circumstances arise and reconfiguring is needed. In configurations where only sensing or only reconfiguring is present, employee participation helped to overcome missing dynamic capabilities [65].

5.2 Contribution to Theory and Practice

Our results extend research on dynamic capabilities and their interactions with socio-cognitive inertia. We answered calls for research on dynamic capabilities with a configurational approach [23] and [66] and an explanation of outcomes not directly related to performance [66]. Our results show that, generally, dynamic capabilities positively contributed to an organizations' ability to overcome socio-cognitive inertia during DT. When reconfiguration capabilities are important, sensing capabilities had a positive impact. In our analysis, seizing capabilities did not form part of any configuration and, therefore, had neither a positive nor a negative influence. Further research could validate our findings through the use of other quantitative methods (e.g., surveys of larger samples). We also provided further evidence for the importance of participation already seen as an important factors in IS change processes [18] and change in general [10]. We furthermore contribute to research on governing DT projects. Although extant literature describes decentralized governance types as less effective [12], our results only partially support these findings. Both centralized and decentralized governing agency types form parts of configurations that overcame socio-cognitive inertia.

In summary, we showed that different types of dynamic capability, participation, and the governance structure in different configurations were present when overcoming socio-cognitive inertia. From this, we derived several recommendations for practitioners. We suggest that companies build up their dynamic capabilities, especially those of sensing and reconfiguring. Furthermore, we advise firms to include the employees during the change process. Whereas the optimum degree of participation relies on the circumstances, it would also help to compensate any missing capabilities.

5.3 Limitations

Our research is not free from limitations. There may be other concepts having explanatory power that we did not incorporate into our research model (e.g., cognition [67], social network theory [68], personal traits [63], leadership theory (i.e., transformational vs. transactional [45], or the moment of change [63]). Future research should extend our model or change specific factors to test their explanatory power. Furthermore, our chosen research approach also leads to some limitations. Owing to coding our categories from existing case studies, our results were affected by the bias of the authors and their interpretation of the cases, which were mostly considered successful. However, when considering inertia, the cases differed from each other, because different levels of reduction of inertia were reported. For future studies, we propose researchers use different forms of inertia and select cases having both positive and negative outcomes.

6 Conclusion

In this paper, we investigated the dynamic capabilities that can be used to overcome socio-cognitive inertia in the context of DT. To this end, we conducted a case survey combined with an fsQCA approach. We showed that sensing and reconfiguration capabilities had positive impacts on the reduction of socio-cognitive inertia combined with a centralized governance approach. However, seizing capabilities did not have a positive or a negative influence. We also showed that socio-cognitive inertia could also be reduced by ensuring high participation among employees, even when combined with de-centralized governance approaches. Our results contribute to both theory and practice by opening future research avenues and providing actionable insights for DT managers.

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Appendix E. Towards a Conceptualization of Capabilities for Innovating Business Models in the Industrial Internet of Things (P5)

Towards a Conceptualization of Capabilities for Innovating Business Models in the Industrial Internet of Things

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Abstract. The emergence of Internet of Things (IoT) technologies offers promising value potentials for industrial manufacturers based on the combination of smart products and data-driven services. At the same time, many incumbent firms experience a threat to their traditional value proposition and are challenged to innovate and reconfigure their existing business models. However, many of these traditional manufacturers lack or are unaware of the required capabilities for successfully reinventing their business model using IoT technologies. We therefore adopt the lens of dynamic and operational capabilities and conduct an empirical analysis of organizational capabilities required for successful IoT-enabled business model innovation (BMI). Through an exploratory, qualitative study based on interviews with decision makers in industrial manufacturing companies and experts in practice-oriented research institutions, we identify eleven distinct dynamic and operational capabilities. Our findings provide useful insights for research and practice and advance the understanding of enablers in IoT-enabled BMI.

Keywords: Digital Transformation, Industrial Internet of Things, Dynamic Capabilities, Operational Capabilities, Business Model Innovation

1 Introduction

In recent years, the Internet of Things (IoT) received enormous attention in academic literature as well as industry practice and still remains a promising research area [1]. The emergence of IoT technologies and their application in the industrial context, also known as the Industrial Internet of Things (IIoT), changes competitive dynamics by erupting traditional market boundaries between industrial manufacturers, software providers, and technology start-ups [2, 3]. Traditional manufacturers are challenged to generate new value propositions through data-based services and predictive solutions [4] which often requires adaptation of existing business models [5]. The German automotive supplier Bosch, for example, uses IoT technologies to enable customers of its fleet management system to identify potential problems in advance and to analyze the driving behavior of individuals [4]. However, such change brings along numerous challenges and has major implications for incumbent firms [3, 6]. While traditional

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manufacturers possess critical industry knowledge, they most likely face substantial skill gaps when it comes to IoT and related business model innovation (BMI) [2, 6]. Besides a lack of technological expertise in areas such as IoT infrastructure, data analytics, and software engineering, industrial manufacturers are required to rethink existing business model components and to implement new approaches towards customer relationship management, sales, and collaboration with technology providers [3]. All in all, the IoT constitutes an exogenous technological change to which industrial manufacturers need to react by adapting their business model in order to capture the value potential and to secure future competitiveness [7].

Existing academic work on IoT-enabled BMI is still young and little is known about how the change in business models actually occurs. Most notably, there is a missing perspective on how to overcome the identified challenges and barriers of IoT-enabled BMI. In fact, based on our assessment, current literature fails to analyze enablers of IoT-enabled BMI and to conceptualize relevant organizational capabilities. There is thus a strong need to better understand the complex underlying processes and drivers of successful IoT-enabled BMI. Overall, existing research does not clarify the nature of required organizational capabilities for IoT-enabled BMI. In this paper, we present a conceptualization of eleven organizational capabilities that are required for IoT-enabled BMI. We identified these capabilities through an exploratory approach involving semi-structured interviews with decision makers in the German manufacturing industry and experts in practice-oriented research institutions. In the following, we introduce our understanding of IoT-enabled BMI and organizational capabilities that we applied in our exploratory research.

2 Theoretical Background

2.1 IoT-enabled Business Model Innovation

Despite a large body of research, existing theory still misses a common understanding about both business model (BM) and BMI [6, 8]. Therefore, it is essential to define both concepts in the context of our study. Business models are described as “mental models” [9] that represent the underlying architecture of a firm’s overall business [10]. The concept focuses on the underlying organizational structures, processes, and resources that enable value creation [9] and defines “[…] the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit” [11]. According to Foss and Saebi [8] BMI encompasses “[…] designed, novel, nontrivial changes to the key elements of a firm’s business model and/or the architecture linking these elements”. Following Tesch, Brillinger and Bilgeri [2], in the context of our study this includes both “the ‘modification, reconfiguration and extension […] of existing business models’ (business model development) as well as the design of ‘fundamentally new and sometimes disruptive’ business models (business model design)”. Furthermore, we refer to BMI using IoT technologies as IoT-enabled BMI.

Literature on IoT-enabled BMI can be grouped into three major research streams. The first stream focuses on the analysis of business model patterns and frameworks for the IoT and identifies new patterns such as remote usage or condition monitoring [1, 4, 12-14]. While many studies analyze the influence of IoT on specific business model components and describe underlying changes [12, 13], other studies do not focus on single organizations but take a broader view on the overall IoT ecosystem by analyzing the interaction and collaboration of different players [14]. Second, a group of studies analyzes the process of IoT-enabled BMI itself [2, 6]. For instance, Tesch, Brillinger and Bilgeri [2] apply a stage-gate model to IoT-enabled BMI and identify a semi-structured, iterative process. Moreover, current literature builds on processes identified in product development research, such as innovation stages in the process of IoT-enabled BMI [6]. Third, an emerging stream of literature analyzes challenges and barriers in IoT-enabled BMI [4, 6, 15]. Thereby, challenges are analyzed from both a technical and business perspective [6]. Manufacturers require new capabilities to incorporate software, data analytics, and data-based service offerings [2, 15]. All in all, companies need to develop capabilities to master both technology and business-related challenges in order to successfully implement IoT-enabled BMI [4]. However, current research is missing a close analysis of such organizational capabilities.

2.2 Organizational Capabilities

In this paper, we conceptualize organizational capabilities as dynamic and operational capabilities. The concept of dynamic capabilities was first introduced to better address the characteristics of today's volatile business environments and markets [16, 17]. They are described as "higher-order organizational capabilities" [18] that enable incumbent firms to modify existing capabilities, organizational structures, and even company culture [7, 18, 19]. The framework refined by Teece [20] distinguishes three basic dimensions of dynamic capabilities and differentiates the underlying organizational processes into the classes of sensing, seizing, and reconfiguration. Sensing capabilities encompass the organizational ability to discover opportunities related to technological developments as well as changes in customer requirements and the overall market [20, 21]. Seizing capabilities mainly encompass processes related to organizational value generation as well as new product development or service innovation [20]. Reconfiguration capabilities are based on processes for the alignment and realignment of organizational assets in order to meet new requirements [20]. These capabilities can address organizational topics such as decentralization or co-specialization and encompass critical processes of organizational knowledge management [20, 21].

Existing literature argues for the need to differentiate between different levels of hierarchy of organizational capabilities in order to reduce confusion about the concept and to eliminate its "tautological feel" [22]. Therefore, we distinguish two main classes of organizational capabilities: Dynamic capabilities and operational capabilities [23, 24]. Operational capabilities, also described as ordinary [16] or zero-level capabilities [17], encompass the operational function of a firm and enable the value proposition of a business model [22]. They are responsible for the execution of daily business operations and can be described as "how you earn your living" capabilities [17, 22]. In contrast, dynamic capabilities represent “how you change your operational routines” capabilities [22].

2.3 Dynamic Capabilities as Antecedents of Business Model Innovation

Several scholars regard dynamic capabilities as internal antecedents and drivers of BMI processes [8, 25]. Dynamic capabilities are integral to BMI as they enable firms to design and implement effective new business models [20, 25]. In addition, BMI requires strong dynamic capabilities as it involves a complex process of organizational and strategic renewal [19]. Besides strong sensing capabilities to realize the need for change, seizing capabilities are required for the modification and redesign of existing business models [19]. However, Leih, Linden and Teece [19] argue that capabilities for organizational reconfiguration and actual implementation of the business model are most critical, as BMI processes affect organizational boundaries, internal structures, and even company culture. Several authors build on the dynamic capabilities framework to advance theory on enabling capabilities. Mezger [18] conceptualizes BMI itself as a “distinct dynamic capability” and identifies corresponding organizational routines and processes. He uses the original framework by Teece [20] to disaggregate BMI dynamic capability into the dimensions of sensing, seizing, and reconfiguring capabilities. Thereby, “business model sensing” capabilities enable opportunity recognition by monitoring competition, market developments, and changes in industry-wide business models [18]. “Technology sensing” capabilities allow for a systematic assessment of technological possibilities and the exploration of new ideas. Seizing capabilities comprise innovation activities for the design and configuration of business models. Actual business model implementation is realized by reconfiguring capabilities that facilitate the realignment of operational capabilities and resources [18].

3 Methodology

We apply an exploratory, qualitative research design based on interviews with knowledgeable experts from the field to explore and describe the phenomenon of IoT-enabled BMI. We argue that the complex and highly context-specific nature of organizational capabilities is well-suited for the use of qualitative research methods. This approach allows us to generate rich theoretical insights from complex organizational decisions and processes. Further, the present study draws on evidence from multiple organizations to include several perspectives on the researched phenomenon. In the following, we describe our approaches for data collection and analysis in more detail.

3.1 Empirical setting

Regarding our industry interviews, we apply an industry focus on German small and middle sized enterprises (SMEs) in machinery and plant engineering to control for industry, regional, and strategic context [18]. The German industry is characterized by many highly specialized SMEs that contribute large economic value. Although many of the firms are global market leaders in specific segments, their positions are threatened by ongoing commoditization of machinery and by new competition arising from outside of the traditional manufacturing industry [26]. Thereby, most SMEs in machinery and plant engineering represent typical product-oriented manufacturers that are now challenged to innovate their business models [13, 26]. In addition, SMEs are likely to possess fewer resources as compared to industrial giants such as GE. Thus, they might lack sufficient capacities to react to technological change appropriately. The European Commission defines SMEs based on staff headcount and either turnover, or balance sheet total [27]. Thereby, a company qualifies as SME if it does not have more than 249 employees and its annual turnover does not exceed 50 Million €. However, many firms of the so-called "Mittelstand" in German machinery and plant engineering do not meet these requirements. Therefore, we apply the broader definition of SMEs provided by the Institute for SME research in Bonn to our company sample. Consequently, we also consider companies where the majority of company shares is hold by up to two natural person or their family members, given that these shareholders are active in the executive board [28].

We use theoretical sampling [29] to identify appropriate organizations for the empirical analysis. The objective of the selection process was to identify SMEs in the industry that already engage in IoT-enabled BMI and that experience the related transformation towards product-service combinations. We conducted an online search, using information from industry association websites and trade journals, to identify promising manufacturers for our research approach. We then gathered more specific information on single companies based on their corporate websites, product and service portfolios, and related press articles. In total, we contacted 50 individuals of 37 different companies, from which 17 executives replied. Some of them declined participation due to reasons of confidentiality, time pressure, or lack of experience. Eventually, we were able to schedule interviews with representatives from seven different SMEs. Our sample comprises six machine manufacturers and one electrical component supplier. All SMEs are headquartered in Germany but are present on international markets and often conduct global operations.

3.2 Data collection and analysis

In total, we conducted eight qualitative interviews with industry experts on IoT-enabled BMI. Seven interviews represent conversations with representatives of manufacturing firms. Thereby, we performed one interview per organization with each one executive. Moreover, we conducted one additional interview with an industry expert from a renowned research institution at the beginning of the data collection process. The interview was not firm-specific and rather explorative. We used the insights to generate a first understanding of IoT-enabled BMI in machinery and plant engineering and to further refine our interview guideline. **Table 1** represents an overview of all conducted interviews and the respective interview partners. Thereby, all interviewees were required to have at least three years of industry or research experience and, in the case of manufacturing organizations, to hold a managing position, preferably senior management, in research and development, business development, or product and innovation management.

Table 1. Overview of interviewed experts (M = manufacturing organization; R = research institution)

ID	*Expert role*	*Business sector*	*Founding year*	*Number of employees*	*Sales turnover*
M1	Head of Business Development	Packaging machinery and solutions	1869	2.500	€ 835 Million (2017)
M2	Senior Business Development Manager	Packaging machinery and solutions	1922	2.250	€ 350 Million (2017)
M3	Head of Product Engineering	Raw material processing and recycling machinery	1969	400	€ 100 Million (2017)
M4	Chief Information Officer	Environmental simulation and welding machinery	1913	8.200	€ 1,2 Billion (2017)
M5	Head of Digitalization	Packaging machinery and solutions	1961	5.065	€ 1 Billion (2017)
M6	Head of Machinery Solutions	Electrical component supplier	1850	4.700	€ 740 Million (2017)
M7	Head of Process Engineering	Water processing and machinery	1989	220	€ 19 Million (2016)
R1	Research Expert on Digital BMI	Research institution	1995	25.000	n/a

The interviews were recorded and transcribed afterwards. We used Qualitative Content Analysis as introduced by Mayring [30] to evaluate the transcribed expert interviews. While the initial categories were derived directly from the text basis using an open coding approach, we developed the main categories in close relation with existing theory on organizational BMI capabilities [18]. Challenges encountered by the organization on their way to IoT-enabled BMI constitute the basis of our category system. Thereby, a challenge comprises a situation that is described as being problematic and relatively new to the firm. Moreover, it cannot be solved with existing organizational processes, but requires management attention and dedicated investments. In addition, the challenge must not be firm-specific but can be transferred to the context of other organizations. The coding itself was conducted separately for each case study in order to allow for within-case analysis before aggregating the results. We then used existing literature on organizational capabilities to develop main categories for the identified challenges. The main categories group similar findings and allow us to identify critical capabilities for IoT-enabled BMI.

4 Organizational Capabilities for IoT-enabled BMI

We propose a conceptualization of IoT-enabled BMI organizational capabilities to link our findings to extant literature. We apply the lens of dynamic and operational

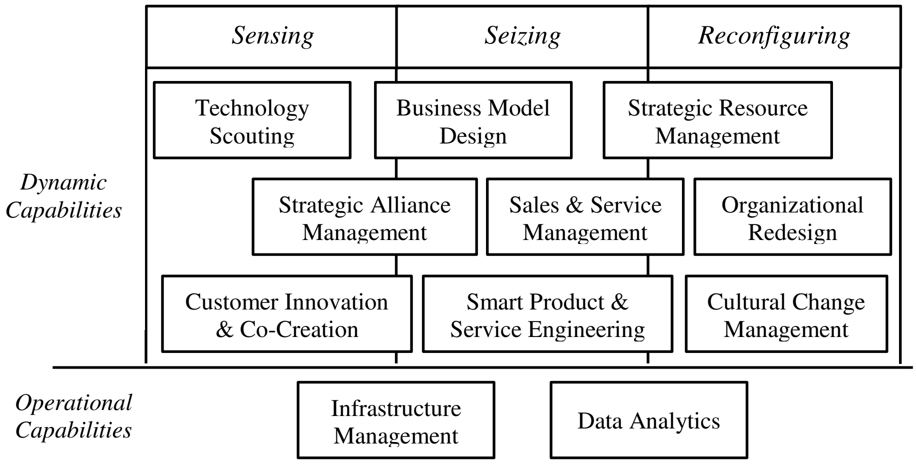

Figure 1. Conceptualized organizational capabilities for IoT-enabled BMI

capabilities to interpret our findings and group them according to the three dimensions of sensing, seizing, and reconfiguring dynamic capabilities [20]. Moreover, we use the concepts of dynamic and operational capabilities to distinguish between different types of organizational capabilities and the level of hierarchy on which they operate. Figure 1 presents our theoretical model that integrates the empirical findings into existing theory on BMI capabilities. We do not interpret the identified dynamic capabilities as purely sensing, seizing, or reconfiguring since they are often based on intertwined processes that relate to more than one capability dimension. Therefore, we interpret the three dimensions rather as a continuum and allocate identified dynamic capabilities in accordance to their main function and purpose. Furthermore, the model does not imply a strict chronological order. Although sensing capabilities are clearly needed at the beginning of the innovation process, the process of BMI is of iterative nature [2].

(1) Technology Scouting: A key challenge described by interviewees from all organizations in our sample is the understanding of IoT as a technology itself. Moreover, companies need to track the trends in technology development and assess the potentials of current IoT technologies. They first need to identify and then test appropriate solutions for the implementation within the own business environment:

> *"To a certain degree we are confronted with a real flood of suppliers. [...] Consequently, there are incredibly many service providers and suppliers of IoT technologies that are entering the market. And [...] it is a big challenge to [...] identify the right technologies that are appropriate for the own use case."* (M5)

This underlines that without a critical assessment at the beginning of the BMI process, companies will not be able to fully leverage the potential of IoT technologies and establish them at the foundation of their new business models. The capability "technology scouting" guides the evaluation process and increase the overall understanding of the technology itself.

(2) Infrastructure Management: Another challenge is the establishment of infrastructure that enables interconnection. Manufacturers need to install the required sensor technology on the machinery and establish network connections. Thereby, data and network security are highly important and need to be assured at all time:

"*Usually, our clients have their internal networks which are secured and protected. This is a major topic nowadays. Network security. But you have to access these networks. You have to access the client's network from the outside to do your job and this a major technical challenge"* (M7)

This also includes important decisions with regards to infrastructure for data storage, data processing, and data utilization. Many SMEs in machinery and plant engineering have no or little experience when it comes to sensor technology and IT security. Therefore, Infrastructure Management represents a critical IoT-enabled BMI capability. It encompasses the ability to establish and manage the required IoT-infrastructure for data generation and data-based value creation.

(3) Data Analytics is another organizational capability that is required to address the challenge of IoT technology as an enabler of BMI. It constitutes the capability to generate customer value from machine and process data, and to develop related software applications for data-based services. Therefore, organizations need to expand their existing skills in software engineering and build up critical expertise in areas such as big data or data science:

"I believe that one challenge that many companies face is to extensively collect data, to retrieve this data, to analyze it, and to draw the right conclusions in order to generate value for customers and for themselves." (M3)

(4) Business Model Design: Besides technology-related capabilities to implement IoT technologies as the necessary foundation, actual business model design is a key challenge. Organizations need to map business opportunities and define the corresponding use cases. This includes the design of new value propositions to meet emerging customer demands and to clearly segment existing and potentially new customer groups. Altogether, business model design depends on entrepreneurial processes which enable the exploration of new value propositions. Key decision makers need to promote the idea of recurring revenues and design appropriate revenue models. We therefore propose the organizational capability of Business Model Design that enables the organization to identify IoT-enabled value propositions and to design the corresponding BM. The capability is based on a systematic process for the exploration of new value opportunities and use cases. It is required to challenge the existing

business models and to implement a systematic and strategic approach towards business model design:

> "*Well, everyone has already heard at one point about leasing or predictive maintenance. But to systematically list 80 different business models and to analyze what fits to our company, that has not happened in the beginning. It was all very casual and rather informal"* (M1)

(5) Strategic Resource Management: The implementation of IoT-enabled BMI and the development of related organizational capabilities depends largely on the right resource endowments. Companies that engage in IoT-enabled BMI need to identify critical know-how and develop it within the organization:

> "*I also think that we should develop a lot of these competencies internally and not source them from the outside. Because at the moment it is quite difficult to foresee which competencies will be most critical for our future business."* (M6)

This also emphasizes the need for qualified employees. Many organizations are highly dependent on specialists that bring required know-how into the organization. Several companies in our sample have mentioned challenges with regards to the location of their headquarters that are often situated in rural areas. Besides the lack of know-how, the allocation of resources to innovation-related activities in addition to the current operations represents a key challenge, especially because most of the companies from our sample face exceptional good order positions and are working at full capacity. Our proposed capability allows companies to manage internal competition for resources and to pursue BMI activities without affecting ongoing operations negatively. Moreover, it encompasses the ability to identify areas of expertise that are best developed internally in order to gain competitive advantage in the long run.

(6) Customer Innovation & Co-Creation: Customer relations represent another main challenge faced by our sample organizations. On the one hand, industrial manufacturers require a certain level of openness to collaborate with customers and consider their input for product and service innovation. They need to understand the value of such co-innovation and establish the processes for collaborative innovation. However, this often contradicts the traditional mindset of SMEs in machinery and plant engineering. Many organizations have been very critical towards open innovation in the past and now face difficulties to open themselves and promote a new understanding of their clients as valuable business partners:

> *"We agree that it is important to understand customers more as partners. In my opinion that is inevitable for the survival in global competition."* (M3)

(7) Sales & Service Management: Our interviewees have pointed out the necessity to adapt existing marketing and sales processes. They need to create new ways on how to approach the client in order to demonstrate the value of data-based IoT services. The responsible sales teams need to understand the business value arising from software

applications as well as smart services and integrate the idea of recurring revenues in contrast to onetime sales. They also have to convince clients of the new value proposition and overcome customer concerns with regards to data privacy:

"Consequently, we have to change the way we approach our clients and how we are selling our solutions. So far, our machinery has never been online. We sold pure offline machinery that is usually located at […] storages at client site […]. This has never been an issue for them. Actually, they are very sensitive when it comes to external data and network connections, especially data sharing." (M5)

Moreover, the sales system needs to internalize a new understanding of services and digital products. In accordance with new revenue models, a shift from a product-centric towards a service-centric sales system might be required. We propose IoT Sales & Service Management as another capability to address the challenges at the front end of the IoT business model. This capability allows to market IoT-enabled products and services appropriately by reconfiguring established sales processes and by designing appropriate IoT sales and service strategies.

(8) Strategic Alliance Management: Many traditional manufacturers in machinery and plant engineering have only recently started to engage in open discussions on market and technological developments. In fact, some of them have never built on external solutions before to realize their product offerings. That is why they need to promote an integral organizational openness towards external collaboration:

"I am convinced that only those companies will succeed in IoT-enabled BMI that engage in strategic alliances. This means to cooperate with others along the value chain, with regards to data usage and data processing, if necessary with competitors […]. Only if these networks are created, which by the way is totally untypical for German machinery and plant engineering, […] success […] will be possible." (M1)

We propose that organizations need to develop Strategic Alliance Management capabilities to collaborate with external partners and networks in order to complement their existing capabilities. Moreover, they need to establish organizational processes that help to identify potential partners and to build up strategic alliances.

(9) Smart Product & Service Engineering: The value creation itself represents another major challenge. IoT-enabled BMI affects existing product innovation processes that so far are mainly oriented towards the development of physical products and add-on services such as repair and maintenance. Established product engineering processes are often not appropriate for the development of smart, digital products. Moreover, companies need to develop and implement a new understanding of a value creation that is based on machine and process data:

"Many organizations have no experience when it comes to data-based services. […] For example, if you do not sell machinery anymore but provide operator models you have to abandon the idea of onetime sales and implement processes for lifecycle-

services and recurring revenues. But this requires a huge shift in mindset with regards to value creation." (R1)

Therefore, we propose Smart Product & Service Engineering as an essential organizational capability for IoT-enabled BMI. It enables the organization to redesign existing product and service engineering processes and to develop smart products and smart services for data-based value creation.

(10) Organizational Redesign: Both scope and complexity of the organizational implementation of IoT-enabled BMI represent major challenges for our sample companies. Besides the necessity to redesign many critical organizational processes, nearly all organizational departments are affected by business model change. This emphasizes the need for a comprehensive transformation process that incorporates all organizational departments. Such complexity of implementation likely overwhelms traditional industrial manufactures:

"Another point is that we realized that the whole topic around digitalization, transformation, changing market requirements, and organizational culture involves such high complexity that we feel overwhelmed and that very likely we are not able to cope with this transformation on our own, organically." (M2)

Although all of the identified organizational capabilities enable organizations to reconfigure organizational processes, we propose a distinct capability of Organizational Redesign that allows to reconfigure organizational structures and support processes as well as to reallocate responsibilities to organizational units.

(11) Cultural Change Management: Many of the above-mentioned challenges and capabilities already point out the importance of a change in organizational mindset. Thereby, organizations not only need to challenge their existing business models, but also need to realize the importance of change in the first place. Despite current favorable market conditions, they need to take notice of the developments in the industry and raise overall awareness and openness towards change:

"It is also a very comfortable position to just say and acknowledge something could happen. I mean our order books are so full and the situation at the moment is just heavenly." (M4)

Organizations need to develop a certain organizational mindset that allows them to observe changes in market and technology and to initiate first actions. We therefore propose Cultural Change Management as an organizational capability that enables manufacturers to induce and manage cultural change throughout the organization. Thereby, it promotes a culture that values exploration and raises the openness towards IoT-enabled BMI.

5 Discussion, Contributions, and Limitations

The findings from our qualitative study support our understanding of dynamic capabilities derived from existing literature. They encompass a collective activity that enables organizations to systematically modify its operating routines [31]. We also find evidence for the key role of top management in the reconfiguration process [32]. Moreover, the empirical findings show the importance of sensing, seizing, and reconfiguring dynamic capabilities for IoT-enabled BMI [20]. In order to cope with technological change such as the emergence of IoT technologies, organizations need to reconfigure their existing resources as well as operational capabilities and establish new organizational processes [7]. Several of our identified capabilities could also be applied to general BMI (e.g., Business Model Design or Technology Scouting) or to data-driven BMI (e.g. Data Analytics), i.e., BMI based purely on the use of data analytics. However, capabilities such as Smart Product & Service Engineering go beyond the mere collection and analysis of data. While data-driven business models focus on "acquisition of data, its subsequent aggregation, the analysis of data […], and actions that are triggered" [33], we argue that IoT-enabled business models can be interpreted as an instance of data-driven business models that focus on more specific aspects such as enriching physical products with digital services [1]. However, future research could further explore how IoT-enabled BMI differs from more general data-driven BMI.

Our study contributes to literature on dynamic capabilities to advance theory on enabling factors in BMI [8]. Thereby, our set of organizational capabilities confirms the relevance of previously identified dimensions of dynamic capabilities in BMI research. Furthermore, we reduce the abstractness of the dynamic capabilities framework [5] by analyzing the underlying processes and providing a conceptualization of concrete capabilities.

The proposed findings have several important implications for industry practice and managerial decisions. In essence, SMEs are required to undertake a systematic assessment of their existing organizational capabilities and to define a set of capabilities required for their individual BMI aspirations. Key decision makers in the organization need to realize the need for change and interpret the value opportunities of IoT technology accordingly. IoT-enabled BMI very likely affects the entire organization and requires organizational redesign and restructuring. One key insight for managers is the necessity of cultural change. Leadership needs to promote an overall organizational openness towards external exploration and to overcome traditional thinking. Overall, we believe that our conceptualization of capabilities assists practicing managers in making informed decisions about the required investments in capability development and in reflecting on IoT-enabled BMI in general. Thereby, the practical implications are not limited to SMEs in machinery and plant engineering.

Our findings are not free from limitations. First, our model does not represent a complete set of capabilities and several capabilities might overlap to some degree or depend on each other (for example Organizational Redesign and Cultural Change Management). Organizational capabilities are highly context-dependent, and every incumbent firm faces different capability endowments [16]. Therefore, there is no definite set of key capabilities and our findings need to be interpreted within the given organizational context of a firm. Although we propose that our proposed capabilities lead to successful IoT-enabled BMI, we do not measure the interrelation with firm performance nor do we provide any evidence of a positive effect of the realization of our capabilities on actual BMI implementation. In fact, we argue that a capability-based conceptualization of IoT-enabled BMI alone cannot explain successful IoT-enabled BMI and superior performance since many factors need to be taken into account for an analysis of firm performance [16]. Furthermore, while exploratory, qualitative research approaches offer great potential to add new perspectives and extend existing theory, our relatively small expert sample limits the generalizability of the findings [29].

As mentioned in section 3.1, our empirical settings is focused on German SMEs in machinery and plant engineering in order to control for industry, regional, and strategic context. Furthermore, we believe that these SMEs are, due to their limited resources, under high pressure to build up relevant capabilities and thus represent an interesting context for our study. On the other hand, our identified capabilities could also be specific to SMEs in our chosen context while capabilities for large corporations or companies in other regions could be different. Strategic Alliance Management, for example, could be less critical for large corporations due to their extensive sets of existing resources. We regard our results as a first step towards an exhaustive conceptualization of capabilities for IoT-enabled BMI and invite other researchers to verify, extend, or adjust our set of capabilities by replicating our study in different contexts.

6 Conclusion and Opportunities for Future Research

The emergence of IoT technologies brings along new business opportunities in industrial manufacturing. However, IoT-enabled BMI constitutes a highly complex transformation process and implicates severe challenges [6]. Thus, the main purpose of this paper is to advance research on organizational capabilities that are required to master the challenges of IoT-enabled BMI. We identify several dynamic and operational capabilities that represent enablers of IoT-enabled BMI. Overall, organizations are required to assess their existing capability endowment and strategically invest in IoT-enabled BMI capabilities to seize the value opportunities of the Internet of Things in industrial manufacturing. Thereby, our empirical findings contribute to understanding key enablers and antecedents in BMI [25]. Finally, they outline a promising field for future research on IoT-enabled BMI.

IoT-enabled BMI in industrial manufacturing offers a promising area for future research in both information systems and strategic management literature. Especially the concepts of BMI and dynamic capabilities require additional empirical studies to advance existing conceptualization and overall understanding. While we present a rather aggregated view on different capabilities, future studies could focus on distinct capabilities and analyze underlying processes and resources in detail.

Furthermore, future research could include large-scale, empirical studies with longitudinal design. Such studies would allow observing the entire process of IoT-enabled BMI and could provide important insights on performance outcomes and the interrelation of different organizational capabilities. In addition, studies applying a retrospective analysis on success cases could provide interesting benchmarks and contribute to a comprehensive understanding of IoT-enabled BMI.

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Appendix F. Pathways to Successful Business Model Innovation in the Context of Digital Transformation (P6)

Pathways to Successful Business Model Innovation in the Context of Digital Transformation

Completed Research Paper

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Abstract

The process of digital transformation (DT) is driving established companies to innovatively modify existing business models. However, extant research provides very little insight into the determinative factors that contribute to successful business model innovation (BMI) in the context of DT. In this analysis, we draw on a resource-based view (RBV) by analyzing firms' dynamic and information technology (IT) capabilities by applying a configurational perspective to explore how companies can successfully transform their business models. To do so, we collected data of 15 established companies and employed fuzzy-set Qualitative Comparative Analysis (fsQCA) to derive the specific configurations that ultimately lead to success. We extend existing research on BMI in the context of DT and provide new insights regarding the combination of IT and dynamic capabilities.

Keywords: Digital transformation, business model innovation, fuzzy-set Qualitative Comparative Analysis, IT capabilities, dynamic capabilities

Introduction

The process of digital transformation (DT) is currently disrupting virtually every industry in developed economies. The increased and widespread availability of innovative technologies has enabled startups to enter traditional markets such as banking, automotive, and manufacturing (Fitzgerald et al. 2013). To sustain their competitive positions, large, established companies are increasingly being pressured to transform their existing business models. However, even the availability of resources such as specialized knowledge or an existing customer base does not guarantee that a company will be able to successfully innovate their business model. General Electric, for example, introduced a novel Internet of Things (IoT) platform and launched new services based on digital technologies but their innovative efforts were met with languishing stock prices (Davenport and Westerman 2018). Nonetheless, extant research provides little insight into the success factors that determine business model innovation (BMI) success in the context of DT.

In this paper, we used the lens of resource-based view (RBV) to investigate how established firms can successfully innovate their business models in the context of DT. We used an RBV perspective that specifically considered a firm's dynamic and information technology (IT) capabilities since these concepts have been frequently linked to the success of DT initiatives (Nwankpa and Roumani 2016;

Vial 2019). We argue that traditional approaches such as regression-based models do not sufficiently represent and explain the inherently complex process of DT. Therefore, we conducted a multiple-case study of 15 established companies that recently innovated their business models as part of a DT initiative. We then drew on configurational theory by applying fuzzy-set qualitative comparative analysis (fsQCA) to reveal a variety of pathways and combinations of capabilities, resulting in a more holistic perspective (Ragin 2009). We extend existing, emergent research on BMI in the context of DT and provide new insights regarding the combination of IT and dynamic capabilities. Our results are relevant to scholars and practitioners alike.

The remainder of this paper is structured as follows. First, we provide an overview of the relevant literature on DT and BMI as well as dynamic and IT capability theory. Then, we introduce a configurational research model and describe our methodological approach. Afterward, we provide a descriptive account of our results and discuss them. We also discuss the limitations of our work as well as potential for future research. Finally, we conclude the paper by outlining the contributions of our work.

Conceptual Background

Digital Transformation and Business Model Innovation

Digital technologies have fundamentally changed the way companies conduct business. Unlike earlier forms of IT-enabled change, DT impacts the business model of a firm to a high degree (Riasanow et al. 2019; Soto Setzke et al. 2020b; Vial 2019). Business models can be described as mental models that represent the underlying architecture of a firm's overall business (Foss and Saebi 2017). Thus, they focus on the underlying organizational structures, processes, and resources that enable value creation (Foss and Saebi 2015) and define "the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" (Teece 2010, p. 172). Business models consist of four components: the value proposition, the target customer, the value chain, or the revenue model (Gassmann et al. 2013). The target customer deserves particular attention since, without the ability to meet customers' needs, many business models fail (Morris et al. 2005). The value proposition describes the products or services offered to create value for the customer. The processes and activities needed to create and distribute a value proposition are defined within the dimensional value chain. The fourth dimension, the revenue model, explains the financial viability of a business model. It encompasses the cost structure and revenue-generating mechanism of a business model (Gassmann et al. 2013).

Startups are using digital technologies to enter and claim markets that were once dominated by traditional, established companies. To defend their positions, these companies are now under pressure to adapt their business models, a process known as BMI (Schneider and Spieth 2013). We draw on Foss and Saebi (2017, p. 216) who define BMI as "designed, novel, nontrivial changes to the key elements of a firm's business model and/or the architecture linking these elements". The properties of digital technologies add a new perspective to the relatively new research stream on BMI. A business model can be classified as digital if fundamental changes within the organization, as well as the value generation paths, are modified using digital technology or if digital products or services are offered (Veit et al. 2014). Digital business models differ from traditional ones in several aspects (Remane et al. 2017). The main difference lies in the extremely low marginal cost of digital goods and its network externalities, namely, that the value of the good increases if more people utilize it (Shapiro and Varian 1999). Moreover, the value of the good is only generated while the user is interacting with the product and by creating an entire user experience (Vargo and Lusch 2008). Finally, digital business models rely on a product's ecosystem to increase their value (Hein et al. 2019a; Iansiti and Levien 2004).

Scholars have identified different antecedents for BMI and digital BMI in particular (Böttcher and Weking 2020; Foss and Saebi 2017). External antecedents include factors such as new or changing customer needs and market, technology ascendance, and competitive pressure, while internal antecedents include financial needs, technology exploitation, or limitations of a current business model (Böttcher and Weking 2020). In particular, organizational capabilities have been identified as important antecedents for BMI and digital transformation success (Ertl et al. 2020; Soto Setzke 2020; Soto Setzke et al. 2019). Dynamic capabilities allow firms to design and implement new business models as it involves a complex process of both organizational and strategic renewal (Bouncken and Fredrich 2016; Saebi 2015). They are helpful since BMI impacts organizational boundaries, internal structures, as well as company culture (Leih et al. 2015). Furthermore, we argue that in the context of digital transformation, IT capabilities play a decisive role, as supported by previous research (Nwankpa and Roumani 2016; Pavlou and El Sawy 2010).

IT Capabilities

IT capabilities are defined as a firm's "ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities" (Bharadwaj 2000, p. 171). IT capabilities can endow a company with a sustainable competitive advantage if they are valuable, rare, imperfectly imitable, and non-substitutable (Wade and Hulland 2004). When a firm possesses these characteristics, they are considered to be key organizational capabilities that foster superior firm performance because they enable companies to utilize emerging digital technologies to their advantage in response to change (Bharadwaj 2000; Nwankpa and Roumani 2016; Wade and Hulland 2004). Also, El Sawy et al. (2010) demonstrated that IT capabilities play a critical role in facilitating superior firm performance in turbulent environments. Due to their effect on a company's competitive advantage, significant scholarly attention has been directed toward this topic (Bharadwaj 2000; Mithas et al. 2011; Wade and Hulland 2004). Lu and Ramamurthy (2011) conceptualized IT capabilities in terms of three dimensions: *IT infrastructure capability* refers to a firm's ability to manage data, network, and processing architecture to build a foundation of enterprise applications and IT services. *IT business spanning capability* refers to a firm's ability to successfully support business objectives by exploiting its IT resources. *IT proactive stance* describes a company's ability to continually generate ideas for utilizing IT resources to identify new business opportunities.

Empirical evidence indicates that a firm's IT capabilities contribute to organizational performance by enabling companies to outperform their competitors (Bharadwaj 2000; Mithas et al. 2011). However, there is also substantial evidence that IT capabilities, rather, play a mitigating role in firm performance. Thus, IT resources influence firm performance indirectly by impacting the productivity of other firm resources (Chen et al. 2013; Wade and Hulland 2004). Interestingly, manufacturing firms invest in different types of IT resources, explaining some of the differences in how IT capabilities impact service and manufacturing firms (Aral and Weill 2007). Also, El Sawy et al. (2010) found that IT capabilities do not always bestow competitive advantage; within stable environments with predictable change, IT capabilities can even negatively affect firm performance in the case of big companies. Moreover, Bharadwaj (2000) discovered that IT investments and firm profitability are not correlated, suggesting that not all firms are successful in creating effective IT capabilities. Therefore, only when combined efficiently with other valuable, rare, imperfectly imitable, and non-substitutable resources, are IT capabilities able to provide a firm with competitive advantage.

Dynamic Capabilities

Dynamic capabilities enable companies to create a sustainable competitive advantage in quickly changing environments (Teece 2007). Thus, they play a major role in information systems (IS) literature (Riasanow et al. 2019). They are defined as an "organization's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997, p. 516). Specifically, dynamic capabilities enable firms to modify their existing capabilities, organizational structures, and even company cultures (Leih et al. 2015). They reflect the degree and velocity to which a company's resources can be realigned to fulfill the requirements of a changing environment as well as shape that environment by exploiting opportunities (Katkalo et al. 2010). Furthermore, they allow companies to effectively implement new business models (Teece 2007). Especially for firms changing the degree of their service offerings, dynamic capabilities are of high importance (Kindström et al. 2013). Thus, dynamic capabilities can be seen as a main driver of BMI and essential to a firm's long-term success by enabling organizations to achieve high returns (Katkalo et al. 2010; Soto Setzke et al. 2019; Teece 2007).

To increase the understanding and assessment of dynamic capabilities, this concept is commonly split into three micro-foundations: a firm's sensing, seizing, and reconfiguration capabilities (Katkalo et al. 2010; Teece 2007). *Sensing capabilities* are similar to their exploratory capabilities, as they encompass the ability to identify opportunities. They capture value by enabling a firm to transform itself with perfect timing by leveraging the benefits of first-mover strategy (Katkalo et al. 2010). *Seizing capabilities* relate mainly to organizational value creation, service innovation, and product development abilities and refer to the concept of exploitation (Teece 2007). *Reconfiguration capabilities* consist of actual transformational capabilities that enable a company to actively manage threats, iterate its business model, and develop new complements by enhancing, combining, protecting, and reconfiguring its resources (Katkalo et al. 2010; Teece 2007). These capabilities are most critical for the success of BMI since they facilitate the actual transformation. While IS literature, for the most part, connects dynamic capabilities to BMI or technological artifacts, organizational literature also links them to the ability to implement internal changes, such as overcoming resistance to change (Ertl et al. 2020; Riasanow et al. 2019; Soto Setzke 2020). Just like IT capabilities, extant literature states that dynamic capabilities are only able to become fully developed in combination with other resources (Bharadwaj 2000).

Research Model

In this paper, we investigate how organizational capabilities and types of BMI influence the success of a firm's BMI. We argue that due to DT's inherent complexity, several distinct paths can ultimately lead to success. Thus, we pursued a configurational approach to incorporate the equifinality and asymmetry of the constructs' influences on the outcome. We operationalized **BMI success** as customer acceptance of the new offering. We defined customer acceptance as expressed, as well as executed, need or desire to acquire the respective product or service by the relevant customers (Herbig and Day 1992). Relevant customers thereby refer to the target customer group that a firm intends to address, adjusted according to the company's target market share.

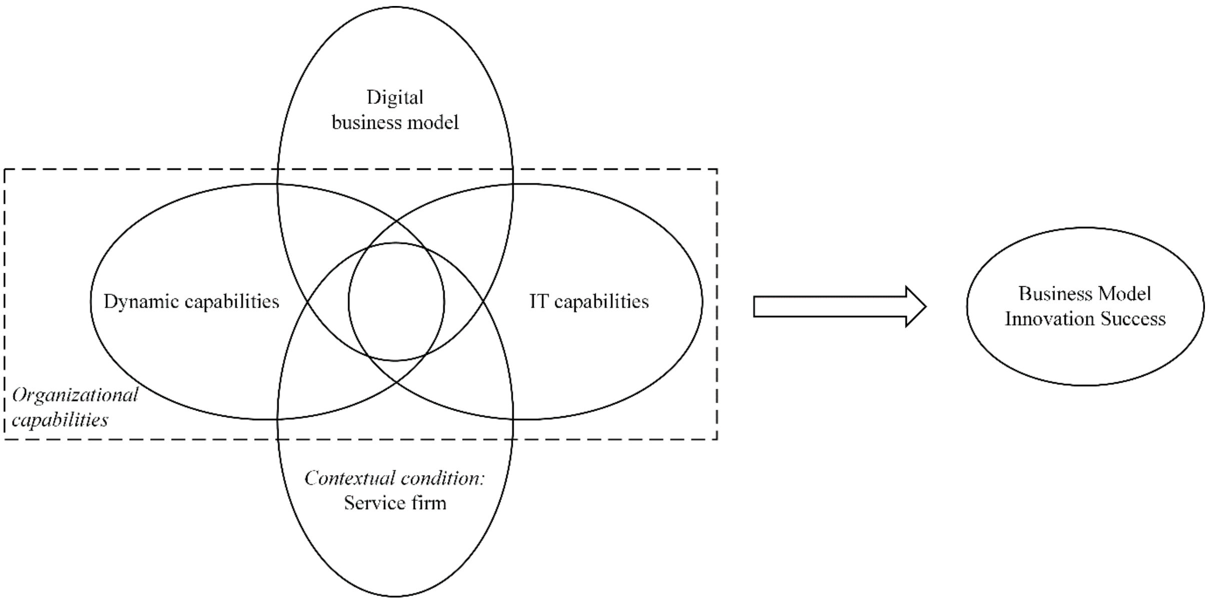

Figure 1. Configurational research model

As explanatory factors, we included two types of organizational capabilities in our model: **dynamic capabilities** and **IT capabilities**. We further analyzed whether a company offered a purely digital product or service, such as an IoT platform, or whether it used digital technologies to offer an add-on to an existing business model (i.e., a digitally enabled business model). We labeled this condition a **digital business model** (Veit et al. 2014). Due to differences in IT capabilities as well as the varying level of importance of dynamic capabilities to service and manufacturing firms, we also included a firm's **degree of service offering** as a contextual condition in our research model (Aral and Weill 2007; Kindström et al. 2013). Moreover, Anderson et al. (1997) discovered that the tradeoffs between customer satisfaction and productivity are more challenging in service industries, potentially influencing our outcome of interest, BMI success. Figure 1 depicts a Venn diagram that illustrates our configurational research model.

Methodology

Our dataset consists of 15 companies that recently initiated BMI projects leveraged by digital technology. The companies varied in terms of their general properties such as size, family ownership, and industry. Only companies that modified at least two of the four BMI categories (value proposition, target customer, value chain, and revenue model) were considered, following the definition of BMI previously established by the theoretical background. Further, these changes must have been made as the result of a DT initiative. We selected only firms in at least an intermediate or advanced stage of a BMI endeavor. We excluded firms in conceptualization or early stages of transformation since we would be unable to detect any of the defined success indicators, such as customer acceptance. All case studies were based on semi-structured interviews that were conducted with employees, managers, and executives from various levels of company management. On average, eight interviews were conducted for each case. If specific information was not present in any case, we triangulated data from several additional sources. An overview of the selected cases is provided in Table 1.

Table 1. Case study overview

Case Study	Headquarters	Industry	†Customer Type	*Number of Employees (2017)	Number of Interviews
MOVIE	Germany	Media	B2B	Medium-sized	8
HARDWARE	Germany	IT-Service	B2B	Medium-sized	8
MUSIC DHC I	Germany	Entertainment	B2C	Small	7
MUSIC DHC II	Germany	Entertainment	B2C	Small	7
MUSIC LABEL	Germany	Entertainment	B2C	Small	7
MEDIA	Germany	Media	B2C	Large	7
LOGISTICS	Germany	Logistics	B2B	Large	9
MEASURE	Germany	Plant engineering	B2B	Large	6
FARMER	USA	Agriculture	B2B	Large	8
COMPRESSOR	Germany	Plant engineering	B2B	Medium-sized	5
BOTTLE	Germany	Plant engineering	B2B	Large	8
SOFTWARE	USA	Software	B2B/B2C	Large	7
BEVERAGE	Austria	Food & Beverage	B2C	Large	15
SYSTEM	Germany	Software	B2B	Large	5
MULTI	Germany	Engineering	B2B/B2C	Large	7

Note: *Small firms: < 1,000 employees; medium-sized firms: 1,000-10,000 employees; large firms: > 10,000 employees. †B2B: Business-to-Business, B2C: Business-to-Consumer.

To analyze customer acceptance of BMI, we employed fsQCA. Configurational approaches support the analysis of complex phenomena characterized by asymmetric relationships since the method analyzes conditions both simultaneously and interconnectedly (Hein et al. 2019b; Liu et al. 2015; Soto Setzke et al. 2020a). Therefore, qualitative comparative analyses (QCAs) build on set theory, transforming cases into configurations. A configuration can be described as "a specific combination of [conditions] that produces a given outcome of interest" (Ragin 2009, p. xix). Cases are categorized into sets according to their characteristics. Using fsQCA, cases can hold membership (*fully in*) or non-membership (*fully out*) in a set, while partial membership scores for the respective conditions are also allowed (Ragin 2009), p. 89). Fuzzy values on a continuous range from zero (0) to one (1) build the underlying data for the analysis. FsQCA analyzes how membership of cases in conditions is linked to membership in the outcome set (Fiss 2011). In terms of sample sizes, fsQCA can be used with a minimum of twelve cases

(Ragin 2009). Thus, it is especially useful with a medium-sized sample set (12-50 cases) with rich data and allows researchers to systematically compare causal connections between these cases (Greckhamer et al. 2013). It should be noted that, unlike traditional regression-based methods, fsQCA is based on an approach of "modest generalization" (Berg-Schlosser et al. 2009, p. 12). Specifically, a researcher can deduce propositions based on an fsQCA and apply these to other cases that share similar characteristics (Berg-Schlosser et al. 2009). While this approach may be more limited than traditional regression-based generalizations, it is also more robust than generalizations drawn from multiple-case studies with smaller data set. Apart from this, we assume that the reader possesses basic knowledge of fsQCA and recommend, if needed, referencing the work of Liu *et al.* (2015), Ragin (2009), and Schneider and Wagemann (2012) for further information. Regarding our fsQCA, we performed four main steps: building the configurational model, calibrating the data, analyzing the necessary conditions, and analyzing sufficient configurations. To perform the fsQCA, we utilized the QCA for R software package developed by Dușa (2019). As recommended by Schneider and Wagemann (2012), we examined the presence and absence of the outcome separately.

Table 2. Calibration table

Dimension / Case	**IT Capabilities**	**Dynamic Capabilities**	**Digital Business Model**	**Service Focus**	**Customer Acceptance**
Theoretical ideal (fully in = 1)	The IT infrastructure is functioning robustly and strongly supports business goals (Chen et al. 2013; Nwankpa and Roumani 2016).	The company can reconfigure its business in response to new opportunities in a timely manner (Teece 2007).	The new business model is purely digital as opposed to a traditional business model that is supported by digital technology (Remane et al. 2017).	The company provides only services instead of goods (Verhoef & Leeflang, 2009).	Most of the relevant customers express a need/want and acquire the product or service (Herbig and Day 1992).
MOVIE	0.67	0	0.67	1	0
HARDWARE	0	0	0	0.67	0.33
MUSIC DHC I	0.33	0.33	0.33	1	0.33
MUSIC DHC II	1	1	0.33	1	1
MUSIC LABEL	1	1	0	0.33	1
MEDIA	1	0.67	1	1	0
LOGISTICS	0	0	0.33	1	0.33
MEASURE	1	1	1	0.33	0
FARMER	1	1	1	0.33	0.67
COMPRESSOR	1	0.33	0	0.33	1
BOTTLE	1	1	1	0.33	0.67
SOFTWARE	1	0.33	1	0	1
BEVERAGE	1	1	0.33	0	1
SYSTEM	1	0.33	1	0.33	1
MULTI	1	0.67	1	0.33	1

First, we built our configurational model. For this purpose, we precisely defined the outcome of interest—BMI success—as well as the various configurations (Greckhamer et al. 2018). Following Greckhamer *et al.* (2018), we selected explanatory conditions using existing theory and applied case-based knowledge to develop new theory. In the present study, we combined a deductive with an inductive approach to determine the conditions (Halme et al. 2018). Second, we calibrated the data by assigning fuzzy membership values to each case and condition. The process of calibration is defined as assigning set membership scores to each condition and to the outcome to convert distinct category measures into a scale ranging from zero (0) to one (1) (Juntunen et al. 2019). To achieve consistent scoring, we created an interpretation scheme that describes the respective set memberships by quantifying the degree to which a case belongs to a set (Ragin 2009). We defined the theoretical ideal, or ideal state (*e.g.*, *fully in* = 1, *fully out* = 0), for each condition by drawing on existing literature (Fiss 2007). The level of detail in our data favored a four-value scale that permitted membership scores of "*fully out* = 0," "*more out than in* = 0.33," "*more in than out* = 0.67," and "*fully in* = 1" (cf. (Halme et al. 2018). When scales for fuzzy-set scores were not readily available, we used within-case and cross-case comparison to determine their characterizations (Iannacci and Cornford 2018). To determine the final membership level, we followed the approach employed by Iannacci and Cornford (2018), utilizing the lower set membership of all first-order constructs. Through in-depth analyses of the cases and corresponding interviews, we determined fuzzy-set memberships for each case and condition according to the interpretation scheme established. The actual membership scores are listed in Table 2.

Third, we analyzed the set relations regarding their necessity (Ragin 2009). We considered conditions as necessary when they exceeded a consistency level of 0.9 and a relevance of necessity above 0.6 (Duşa 2019; Greckhamer et al. 2018; Ragin 2009; Schneider and Wagemann 2012). Finally, we pursued a sufficiency analysis to examine configuration of conditions associated with customer acceptance, BMI success. Since our sample consisted of 15 cases, we used a frequency threshold of one (1) to cut off empty rows in the truth table as recommended for small-N analyses (Ragin 2009). Furthermore, we considered configurations with consistency scores above 0.8. For configurations that were sufficient in terms of both the occurrence and non-occurrence of the outcome, the proportional reduction of inconsistency (PRI) served as a decision criterion for selecting relevant configurations (Schneider and Wagemann 2012). Only relationships with a PRI above 0.75 were included in the analysis (Misangyi and Acharya 2014). In line with prior research, we utilized the intermediate solution to serve as the primary model for making causal claims and the parsimonious solution for determining peripheral conditions (Fiss 2007; Halme et al. 2018). Core conditions appeared in both the parsimonious and intermediate solutions, while peripheral conditions were only part of the intermediate solution (Fiss 2011). Core conditions held higher causal relevance for the outcome. Although peripheral conditions possessed a weaker decisive nature for the outcome, they could not be removed from the solution as this would require making implausible assumptions (Juntunen et al. 2019; Misangyi and Acharya 2014). To interpret our findings, we drew on coverage values to assess relative importance (Forkmann et al. 2017). Configurations should contain high coverage to be considered as relevant and explain a large proportion of the outcome (Misangyi et al. 2017). Moreover, we analyzed the consistency of the respective solutions to investigate whether or not the configuration implied a positive or negative outcome. The consistency score should exceed a value of 0.8 to represent a satisfactorily approximated subset relationship, similar to the requirements of the sufficiency analysis (Misangyi and Acharya 2014; Schneider and Wagemann 2012).

To determine the validity of our results, we performed several sensitivity tests. We tested whether our results would change when deviating coverage thresholds by ±0.05 (Skaaning 2011). When the coverage threshold was lowered from 0.8 to 0.75, our model remained consistent with the existing solutions. When the threshold was increased to 0.85 for coverage, dynamic capabilities were labeled as being a core rather than a peripheral condition in a configuration. This indicated that dynamic capabilities might have a larger joint effect. As all solutions passed the sensitivity test, our results could be considered quite robust.

Results

Analysis of Necessity

None of the conditions could be identified as necessary for a positive outcome (see Table 3). Although IT capabilities exhibited a high inclusion value of 0.93, above the recommended threshold of 0.9, the relevance of necessity showed a score of 0.474, below the recommended threshold of 0.5 (*cf.* (Greckhamer et al. 2018; Ragin 2009; Schneider and Wagemann 2012). For the absence of the outcome, no condition was found to be necessary. Therefore, no condition needed to be excluded from the sufficiency analysis.

Table 3. Analysis of necessity

Condition	Presence of the Outcome			Absence of the Outcome		
	Inclusion of Necessity	Relevance of Necessity	Coverage of Necessity	Inclusion of Necessity	Relevance of Necessity	Coverage of Necessity
IT capabilities	0.93	0.47	0.72	0.65	0.27	0.31
Dynamic capabilities	0.68	0.73	0.73	0.47	0.51	0.31
Digital business model	0.61	0.64	0.63	0.70	0.55	0.44
Service firm	0.43	0.64	0.50	0.88	0.70	0.63

Analysis of Sufficiency

The specific configurations that are associated with customer acceptance and customer rejection are depicted in Table 4. We found two solutions that led to customer acceptance of the company's BMI. Since the overall solution coverage was 0.79, almost 80% of the variance within the outcome could be explained by our solutions, indicating a high level of empirical importance (Juntunen et al. 2019). All of the configurations of the solution were empirically relevant because their unique coverage was above zero (Forkmann et al. 2017). The overall solution consistency was very high, with values above 0.9. The raw consistency of the configurations was equally high, ranging between 0.9 for S1 and one for S2. Raw coverage implied a high explanatory value for S1 and a lower explanatory value for S2.

The empirically most relevant configuration is S1, with the highest unique coverage of 0.47. This configuration suggests that strong IT capabilities foster customer acceptance of firms selling goods rather than services. The solution is indifferent regarding dynamic capabilities and the degree of digitalization of the business model. S2 states that if companies transformed into a digitally enabled traditional business model instead of a purely digital business model, firms possessing both IT and dynamic capabilities achieved high success rates in customer acceptance. Whether the firm was service-oriented was irrelevant to the solution.

Table 4. Analysis of sufficiency

Conditions	Customer acceptance		Customer rejection
	S1	S2	S3
Capabilities			
IT capabilities	●	⬤	⊗
Dynamic capabilities		●	
Digital business model		⊗	
Service firm	⊗		●
Raw consistency	0.9	1.0	0.88
Raw coverage	0.65	0.32	0.41
Unique coverage	0.47	0.14	-
Solution consistency	0.92		0.88
Solution coverage	0.79		0.41

Black circle = Presence of a condition; Crossed-out circle = Absence of a condition; Empty row = may be either present or absent; Large circle = Core condition; Small circle: Peripheral condition; Raw consistency threshold: 0.8; PRI consistency threshold: 0.75; Frequency threshold: 1.

We found only one solution leading to customer rejection. Despite the sound consistency and coverage of the configurations for the positive outcome, the solution for customer rejection displayed a slightly weaker relevance. Nonetheless, the configuration showed a relatively high consistency score that was above 0.8. As the unique coverage was zero, we could not extract any empirical relevance from the results. For solution S3, we found that the absence of IT capabilities led to customer rejection of service firms. Therefore, a lack of IT capabilities was the only core condition, providing higher causal explanatory value (Fiss 2011; Juntunen et al. 2019). Whether the firm possessed dynamic capabilities and the type of BMI did not influence customer rejection in this configuration.

Discussion

Our findings illustrated two distinct configurations of conditions for companies to achieve customer acceptance *(i.e.*, BMI success) and one configuration to experience customer rejection. By finding multiple solutions leading to the same outcome, we can demonstrate the equifinality of BMI in the context of DT (Fiss 2007). These results further support that DT is a complex phenomenon consisting of individual developments wherein configurational approaches can contribute to understanding by simplifying this complexity . We further discuss our findings in the following sections, complementing our insights with case knowledge.

Joint effects of IT and dynamic capabilities. Previous literature suggests that for DT initiatives, dynamic capabilities (Katkalo et al. 2010; Soto Setzke 2020) and IT capabilities (Bharadwaj 2000; Nwankpa and Roumani 2016) are of particular importance (Vial 2019). However, these capabilities only develop their full potential when deployed in combination with other resources (Bharadwaj 2000; Chen et al. 2013; Leih et al. 2015; Wade and Hulland 2004). Our findings partially support this view. For customer rejection, we discovered that if IT capability (S3) was absent, it played a subordinate role in whether the other type of capability was present or not. Thus, only the combination of dynamic and IT capabilities could potentially prevent the outcome of customer rejection within these specific configurations, indicating the combined effect of capabilities. This finding is in line with previous research (Bharadwaj 2000; Katkalo et al. 2010; Teece 2007). Moreover, for S2, both IT and dynamic capabilities were necessary to achieve customer acceptance in the context of digitally enabled traditional business models. Configuration S2 was also reflected in the digital business model transformation of MUSIC in the case of the company founding its own label. They were able to develop and improve their dynamic capabilities through various other BMI initiatives that they undertook throughout previous years. They furthermore built up profound IT capabilities by learning from the failure of their first transformation. The joint dynamic and IT capabilities enabled the firm to succeed with their new business model, demonstrating that learning from failure can create the capabilities necessary for implementing future changes.

However, the concurrent presence of both capabilities does not necessarily lead to customer acceptance of digital business models. We could not find such a relevant configuration. Moreover, within the displayed solutions, the presence of a digital business model was not an irrelevant condition. In contrast, the absence of a digital business model was even found to be a core condition of configuration S2, suggesting high causal relevance (Fiss 2011; Juntunen et al. 2019). Thus, the combination of capabilities did not lead to success, in opposition to the results of prior research. Further, Configuration S1 suggests that only IT capabilities are important for the success of DT when a firm is selling goods instead of services (S3), implying that IT capabilities can achieve customer acceptance without the deployment of other resources. This contradicts previous findings that resources require other resources for creating sustainable competitive advantage (Bharadwaj 2000; Chen et al. 2013; Wade and Hulland 2004). Moreover, these findings also oppose current research (Leih et al. 2015; Teece 2007), as dynamic capabilities seem not to be required for the achievement of BMI success (S1). Further research is required to analyze whether the other capabilities that were not integrated into the model ultimately led to successful BMI or whether IT capabilities can create a competitive advantage independently.

Digital business models. Due to their digital nature, we expected digital business models to require more dynamic and IT capabilities into which they could transform. However, our results rather suggest the contrary. Digitally enabled traditional business models seem to inherit more challenging characteristics and require additional capabilities for their success. Configuration S2 demonstrates that digitally enabled business models require both dynamic and IT capabilities of a firm to achieve customer acceptance while purely digital business models are not explicitly part of any configuration. Although digital business models might be subject to other challenges not included in our model, our findings connote less success potential for digitally-enabled traditional business models. We argue that the reason for this difference might lie in the scope of change required for an entire organization. For digital business models, most companies build a new department (*cf*. MULTI) or subsidiary (*cf*. BOTTLE). Therefore, most parts of the organization remain largely unaffected by the transformation. In contrast, the transformation of a traditional business model requires the whole organization, including existing departments, to evolve. For example, COMPRESSOR needed to adapt their entire service division to comply with their uptime guarantees. Moreover, the sales department was required to adapt their processes, since they were contacting finance managers instead of production planners. These qualitative examinations support the view that digitally-enabled traditional business models imply a higher scope of change, increasing the difficulty in successfully managing the change. With these findings, we connect the type of BMI to classical change management literature. A vast number of prior studies have investigated the difficulties of change (Aladwani 2001; Josserand et al. 2006; Schein 1992), finding that about 70% of organizations fail in their transformational attempts (Balogun and Hailey 2008). This further supports our finding that digitally-enabled traditional business models require more capabilities since BMI success is more difficult because they require large-scale, organizational transformation.

Service firms. Service firms differ from firms that sell goods about the types of IT capabilities into which they invest (Aral and Weill 2007), suggesting a relationship between IT capability and the service focus of a firm. In line with these findings, our data displayed differences regarding the importance of IT capabilities to service firms. In configuration S1, it is evident that for firms offering goods instead of services, the presence of IT capabilities led to customer acceptance, whereas for service firms, the absence of IT capabilities led to customer rejection (S3). Accordingly, there is no specific evidence that firms selling goods fail with the absence of IT capabilities or that service firms succeed with the presence of IT capabilities. This further demonstrates that achieving customer acceptance is more challenging for service-oriented rather than product-oriented firms (Anderson et al. 1997). This might be because knowledge-intensive services require IT capabilities as central rather than support functions, making the lack of such crucial to customer rejection (Khatri et al. 2010).

COMPRESSOR, a German middle-class family firm, serves as an excellent example of this configuration. COMPRESSOR manufactures compressors, which they sell directly to customers. Over years of rather an evolutionary transformation, they were able to build unique IT capabilities by gathering scarce knowledge about machine data. For the firm, these unique capabilities endowed them with a competitive advantage over their rivals. As the first to offer performance-based contracting, this company was able to gain many new customers. On the other hand, service providers like LOGISTICS and HARDWARE failed in digital BMI as a result of their obsolete legacy IT systems. This further acknowledges the indifference regarding the presence of dynamic capabilities for absent IT capabilities (S3). Even with strong dynamic capabilities, the obsolete, legacy systems would have prevented the companies from succeeding in transformation. Interestingly, according to our findings, this seems not to apply to firms selling goods.

Summarizing the two configurations, service companies are prone to failure for absent IT capabilities (S3) while firms selling goods require IT capabilities to succeed (S1). Intuitively, these two statements support a common conclusion: that for both services- and goods-selling companies, IT capabilities are crucial. However, the presence or absence of a service focus shows a distinctive characteristic exists among the two types of firms. Thus, service firms might not create competitive advantage, but only prevent their failure through the presence of IT capabilities, while firms selling goods might not fail because of absent IT capabilities but require them to achieve outstanding success. Future research needs to be conducted to examine whether there is no difference between the importance of IT capabilities for service firms or firms selling goods, or whether service firms have more difficulty with a lack of IT capabilities (Anderson et al. 1997).

Limitations

Compared to classical variance methods, set-theoretic approaches have several advantages, especially for studying complex phenomena like DT (El Sawy et al. 2010; Liu et al. 2015). In particular, fsQCA enables a high granularity enabling the researcher to discover interconnected patterns in their data (El

Sawy et al. 2010). Despite the many advantages, fsQCA implies certain methodological limitations. Although difficulties arise in any empirical analysis in terms of the selection of relevant conditions (*i.e.*, independent variables in variance theory), these limitations are even more apparent in small-N or intermediate-N QCAs . For our study, only four conditions could be simultaneously selected, leaving limited options for control elements. We encourage other researchers to create a larger dataset to run the same analysis with additional or different conditions. Doing so could provide further explanation of customer rejection, for which we were unable to identify any configurations with high empirical relevance. Although our dataset was carefully selected to guarantee variance in general firm characteristics such as family ownership, size, and industry, our data sample consisted mainly of European and North American companies. To verify or localize our solution in other regions, scholars should extend the data sample to include companies from the Asia-Pacific region, Africa, or South America. Such cases could also be used to enlarge the dataset and confirming or disconfirming the results from our small-N analysis. Furthermore, future research should analyze whether the results differ if other measures of BMI success would be utilized. Despite the relevance of customer acceptance to the success of BMI (Morris et al. 2005), other measures of success might be able to examine different aspects and be more appropriate for other target groups. It would be interesting to compare our results to studies that operationalized success with the firm performance or company-specific metrics such as the fulfillment of the firm's purpose.

Future research should build on these findings in prospective studies. For example, we found that IT capabilities might have a positive effect on customer acceptance without the presence of other capabilities, contradicting the results of previous research that stated that IT capabilities only have a moderating effect (Bharadwaj 2000; Chen et al. 2013; Wade and Hulland 2004). We suggest that researchers examine the underlying rationales of this finding. One starting point might be to analyze the types of IT capabilities and respective circumstances creating a competitive advantage for the firm. Moreover, researchers could also investigate which capabilities not integrated into the model in combination with IT capabilities led to successful BMI or whether IT capabilities can independently create a competitive advantage. Moreover, forthcoming studies should focus on the difference between digital business models and digitally enabled traditional business models. Finding that digitally-enabled traditional business models require the presence of both dynamic and IT capabilities while digital business models can cope without one of them suggests that digitally enabled business models have more difficulty in achieving customer acceptance. As described above, we argue that the reason for this lies in the scope of change, connecting our findings to existent change management literature (Aladwani 2001; Balogun and Hailey 2008; Josserand et al. 2006; Schein 1992). Researchers should conduct studies more closely examining the difference between the two types of business models to gain new insight into the discovered outcomes and validate our argumentation. Furthermore, future studies could adopt a distinct perspective on such business model types, for instance, by also considering purely analog, traditional business models. Another interesting research field is determining the underlying reasons for differences between service-oriented and product-oriented firms. Our findings suggest that IT capabilities are more relevant to achieving success for firms selling goods, but are more important to service firms to avoid failure, while the literature suggests a higher level of difficulty for service firms (Anderson et al. 1997). Future studies should generate more insight regarding which findings are most relevant to the case of DT. Furthermore, it is unclear whether the differentiation between service and manufacturing firms might provide a more appropriate perspective than distinguishing between service firms and companies selling goods. Scholars can replicate our study by including such differentiation in their analysis. Finally, in the light of the mentioned "modest generalization" approach inherent to fsQCA, we recommend validating the results of our analysis with a regression-based research approach (Berg-Schlosser et al. 2009, p. 12).

Conclusion

In this paper, we investigated the influence of IT and dynamic capabilities on the success of BMI in the context of DT. To this end, we conducted 15 multiple-case studies and employed fsQCA to derive different configurations that led to both success and failure. Our results demonstrate the importance of IT capabilities for the success of goods-oriented companies and the importance of combined IT and dynamic capabilities for digitally enabled business models. We also presented the absence of IT capabilities as a factor contributing to the potential failure of service-oriented firms. Our results contribute to both practice and theory and present multiple avenues for future research.

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Appendix G. Pathways to Digital Service Innovation: The Role of Digital Transformation Strategies in Established Organizations (P7)

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Pathways to Digital Service Innovation: The Role of Digital Transformation Strategies in Established Organizations

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Abstract
Digital technologies are radically changing how established organizations design novel services. Digital transformation (DT) strategies are executed to manage the transition from product-centric to service-centric business models based on digital technologies. However, little is known about what configurations of DT strategies lead to successful digital service innovation (DSI) in established organizations. We employ fuzzy-set Qualitative Comparative Analysis on a set of 17 case studies of DT strategies from established organizations with different industry backgrounds. We identify several distinct configurations of DT strategies that lead to successful and unsuccessful DSI. Based on these configurations, we deduce that the threat of digital disruption negatively impacts an organization's innovation activities. Furthermore, we find that strategic partnerships can be leveraged by organizations that face an imminent threat of digital disruption while organizations with competitive advantages may rely on "do-it-yourself" approaches. Lastly, we find that the involvement of a C-level executive is a necessary requirement for successful DSI. Our results contribute to theory by integrating research on DSI and DT, providing a perspective on DSI failure, and employing a configurational research approach that allows us to highlight interdependencies between factors as well as insights into the individual factors. Furthermore, we provide actionable recommendations for executives.

Keywords Digital transformation · Digital service innovation · Radical service innovation · Digital transformation strategies · Qualitative comparative analysis

1 Introduction

Service innovation plays a decisive role in our society. The continuous refinement and development of radically new services have brought substantial advances to the individuum, companies, and society as a whole (Miles 2005). The widespread availability of digital technologies such as in-memory databases, cloud computing, or distributed ledgers enables organizations to radically transform value propositions. These advancements enable higher accuracy and efficiency to meet economic needs, and also tackle worldwide challenges and pave the way for sustainable societies (Pappas et al. 2018). This comprises a multitude of sectors and use cases: for example, platform-based service concepts such as crowdsourced delivery have the potential to significantly reduce traffic and pollution in densely populated areas (Paloheimo et al. 2016). In developing economies and rural areas, financial services offered by so-called mobile money operators enable financial access and inclusion for disadvantaged communities (Economides and Jeziorski 2017). In the health care sector, novel devices such as wearables or smart glasses improve the quality of treatments and patient care (Klinker et al. 2020). To effectively design and develop these new services, established organizations need to embrace digital technologies and integrate them into their processes, organizational structures, and working models, a process known as digital transformation (DT) (Vial 2019). While information systems (IS) research and organization/management theory (OMT) have a long history of exploring the relationship between technology and organizational change, the phenomenon of DT is novel concerning the use of digital technologies

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(Besson and Rowe 2012). They differ from earlier technologies in their inherent characteristics such as programmability, the homogenization of data, and their self-referential nature (Yoo et al. 2010). Thus, the transformational abilities of digital technologies go further than merely automating processes and satisfying information needs to enable fundamental changes in a company's business model (Besson and Rowe 2012). This also implies that DT is not merely "old wine in new bottles" and learnings from earlier schools of thought may not necessarily apply to the logic of DT (Vial 2019).

Extant research on service innovation acknowledges the importance and game-changing nature of DT (Goduscheit and Faullant 2018; Barrett et al. 2015; Lusch and Nambisan 2015). So far, research on DSI and DT has highlighted process models for agile co-creation (Sjödin et al. 2020), organizational enablers in established companies with data-rich environments (Troilo et al. 2017), and design frameworks for service innovation in the context of smart product-service systems (Zheng et al. 2018). Furthermore, there are articles about the importance of digital service innovation (DSI) for including service-disadvantaged communities (Srivastava and Shainesh 2015), archetypes of service innovations in the sharing economy (Frey et al. 2019), and scaling contact-intensive services through the use of IT (Kleinschmidt et al. 2019). Various scholars have explored the formation and execution of DT strategies as well as the emergence of new executive roles, such as the Chief Digital Officer (CDO), and their integration into the organization (Chanias et al. 2019; Hanelt et al. 2020; Singh et al. 2019).

However, little is known about how the building blocks of DT strategies impact service innovation. IS research has explored the characteristics of DT strategies and their impact on innovation processes mostly through conceptual works and single or multiple-case studies (Matt et al. 2015; Hess et al. 2016; Chanias et al. 2019). We argue that these case studies are highly context-dependent, with limited generalizability. Companies such as SAP or Siemens have successfully managed to transition from a product-centric to a service-centric business model using digital technologies. Both companies designed and executed large-scale DT strategies to manage this transition. However, the mere existence and formulation of a strategy do not guarantee its success. Although General Electric (GE) equipped many of its products with sensors, built its own Internet of Things platform, and developed new digitally-enabled services, its stock price continued to languish which eventually led to the departure of its former CEO. This suggests that the success of DSI depends on different factors, which may not be uncovered through a single-case study alone. As can be observed in the mentioned case of GE, a strategy that may have worked effectively for one organization may not easily be transferable to another. Research on DT strategies, however, has so far mainly investigated how DT strategies are formulated and executed, but not their degree of success (Berghaus and Back 2017; Matt et al. 2015). Against this background, we argue that combining DT strategies and service innovation enables the filling of a theoretical research gap as well as providing actionable guidelines for practitioners. Thus, we investigate the building blocks of a DT strategy that lead to successful DSI. Since these elements may depend on each other and contextual or environmental factors, we employ configuration theory. As a result, the research question that guides this paper is as follows:

> **RQ:** *What configurations of digital transformation strategies lead to successful and unsuccessful digital service innovation?*

To address this question, we first carried out exploratory, in-depth case studies with 17 established organizations that have recently formulated and launched a DT strategy. To systematically compare these cases and to derive configurations, we chose the set-theoretic method of fuzzy-set Qualitative Comparative Analysis (fsQCA) (Ragin 2008). Our analysis yields two configurations for successful and three configurations for unsuccessful DSI. Our study makes several contributions. First, we integrate the literature on DSI and DT strategies to paint a more complete picture of these complex and interrelated phenomena. Second, we add a perspective on DSI failure to the predominant focus on DSI success. Third, we employ a configurational viewpoint to investigate our research question, following recent calls for both DT research (Riasanow et al. 2019; El Sawy et al. 2010) and service (innovation) research (Goduscheit and Faullant 2018; Kohtamäki et al. 2019). This enables us to highlight the interdependencies between the different DT strategy building blocks and shed light on the individual factors and explore their contributions to DSI at the same time. Fourth, we provide actionable insights for practitioners regarding the design of DT strategies.

2 Conceptual Background

2.1 Digital Service Innovation

The concept of service innovation emerged recently and as a result, it is still far from having an established common understanding among scholars (Goduscheit and Faullant 2018). Service-dominant (S-D) logic is a frequently used conceptual framework that interprets service innovation as "the creation of new value propositions by means of developing existing or creating new practices and/or resources, or by means of integrating practices and resources in new ways" (Skålén et al. 2014). Concerning its degree of change, service innovation can be categorized as either incremental or radical

(Goduscheit and Faullant 2018). While incremental innovation is associated with only minor changes to the already existing characteristics of a service's value proposition, radical innovation refers to an entirely new set of characteristics (Johansson et al. 2019). For example, a tracking system for door-to-door deliveries adds value through the use of digital technologies to an already existing service and can, therefore, be classified as incremental service innovation (Cheng 2011). On the other hand, providers such as Amazon are implementing radical innovations through the use of internet technologies by changing how the benefits of their services are delivered (Cheng 2011). In highly competitive environments, pursuing radical service innovation has been identified as a critical success factor for achieving high performance and service quality (Sok and O'Cass 2015). Recently, the widespread availability of different digital technologies has led to a multitude of startups disrupting traditional markets and, therefore, increasing competition. Thus, established organizations are challenged to engage in radical service innovation that builds on the distinctive features of digital technologies (Lusch and Nambisan 2015; Yoo et al. 2012; Sklyar et al. 2019).

Several scholars have highlighted the role of digital technologies in service innovation (Lusch and Nambisan 2015; den Hertog 2000; Goduscheit and Faullant 2018). Extant research has also demonstrated that technology is a fundamental enabler of service innovation (Troilo et al. 2017), and, in particular, a major driver for achieving radical service innovation in established organizations (Goduscheit and Faullant 2018). A major focus of extant research is the process of DSI. The challenge of managing efficient value co-creation can be tackled by using an agile micro-service innovation approach (Sjödin et al. 2020). To ensure successful cooperation and governance, relational teams that integrate knowledge from both providers and customers are required. To connect data-rich organizational environments with opportunities for service innovation, data density processes need to be implemented (Troilo et al. 2017). To make these processes more effective, companies are required to design a customer-centric, data-oriented organizational culture, and to implement strong support from senior management (Troilo et al. 2017). Various articles have also investigated the characteristics and benefits of DSI. In particular, it can be used to include service-disadvantaged communities, for example, in the context of healthcare or finance (Srivastava and Shainesh 2015; Economides and Jeziorski 2017). Depending on the specific context, there are also distinct archetypes of innovation (Frey et al. 2019). While DSI provides various benefits for organizations, it also comes with serious challenges since it "requires a change in managing provider-customer relationships by adopting new and innovative co-creation approaches" (Sjödin et al. 2020, p. 479). While extant literature provides multiple insights into organizational enablers and process frameworks for DSI (Goduscheit and Faullant 2018; Troilo et al. 2017; Sjödin et al. 2020), so far it has not shed light on the role of DT strategies in achieving radical innovations.

2.2 Digital Transformation Strategies

DT is "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial 2019, p. 118). For the remainder of this paper, we use organizations as the entity of interest. Significant change refers, among other things, to the "creation of new value propositions that rely increasingly on the provision of services" (Vial 2019, p. 125). To trigger or to enable DSI, established organizations (so-called brick-and-mortar firms) design large-scale DT strategies (Matt et al. 2015; Hess et al. 2016). This type of strategy has appeared relatively recently and complements an organization's existing repertoire of IT and digital business strategies. While these strategies focus on managing a firm's internal IT infrastructure with little to no impact on innovation or potential future business opportunities based on digital technologies, DT strategies focus on the transformational steps needed to realize future opportunities (Matt et al. 2015). In this paper, we suggest DT as an appropriate antecedent for DSI in established organizations. In particular, we focus on DT strategies that aim to induce the process of DT at an organizational level (Matt et al. 2015). Research on DT strategies is still in its infancy, due to its relatively recent emergence and focuses mainly on the formation and execution of strategies (Vial 2019; Hanelt et al. 2020). DT strategies are often initially shaped by separate sub-communities in an organization (Chanias and Hess 2016). Management then tries to align these efforts to the already existing strategy, leading to a highly dynamic process that iterates between learning and doing (Chanias and Hess 2016; Chanias et al. 2019). In the initial stage of the transformation, companies may choose a centralized or a decentralized approach for implementing the strategy (Berghaus and Back 2017; Singh et al. 2019). This often involves a Chief Digital Officer (CDO) who leads and initiates the transformational endeavor (Haffke et al. 2016). Depending on the organization's strategic focus, the specific tasks of the CDO and their anchoring in the organization may vary. For example, CDOs that fulfill the role of change agents may predominantly rely on formal coordination mechanisms, such as cross-functional steering committees (Singh et al. 2019). Innovation-focused CDOs, on the other hand, may focus more on informal coordination mechanisms, such as brainstorming or ideation sessions (Singh et al. 2019). When designing DT strategies, organizations often have a wide range of options to choose from (Hess et al. 2016). These include questions of leadership (who is in control of DT), organizational structures (how should organizational structures adapt), and outsourcing (what needs to be done by the organization itself and what can be done by partners/service providers).

The transformative nature of digital technologies poses the question of how to adapt organizational structures, i.e. the concept of structural separation. Several scholars posit that existing organizational structures are often not an adequate environment to explore digital innovation and exploit its business potential (Teece 1996; Yoo et al. 2012). What changes should be made and how is heavily debated in different literature streams (Dixon et al. 2017; Haffke et al. 2016; Markides 2013). Separating different parts of the organization not only from an organizational structure point of view but also physically likely favors innovation-related activities (de Visser et al. 2010). On the other hand, organizations may choose to fully incorporate new activities into existing corporate structures either without or with only minor organizational changes, resulting in lower restructuring efforts. Close integration with the core business can lead to increased collaboration between business units and thus favor synergies between old and new parts of an organization. Matt et al. (2015) suggest that for smaller changes in products or processes, integration into existing corporate structures may be favorable. For substantial changes, however, separate subsidiaries such as new business units or spin-offs should be chosen. New organizational units are often implemented as so-called digital innovation labs (DILs). These are separate units, intended to bundle an organization's innovation activities and capabilities (Hund et al. 2019). Spin-offs, however, are entirely separated from the main organization's corporate structure and are often completely autonomous entities. This may increase decision-making speed as well as response times to market changes. As an additional benefit, separation also prevents spillovers of corporate culture, policies, and systems that hinder innovation activities (Sklyar et al. 2019). Still, spin-offs pose new challenges to the main organization. Embedding them may result in difficulties, especially when trying to integrate them again in the future (Dixon et al. 2017). Furthermore, separating innovation activities from the main organization may also lead to failure in synergy exploitation and a risk of missing collaboration between the spin-off and relevant business units from the main organization (Markides 2013).

Furthermore, when designing a DT strategy, organizations need to decide on the locus of authority to plan concerning the execution of such decisions. Following Mihalache et al. (2014) and Wong et al. (2011, p. 1210), the centralization of decision-making "occurs when decision-making power resides in the hands of a selected few at the upper levels of an organization, whereas decentralization occurs when decision-making power involves individuals at various organizational levels". Various organizational science scholars highlight the advantages of decentralized decision-making (Mihalache et al. 2014; Jansen et al. 2006). Such an approach may strengthen the responsiveness and flexibility of an organization due to a decrease in information decay, caused by the exchange of information between different levels of hierarchy (Mihalache et al. 2014). Thus, this may also enable a higher degree of local control over IT systems since these can more easily be adapted to the individual needs of different internal stakeholders (Huang et al. 2010). Furthermore, for locally organized customer relationships, centralization leads to corporate dissonance which is often resolved by shifting the responsibility to lower-level managers since they are closer to the customer (Sklyar et al. 2019). On the other hand, IS scholars oftentimes recommend centralized decision-making, especially for DT strategies (Horlacher et al. 2016). Recently, there is increasing evidence of the effectiveness of introducing CDOs (Singh and Hess 2017). They are usually part of the management board since they need sufficient opportunities to influence DT-related decisions. However, in organizations in which business departments are in charge of innovation management, CDOs may not be needed or may even have a detrimental effect (Leonhardt et al. 2018). Oftentimes, DT strategies are also managed by a cross-functional steering committee of key executives, sometimes called a "digital committee" (Haffke et al. 2016; Chanias et al. 2019). This committee often replaces the role of the CDO, sharing the responsibilities among the members, but may also be formed in parallel (Haffke et al. 2016). A smaller number of people who are involved in decision-making is associated with an increase of decision-making speed and decisions that challenge the status quo and therefore lead to higher innovation performance (Teece 1996). Furthermore, a centralized approach also enables stricter global control over IT systems (Brown and Grant 2005). This, in turn, leads to a reduction of uncertainty through earlier planning, without the need to involve several decision-makers or to follow decision processes that may be too complex (Reynolds et al. 2010). In the context of DT, centralized decision-making may also lead to higher digital innovation performance when an organization is faced with a highly turbulent environment (Leonhardt et al. 2018). In summary, while extant research agrees that the locus of decision-making is a success factor for organizational transformation, it differs in how centralized it should be.

Typically, established organizations will have extensive know-how on their existing products and processes, but their capabilities for executing DSI will vary. Equally, they have different options for acquiring these capabilities: they may opt to acquire these capabilities internally ("insourcing") or engage in strategic outsourcing through alliances and partnerships to externally acquire the necessary innovation capabilities (Vial 2019). To insource, organizations may choose to train their established workforce to turn them into co-creators of DT (Müller and Renken 2017) or they may extend their workforce by hiring employees that bring the required capabilities into the organization (Teece 1996). Additionally, acquiring other organizations may have a positive effect on innovation processes if the acquired companies have relevant digital innovation capabilities (Hildebrandt et al. 2015). However, the importance of outsourcing and building strategic partnerships for DSI has grown over the last few years since building up capabilities internally may not be feasible for many organizations. Diverse entities such as "competitors, suppliers, customers, end-users, universities, or public research institutions" may serve as partners for DSI (Hottenrott and Lopes-Bento 2016, p. 778). Engaging in partnerships leads to higher dynamic adjustability and scalability of a firm's assets and competencies (Bouncken and Fredrich 2016; Hottenrott and Lopes-Bento 2016). Strategic outsourcing played a significant role in LEGO's digital strategies by complementing their existing capabilities (El Sawy et al. 2016). Furthermore, collaboration helps to reduce internal resistance to innovation as well as creating an agile mentality and working culture (Piccinini et al. 2015). Still, a high collaboration intensity may also lead to a negative impact on innovation performance (Hottenrott and Lopes-Bento 2016). In particular, long partnership durations affect performance negatively since they "might drive misalignment of partners, breed strong conflicts, or opportunism tactics about value capture" (Bouncken and Fredrich 2016, p. 3588). Furthermore, organizations disclose internal knowledge to external parties, which carries certain risks with it. Therefore, the decision of how and to what extent to engage in strategic outsourcing and how this affects innovation performance depends on different factors.

So far, the literature has hardly investigated the effectiveness of DT strategies and their influence on the desired outcomes, such as the effectiveness of service innovation, at all. This limitation is also acknowledged by scholars: Berghaus and Back (2017, p. 14), for example, state that they "cannot make any remarks on one approach being more successful than another". Matt et al. (2015, p. 342) noted that research on DT strategies would benefit from "comparing digital transformation strategies across different industries [...] in order to increase success rates". DT strategies are often regarded as successful if they are implemented as planned, but without measuring the results (Singh and Hess 2017; Hess et al. 2016). A notable exception is the work of Leonhardt et al. (2018), who use a quantitative measure for assessing digital innovation performance. Their results highlight the importance of centralized decision-making in turbulent environments and the potentially detrimental effects of CDOs when business departments are responsible for digital innovation. Furthermore, they show that turbulent environments generally favor innovation performance, which may suggest a positive effect of competitive threats in the context of DT. However, the analysis does not consider other factors such as outsourcing or structural separation.

2.3 Research Framework

In this paper, we focus on explaining what combinations of DT strategies lead to successful and unsuccessful DSI. As DT strategy building blocks, we choose three different elements building on the presented literature review: structural separation, strategic outsourcing, and the centralization of decision-making. Furthermore, we include a contextual variable: the threat of digital disruption for a specific company by new market-entrants (Skog et al. 2018). DT strategies are formulated and executed to counter this threat which is why we expect these strategies to be different depending on how threatened companies are in their respective industries (Skog et al. 2018; Leonhardt et al. 2018). For instance, retailers are already suffering the consequences of digital disruption (Gilbert 2015). However, other industries such as highly specialized manufacturing might not perceive any digital disruption because they are subject to a low level of competition. We argue that due to the complexity of DT, there may not be only one path to success. Furthermore, there may be multiple interdependencies between the building blocks of a DT strategy: for example, a high degree of strategic outsourcing might require better and stricter control through centralized decision-making to keep track of the different implementation efforts. On the other hand, a low degree of structural separation may favor a decentralized approach that allows better local control.

To answer the research question at hand, we adopt configuration theory as our theoretical perspective. Configuration theory proposes that "organizational phenomena can best be understood by identifying distinct, internally consistent sets of firms and their relationships to the environment and performance outcomes" (Ketchen et al. 1997, p. 224). Traditional variance-based theories postulate that predictor variables are both necessary and sufficient conditions for predicting a certain outcome (Liu et al. 2015; El Sawy et al. 2010). Furthermore, they assume that the relationship between the outcome and a predictor variable is always symmetric (Liu et al. 2015). Configuration-based theories allow for asymmetric relationships between predictors and the outcome since they "view phenomena as clusters of interconnected elements that must be simultaneously understood as a holistic integrated pattern" (El Sawy et al. 2010, p. 838). In particular, this means that a predictor could be sufficient for a specific outcome, but not necessary. It also means that the interplay of different predictors leads to a specific outcome and that this interplay can be depicted through different configurations of predictors. This follows the concept of equifinality, which states that a system can reach a specific state through different paths and different initial conditions (Gresov and Drazin 1997). The characteristics of configuration-based theories make them especially suited to build middle-range theories in specific contexts (El Sawy et al. 2010; Park et al. 2017). While variance-based approaches require the researcher to formulate specific hypotheses regarding the relationships of the variables in question beforehand, configurational theories allow for a more exploratory research design. The researcher can identify potentially relevant theoretical constructs based on relevant literature, distill patterns leading to a specific outcome, and afterward return to the literature by theorizing based on the identified patterns (Park et al. 2017). We propose that this approach is especially well-suited to the context of our research question since recent literature on the relatively new field of DT strategies provides plenty of avenues for exploratory research designs. Figure 1 summarizes our proposed research framework. By using a Venn diagram, we denote the configurational perspective that we adopt to answer our research question. On the left side, we show the different antecedents that interact with each other to account for the outcome on the right side of the figure.

3 Research Approach

3.1 Data Collection

We employed a comparative case analysis approach to answer our research question to benefit from advantages such as being able to use additional data from the cases during and after analysis in an iterative way (Ragin 2008). We selected a purposive theoretical sampling strategy based on certain criteria since our goal was to investigate cases "that exhibit the phenomenon at hand in order to look for commonality (i.e. the presence or absence) of the outcome in the configurations of conditions across cases" (Tóth et al. 2017, p. 194). First, we aimed to find established companies to which we refer as companies whose key products and services were established at the latest shortly after the dot-com bubble and who are still active in this market. Second, the company needed to already have launched a DT strategy. Third, this strategy needed to be aimed at developing DSI and offering digital services in addition to existing products and services. We identified initial candidate companies through an internet search and contacted representatives with the request to carry out a case study. Eventually, we were able to carry out exploratory, in-depth case studies with 17 organizations from different industries. Table 5 in the appendix provides an overview of the cases with additional information. The interviewees included positions such as executives (CEO, CIO, CDO, and others), project managers, or business unit leaders. In most of the cases, top executives at the organization provided us with a set of interviewees who were involved in the respective DT strategies. These interviewees, in turn, oftentimes suggested follow-up interviews with other employees. We employed semi-structured interview guidelines covering the central issues of the respective DT strategies. At the same time, we gained insights during the interviews through follow-up questions that were not directly covered by the initial guideline. As an initial data source, several organizations granted us access to their confidential materials such as internal reports, strategy presentations, or market analyses, or anonymized or aggregated customer data. Finally, we consulted publicly accessible material such as company websites to triangulate our findings from the interviews and document analyses.

Our data analysis approach followed both an inductive and a deductive approach. First, we engaged in open coding of our data sources to identify potential antecedents of successful or unsuccessful DSI (Corbin and Strauss 1990). The coded material was then clustered following an axial coding approach, resulting in higher-order themes. Afterward, we performed

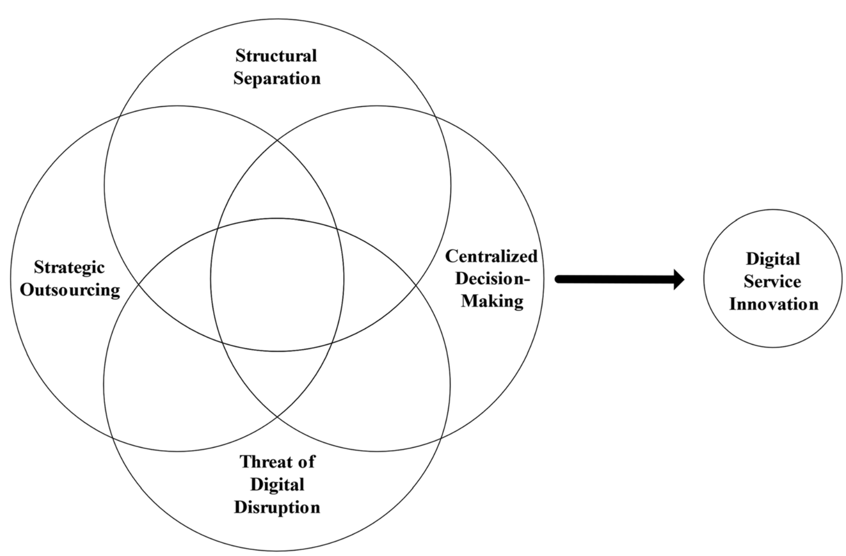

Fig. 1 Research framework

backward coding to cover potentially overlooked themes by engaging in an iterative coding process. Finally, we linked our higher-order themes to our eventual research framework. We used the qualitative data analysis software Atlas.ti during our coding process. Furthermore, we carried out respondent validation of our findings from the case organizations. We performed a member-check procedure by presenting our insights and interpretations of the cases to selected interviewees (Lee and Baskerville 2003). Usually, this was followed by valuable exchanges of perception that led to additional knowledge and insights used in our main analysis.

3.2 Fuzzy-Set Qualitative Comparative Analysis

To derive DT strategy configurations, we employed fsQCA, a set-theoretic configurational approach. While fsQCA is well suited for small to medium-sized samples (11–50 cases) as well as for large samples (>50 cases), its aims and potential contributions may vary (Greckhamer et al. 2018). When performed on large samples, it can be used for both theory building and testing with the possibility to draw statistical inferences (Greckhamer et al. 2013). Small samples, on the other hand, are particularly well-suited for inductive reasoning and theory building due to a higher familiarity with the cases (Greckhamer et al. 2013). It should furthermore be noted that fsQCA uses an approach known as "modest generalization" (Berg-Schlosser et al. 2009, p. 12). This means that a researcher can build propositions based on an fsQCA and then apply them to cases sharing similar characteristics (Berg-Schlosser et al. 2009). On the one hand, this may be a more limited approach than the one used by regression-based methods since it is more difficult to generalize based on a whole population. On the other hand, this approach is also more robust than drawing generalizations from multiple-case studies with even smaller datasets. In our study, we opted for a small-sized sample since we were mainly interested in theory building due to the scarcity of previous research. FsQCA consists of three subsequent steps: assignment of fuzzy-set membership scores to cases (also known as **calibration**), **identification of necessary conditions**, and **identification of sufficient configurations** (Ragin 2009). We used the fsQCA R package to complete all three steps (Duşa 2019). Table 1 provides an overview of our causal conditions and the outcome along with definitions and selected key sources based on the framework derived in the preceding section. Although the threat of digital disruption cannot be actively controlled by an organization, we include it as an element of potential configurations since we expect them to vary depending on the degree of the threat.

FsQCA uses fuzzy-set membership scores ranging between 0 and 1 to determine the degree to which a case is a member of a set (Ragin 2008). For each case and each dimension/outcome, a fuzzy-set membership score is assigned during the **calibration** phase (Ragin 2008). Procedures for calibration typically vary with the sample size. Analyses with large samples are most prevalent in IS and business and management research and are typically combined with questionnaire-based surveys or other quantitative data (Soto Setzke et al. 2020; Wagemann et al. 2016). Calibrating this data is often straightforward and includes choosing appropriate thresholds for Likert scales or quantitative data. Smaller sample sizes, on the other hand, typically involve a considerable amount of qualitative, unstructured data. Calibration of this data is quite challenging since few guidelines can be followed and the results may suffer from subjectivity (de Block and Vis 2019). Therefore, several methodological articles providing guidelines regarding the calibration of qualitative data have been published over the last years (see, e.g., Basurto and Speer (2012); Tóth et al. (2017); Nishant and Ravishankar (2020)).

For this paper, we adopted the methodological guidelines proposed by Basurto and Speer (2012) and closely followed an exemplary application by Iannacci and Cornford (2018). To calibrate data collected through interviews, they suggest the use of "theoretical ideals" as "the best imaginable case in the context of the study that is logically and socially possible" (Basurto and Speer 2012, p. 166). We defined two ideal cases per condition: a "fully in" case that represents definite full membership in the set and (fuzzy value of 1) a "fully out" case that represents definitive non-membership (fuzzy value of 0). Based on these ideal types, we defined a threshold condition that served as our indicator for deciding for or against inclusion in the set. Lastly, we defined how much a case could deviate from a "fully in" or "fully out" case without passing the threshold. Based on these definitions, we assigned fuzzy values 0.33 and 0.66, thus using a fuzzy 4-value scheme (Tóth et al. 2017). Based on the summary statements of the cases, each case can be calibrated according to the previously proposed ideal types. In the following, we explain our rationale for creating "fully in" and "fully out" cases as well as the threshold conditions.

Structural separation: as our ideal "fully in" case, we defined an organization that completely separated its innovation activities into one or more spin-off organizations. To distinguish the relationship between the main organization and spin-offs from partnerships with external organizations, we account for the fact that these innovation activities may still partly be coordinated by the main organization. For our "fully out" case, no new structures should have been created, neither in the form of spin-offs nor internal units. As a threshold, we chose the condition that spin-offs were created since they demark a major structural separation from the core business (Corley and Gioia 2004). Therefore, smaller structural changes such as creating new digital business units were counted as being more out than in, while creating spin-offs that were still

Table 1 Overview of coding elements

Element	Theoretical construct	Definition	Key sources
Causal conditions	Structural separation	Separation of innovation-related activities into distinct organizational units	Matt et al. (2015), Corley and Gioia(2004), Teece (1996)
	Centralization of decision-making	"Decision-making power resides in the hands of a selected few at the upper levels of an organization" (Wong et al. 2011, p. 1210)	Jansen et al.. (2006), Mihalache et al. (2014), Wong et al. (2011), Guadalupe et al. (2014)
	Strategic outsourcing	Reliance of an organization on external partnerships to carry out service innovation	Hottenrott and Lopes-Bento (2016), Teece (1996), Vial (2019), Bouncken and Fredrich (2016)
	Threat of digital disruption	Threat to the core business of an organization posed by new/established market entrants using digital technologies	Skog et al. (2018), Matt et al. (2015), Leonhardt et al. (2018)
Outcome	Digital service innovation	Successful introduction of new services based on digital technologies	Barrett et al. (2015), Goduscheit and Faullant (2018)

mainly controlled by the main organization were calibrated as more in than out.

Centralization of decision-making: in our ideal "fully in" case, decision-making is entirely centralized in one executive at the highest management level, i.e. the "C-suite". Our "fully out" case is characterized by a team lead or no specific role at all. Building upon these cases, we defined the threshold to indicate whether decision-making is done in the C-suite or at a lower management level (Guadalupe et al. 2014). Therefore, cases, where a manager or a business unit leader is responsible, were coded as more out than in. Accordingly, cases where a team of different C-level executives and, potentially, managers were responsible, were coded as "more in than out," since these are part of the C-suite but represent a lower degree of centralization.

Strategic outsourcing: Our "fully in" case represents organizations that rely completely on external partnerships while our "fully out" case represents organizations that do not rely on external partnerships at all. Since partnerships are very common for implementing DT strategies (Vial 2019), we concluded that, apart from the "fully out" case, partnerships would very likely be a part of the majority of DT cases. Thus, we decided to let the threshold indicate to what degree partnerships are used. We coded cases as more out than in if partnerships were used only to implement certain key aspects, but the main effort was still done by the main organization. Accordingly, if the effort was distributed differently, we coded the case as more in than out.

Threat of digital disruption: In the "fully in" case, organizations face an imminent threat of being disrupted while in the "fully out" case, they do not face any considerable threats of disruption in the foreseeable future. We decided to use the timeframe of potential disruption as a threshold: organizations that may face disruption in the long term (5–10 years) were coded as more out than in, while organizations, where disruption may be relevant in the short term (3–5 years), were coded as more in than out.

Digital service innovation: Our "fully in" case represents radical service innovations that are new to the respective industry while our "fully out case" represents cases where ultimately, no new services were launched. Since we are interested in radical innovation, we decided to use the notion of radical innovation as our threshold. If new services had been introduced but they represented mostly incremental improvements of already existing service concepts, they were coded as more out than in. On the other hand, if the organization introduced rather radical services, we classified them as more in than out. Accordingly, for our outcome, we define radical innovation as successful and incremental innovation as unsuccessful.

To facilitate the coding process, we prepared summary statements for each case along with relevant quotes for each dimension. It should be noted that some distinctions may seem subjective and difficult to code, particularly the fine-grained edge cases between fully and more out than in as well as fully in and more in than out. To mitigate this potential imprecision introduced by subjectivity, two authors and another researcher independently calibrated each condition and the outcome for each case, using the ideal types and the respective fuzzy values. Afterward, we assessed interrater reliability for each dimension among all cases by using Krippendorff's alpha, a measure that checks for chance coincidences (Krippendorff 2018). After coding, interrater reliability exceeded the most conservative threshold of 0.8 for all dimensions. Still, differences in assigned membership scores remained. The researchers then resolved these differences through oral discussion (Krippendorff 2018). For the case Kappa and the condition "Centralization of decision-making", for example, two researchers assigned a fuzzy value of 0.33 and one assigned a value of 0.66. The discussion then revolved around a quote in which the project lead of the DT strategy stated that he reports to the executive board of Kappa to ensure support for the strategy. During coding, the third researcher concluded that therefore, at least one C-level executive was responsible for the strategy (i.e., a fuzzy value of 0.66). However, the two other researchers argued that the project lead was merely reporting and ensuring support to secure resources for strategy implementation, but the main responsibility was still assigned to the project lead (i.e., a fuzzy value of 0.33). Eventually, the third researcher was convinced and all three agreed on using a fuzzy value of 0.33.

To provide transparency, we provide additional information on the coding process in the appendix. Appendix Table 6 provides a detailed overview of our ideal cases and the conditions that were used to assign fuzzy values based on extant literature along with the value of Krippendorff's alpha for each dimension. An illustrative example of how fuzzy-set membership scores were assigned to the condition "strategic outsourcing" is shown in Appendix Table 7. Furthermore, Appendix Table 8 shows an example of how case Rho was calibrated. A full overview of membership scores for all cases and dimensions can be found in Appendix Table 9. All other data is available upon request from the authors.

Necessary condition analysis reveals conditions that are present in every case; thus, resulting in a specific outcome. More specifically, this means that the fuzzy-set membership score of the outcome in each case is less than the score of the necessary condition (Schneider and Wagemann 2012). To be considered a necessary condition, a consistency threshold of at least 0.9 should be reached (Schneider and Wagemann 2012). Consistency refers to the degree to which cases with the same conditions share the same outcome (Ragin 2008). Furthermore, the coverage value (i.e., the proportion of the outcome covered by a specific condition) should be assessed for each necessary condition to determine its empirical relevance (Schneider and Wagemann 2012). While necessary conditions are always present when a specific outcome occurs, the condition could also be present while the outcome is not (Ragin 2008). Thus, we proceeded to identify sufficient configurations.

Sufficiency analysis reveals configurations of conditions that guarantee a specific outcome if present in a case (Ragin 2008). Unlike necessary conditions, however, a specific configuration does not always have to be present to produce the outcome. Thus, there can be multiple configurations leading to the same outcome. We first constructed two truth tables showing all 16 (2^k, where k equals the number of conditions) possible configurations of conditions for both outcomes (see Tables 10 and 11 in the appendix). Afterward, we reduced the table by applying the threshold of frequency, raw consistency, and PRI consistency. Since our sample of 17 cases can be classified as medium-sized, we employed a frequency threshold of one (Greckhamer et al. 2013). Thus, configurations that are represented by at least one empirical observation are kept in the truth table. For the raw consistency threshold, we chose a value of 0.85, exceeding the widely accepted conservative threshold of 0.75 (Schneider and Wagemann 2012). As described before, raw consistency assesses the degree of how reliably a configuration results in the outcome and can roughly be compared to the notion of significance in regression analysis (Park et al. 2017). PRI consistency is an alternative consistency measure that "eliminates the influence of cases that have simultaneous membership in both the outcome and its complement" (Park et al. 2017). While there is currently no widely accepted threshold of PRI consistency, we followed the guidelines from Schneider and Wagemann (2012) and apply a threshold of 0.65. Having reduced the truth table by applying thresholds of frequency, raw consistency, and PRI consistency, we applied the Quine-McCluskey algorithm to further reduce and simplify the remaining truth table. Afterward, we were left with configurations of conditions that lead to our outcome in question (Ragin 2008).

Finally, researchers should test for predictive validity, which "examines how well the model predicts the outcome in additional samples" (Pappas et al. 2017, p. 674; Woodside 2014). While a model may exhibit high values of consistency and coverage for a given sample, this does not necessarily mean that it is also able to make good predictions. To perform the test, the sample is first divided into a subsample and a holdout sample. The researcher then runs the analysis against the subsample and recodes all resulting configurations as a new variable. Each configuration variable is then plotted against the outcome of interest using the holdout sample. To guarantee high predictive validity, the resulting consistency and coverage should not contradict the values from the solution (Pappas et al. 2017).

4 Results

4.1 Necessary Condition Analysis

The results of our necessary condition analysis (Table 2) reveal that centralization of decision-making is the only necessary condition for achieving DSI since it exceeds the consistency threshold of 0.9 and, with a coverage level of 0.7, explains a considerable part of the outcome (Ragin 2008). Apart from this, no other condition reaches the minimum threshold of 0.9. We thus conclude that centralized decision-making needs to be part of a DT strategy to succeed and that it is the only necessary condition from our set of candidate conditions. However, even if centralized decision-making is in place, DT strategies can still fail. Thus, we now proceed to present the results of the sufficiency analysis.

4.2 Sufficiency Analysis

Our sufficiency analysis yielded an intermediate solution with five configurations that explain successful and unsuccessful

Table 2 Necessary conditions for digital service innovation

Conditions	Successful digital service innovation		Unsuccessful digital service innovation	
	Consistency	Coverage	Consistency	Coverage
Structural separation	0.61	0.71	0.65	0.63
Centralization of decision-making	1.00	0.70	0.86	0.50
Strategic outsourcing	0.71	0.67	0.78	0.60
Threat of digital disruption	0.39	0.65	0.56	0.77
~Structural separation	0.68	0.70	0.70	0.60
~Centralization of decision-making	0.29	0.72	0.48	1.00
~Strategic outsourcing	0.58	0.76	0.57	0.62
~Threat of digital disruption	0.86	0.70	0.74	0.50

~ logical NOT; Necessity consistency threshold: 0.9

DSI. When deriving the intermediate solution, we employed the simplifying assumption that centralized decision-making has a positive impact on the outcome and a negative impact on the negative outcome. All five resulting configurations are displayed in Table 3. Following the fsQCA convention, black circles denote the presence of a condition while crossed-out circles indicate its absence. Blank spaces indicate that the condition is not relevant for explaining the outcome. Furthermore, large circles denote core conditions with high empirical relevance while small circles represent peripheral conditions that surround core conditions (Fiss 2011). Our proposed solutions show consistency levels of 0.91 and 0.92, which are well above the level of 0.8 which is commonly considered acceptable in QCA research (Ragin 2008). Similarly, our solution coverage levels of 0.75 and 0.52 show that we can explain a considerable share of both outcomes.

As Table 3 shows, we identified two configurations for DT strategies that lead to successful DSI. The first configuration (A1) represents organizations that achieve DSI by organizing innovation activities in spin-offs, involving C-level executives in governing their strategy, and relying on partnerships to implement the strategy. For this configuration, it does not matter whether the organization is facing a threat of digital disruption. The second configuration (A2) depicts organizations where C-level executives are involved in DT strategy governance. However, they implement aspects of the DT strategy mostly on

Table 3 Sufficient configurations for digital service innovation

Causal conditions	**Successful digital service innovation**		**Unsuccessful digital service innovation**		
	A1	**A2**	**B1**	**B2**	**B3**
Structural separation	●		•	•	
Centralization of decision-making	●	•	⊗		⊗
Strategic outsourcing	●	⊗		⊗	⊗
Threat of digital disruption		⊗	●	●	●
Consistency	0.87	0.99	1.00	0.89	1.00
Raw coverage	0.46	0.54	0.17	0.34	0.26
Unique coverage	0.21	0.29	0.04	0.21	0.13
Solution consistency	0.91		0.92		
Solution coverage	0.75		0.52		

Black circle presence of a condition, *Crossed-out circle* absence of a condition, *Empty row* may be either present or absent, *Large circle* core condition, *Small circle* peripheral condition; Raw consistency cut-off: 0.85; PRI consistency cut-off: 0.65; Frequency cut-off: 1

their own and are not facing any imminent threat of digital disruption. Here, it does not matter whether the organization organizes its innovation activities in spin-offs.

We found three distinct configurations for unsuccessful DSI. The first configuration (B1) shows organizations where team/business unit leads or managers are mostly responsible for governing the strategy as opposed to C-level executives. Additionally, these organizations face an imminent threat of digital disruption and conduct innovation activities in spin-offs. The second configuration (B2) depicts organizations that also face an imminent threat of digital disruption and additionally implement key aspects of the DT strategy mostly on their own as opposed to relying on partnerships. As in B1, these organizations have a high degree of structural separation. The third configuration (B3) combines the core conditions of B1 and B2: low degrees of centralized decision-making and strategic outsourcing and a high degree of threat of digital disruption.

Furthermore, we tested for predictive validity to identify whether our model can be used to predict the outcome in additional samples (Woodside 2014; Pappas et al. 2016). To do so, we randomly divided the sample into a subsample and a holdout sample. We then performed the analysis for the subsample and tested the result against the holdout sample. Table 4 demonstrates that the patterns obtained from the first analysis consistently indicate successful and unsuccessful DSI. We then plotted all four models against the outcome variable. Figure 2 illustrates the findings for testing model 1 against the outcome of successful DSI with the holdout sample and exhibits high degrees of consistency (0.966) and coverage (0.47). Similarly, Fig. 3 illustrates the results of plotting model 3 against the negation of the outcome and shows high consistency (0.75) as well as coverage (0.21). We, therefore, conclude that the highly consistent models from the subsample are consistent predictors for the holdout sample. Detailed results are available upon request.

5 Discussion

5.1 Observations and Patterns across Configurations

Our analyses reveal that centralization of decision making is a necessary condition for successful DSI and that there are multiple configurations of DT strategies that lead to either successful or unsuccessful DSI. We will now highlight certain particularities and patterns that can be observed across the identified configurations and compared them with observations from previous research. Throughout our discussion, we will refer to the configurations by using the codes introduced in Table 3 (A1, A2, B1, B2, and B3).

Interestingly, our results show that an imminent threat of digital disruption is a decisive element leading to both success and failure. While the absence of this threat is associated with success in one configuration (A2), the threat's presence is a part of all three configurations associated with failure (B1, B2, and B3). Previous research shows that the threat of disruption or competitive pressure can impact an organization's ability both positively (Amabile et al. 2002; Sheremata 2000) and in an ambivalent way, depending on the context of the competitive situation (Beneito et al. 2015; Ismail 2015; Amabile et al. 2002). The results from our analysis depict competitive pressure in a rather negative way. For instance, case company Rho states that they are under a high amount of pressure since their "current business is stopping in a few years" and their "biggest worry" is whether they can transform their core business fast enough. However, their DT initiative has been focused rather on internal process innovation and less on developing and introducing new business models and services, thus increasing pressure. Case company Kappa, a traditional business-to-business hardware seller, is also facing severe competition resulting in drastically reduced turnover due to rival online platforms. However, their online platform is focused on

Table 4 Complex configurations indicating successful and unsuccessful digital service innovation

	Consistency	Raw coverage	Unique coverage
Models from subsample for successful DSI			
SSE*CDM*~TDD	0.89	0.61	0.23
CDM*~SOS*~TDD	0.99	0.54	0.16
Overall solution consistency	0.91		
Overall solution coverage	0.77		
Models from subsample for unsuccessful DSI (negation)			
SSE*~CDM*~SOS*TDD	1.00	0.49	0.39
~SSE*~CDM~SOS*TDD	1.00	0.30	0.20
Overall solution consistency	1.00		
Overall solution coverage	0.69		

SSE structural separation, *CDM* centralized decision-making, *SOS* strategic outsourcing, *TDD* threat of digital disruption, *DSI* digital service innovation.

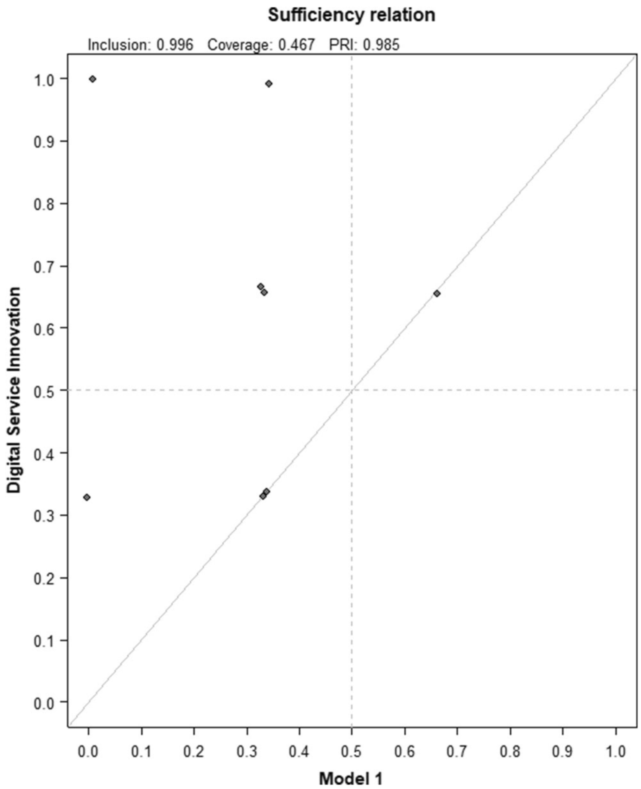

Fig. 2 Predictive validity test of Model 1 from subsample using data from the holdout sample for successful digital service innovation

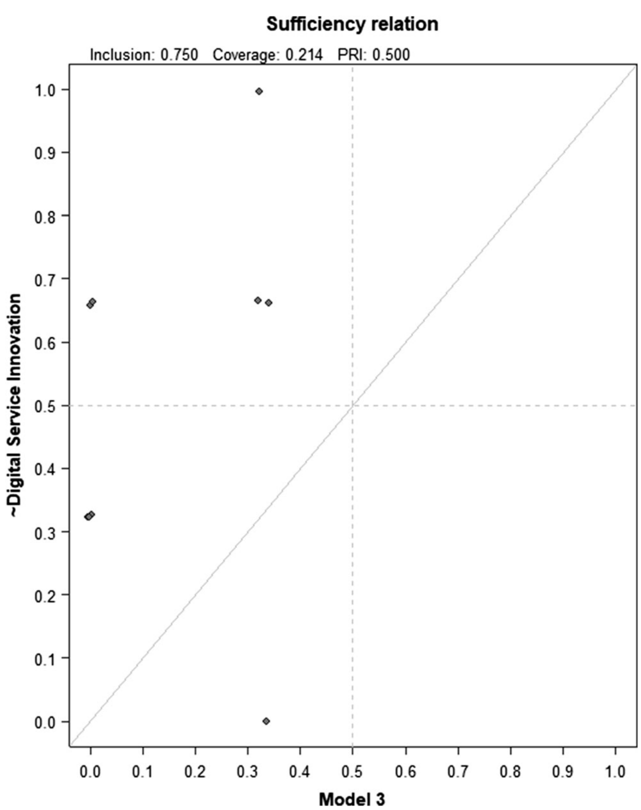

Fig. 3 Predictive validity test of Model 3 from subsample using data from the holdout sample for unsuccessful digital service innovation

supporting existing sales processes and suffers from poor adoption by both customers and sales employees. Still, we propose that even companies under pressure can succeed at DSI given the right circumstances since the absence of the threat of digital disruption is not a necessary condition for success in the results of our analysis nor is the presence of threat a necessary condition for failure. A possible solution is depicted in configuration A1: companies that implement an approach based on spin-offs, centralized decision-making, and strategic partnerships succeed irrespective of the amount of external pressure.

The role of partnerships in implementing DT strategies warrants further discussion in the context of the threat of digital disruption. The results show that organizations under threat fail at DSI when they do not (or only partly) engage in strategic implementation partnerships (B2). On the other hand, a "do-it-yourself" approach seems appropriate when organizations perceive no or very little threat and employ a centralized decision-making approach (A2). We thus conclude that organizations that are not under pressure have enough time to experiment and build up their resources such as information technology infrastructure or software developers. Case company Pi, for instance, is a world leader in industrial manufacturing. Given its excellent competitive position in the market, the threat of digital disruption is very low for Pi. Consequently, Pi had enough time to build a spin-off and hire a lot of software developers who designed and implemented an industrial Internet of Things (IoT) platform, with little external assistance. If Pi had been under higher pressure to transform itself in a short amount of time, it may not have been possible for the company to take its time and implement its strategy mostly on its own. It is important to note that the decision to engage or not engage in partnerships in consideration of impending pressure is sometimes also taken due to this pressure. Case company Iota, for example, finds itself in a competitive environment and does not engage in partnerships. In the results, Iota is covered by configuration B2. An interviewee at Iota stated his belief that "Iota does not dare to engage in partnerships yet" because "Iota does not dare to trust that someone else can bring us benefits and not damage us in some way". Thus, we propose that organizations need to learn how to engage in healthy partnerships that do not threaten the organization's core business but rather benefit both sides. Recent research on DT highlights the importance of ecosystemic thinking and strategizing, especially when it comes to service innovation (Lusch and Nambisan 2015). While organizations that are well-positioned on the competitive field may succeed in innovation-related activities on their own for now, it is unclear whether a rather egoistic perspective will also succeed in sustaining this position.

The necessary condition analysis shows that centralization of decision making is a prerequisite for successful DSI. In particular, this means that organizations need a C-level executive to govern the DT strategy or form a digitalization committee where at least one C-level executive is involved. This confirms previous research that highlights the importance of top management team (TMT) energy in organizational change processes, especially in IS-enabled change projects (Park et al. 2017; Tronvoll et al. 2020). Case company Kappa is an illustrative example of an organization where the TMT is not heavily involved. In Kappa, the DT strategy is mainly steered by a business unit leader who reports to the top management board that approves, for example, budget requests, but is not as heavily involved in leading the strategy. Similarly, in the case of company Rho, a business unit leader is responsible for the DT strategy, stating that the "managers who approve our business cases typically do not know in detail what is actually needed for them". Furthermore, he stated that he "need[s] to make the management aware of every step that is needed to, get features live which can be monetized in the end for Rho". Thus, we propose that a DT strategy requires top management attention and needs to be governed by C-level executives to be successful.

5.2 Theoretical Contributions

This paper contributes to theory in several ways. First, it adds to the growing literature on DSI and DT and is one of the first studies that integrate these two perspectives to paint a more complete picture. As outlined in the theoretical background to this paper, the literature on DSI has mainly focused on effective processes, use cases, or the characteristics of innovations. By regarding DT strategy building blocks as antecedents of DSI, we add a new perspective to explain how effective DSI can be established. On the other hand, the literature on DT strategies has rarely explored the actual outcome and effectiveness of these strategies. Therefore, we add an outcome-oriented perspective to this relatively young literature stream. We also contribute individually to each research stream, addressing research gaps such as effective organizational changes for service innovation (Biemans et al. 2016) or the success patterns of DT strategies (Matt et al. 2015).

Second, we provide a perspective on the ways DSI can fail. While current literature focuses predominantly on successful service innovation, only a few studies have explicitly investigated innovation failure (see, for example, Dudau et al. (2017); Weber et al. (2011); Dörner et al. (2011); Goduscheit and Faullant (2018)). Furthermore, while some of these studies note the importance of digital technologies, they focus on other enablers such as individual attitudes and behavior or other units of analysis such as entire industries. Our results provide the first insights into the characteristics of DT strategies that lead to DSI failure as well as different avenues for future research.

Third, we employed a configurational research approach to answer our research question. By doing so, we follow several calls for research from both DT literature (Riasanow et al. 2019) as well as service innovation (Kohtamäki et al. 2019; Goduscheit and Faullant 2018). Configuration theory enables us to investigate the interplay of different DT strategy building blocks and provide a fine-grained view of their interdependencies. Still, it also allows us to highlight insights into individual factors and thereby contribute individually to each DT strategy building block. For example, we confirm the importance of centralized decision-making in the context of DSI (Tronvoll et al. 2020) and highlight the role of DT committees. So far, this concept has received relatively little attention (Chanias et al. 2019) compared to the more common CDO role (see, for example, Haffke et al. (2016); Horlacher et al. (2016); Singh and Hess (2017)).

Lastly, this paper contributes to the methodological variety in the field of IS. While configurational perspectives are slowly gaining popularity, studies with samples of smaller sizes are still an exception (Soto Setzke et al. 2020). Still, we argue that small-N analyses offer several advantages such as familiarity with the cases and more targeted theory building. Adding to the work of Iannacci and Cornford (2018), we show how QCA can be used to calibrate qualitative data, especially semi-structured interviews, to provide insights into novel phenomena, where large samples may be difficult to acquire.

5.3 Practical Contributions

For practitioners, our study offers implications for established organizations that want to successfully engage in DSI. First, as a general implication, our configurations can be used as a template by executives. They represent different choices that lead to the same outcome and can, therefore, serve as a basis for decisions regarding the DT strategy, depending on the context of the organization. They can also be used to identify gaps between a failing and a succeeding strategy. For example, if the organization's DT strategy currently resembles configuration B1 and may thus be on a path to failure, they can make the respective changes to reach configuration A1 (i.e., centralizing decision-making and adapting their outsourcing approach).

The second implication relates to decisions regarding the locus of authority. Our configurations reveal that centralization of decision-making is a necessary condition for achieving DSI. Established organizations should, therefore, ensure that their DT strategies are governed by C-level executives. Our case studies show three general options: linking the responsibilities with an existing role such as the CEO or CIO, installing a dedicated role such as a CDO, or implementing a DT committee that consists of multiple executives or managers. Since these decisions appear to work equally well, the organization may select their option considering its individual context. If, for example, the organization currently does not have sufficient resources to promote or hire a dedicated CDO, they can take their first steps by building a DT committee with C-level executives and managers from their established workforce. Gradually, the organization could then start shifting the responsibilities to a dedicated role or may even keep the DT committee if it proves to be successful.

Third, our results demonstrate the different options for strategic outsourcing. Engaging in strategic outsourcing is part of one recipe for success and our configurations show that its absence can, under certain conditions, lead to failure. A closer analysis of our cases reveals that organizations may avoid outsourcing or engaging in partnerships due to a fear of letting others inside the organization or even due to believing that they can do everything on their own. While this may be a viable approach for large organizations that possess a lot of resources, smaller or medium-sized organizations, in particular, should aim to build a healthy ecosystem of partners that provide the missing capabilities. Ideally, the organization may also learn from this process and build up its own DT capabilities over time.

6 Limitations and Future Research

Our approach has limitations that we will now address. Due to the lack of previous research on the influence of DT strategies on DSI, we employed a configurational perspective using fsQCA. We used a relatively small sample of 17 cases, which limits the generalizability of our findings. However, we were mainly interested in providing a first theoretical exploration of the mentioned relationship by using rich, in-depth qualitative data. Future research could further validate our findings by applying regression-based methods to a larger, representative sample. In this context, the use of qualitative interview data for fsQCA might raise some concerns as well. Although we followed the methodological guidance provided by scholars such as Basurto and Speer (2012) and de Block and Vis (2019) and accounted for interrater reliability, calibrating interview data to fuzzy sets can still raise valid concerns in terms of the interpretability of the results we obtained. However, we carefully explained our coding scheme and provided transparency regarding decisions throughout the calibration process. Additionally, we may have left out dimensions that could be useful in explaining differences in outcome in our research framework. Although consistency and coverage values in our analyses are relatively high, there might be other causal conditions that could allow a different or even more insightful interpretation of the differences that can be observed in the cases.

Furthermore, each of our chosen conditions deserves further investigation. For example, for centralization of decision making, we did not distinguish between the effects of different C-level roles such as CIOs or CDOs (Haffke et al. 2016), nor did we account for different leadership styles such as transformational or transactional leadership. Future research could thus include these strategy elements to test them for effectiveness. Also, here, configuration theory could be applied to identify configurations of strategy elements where, for example, CDOs are more effective than CIOs. Lastly, owing to the exploratory nature of our analysis, we invite fellow researchers to validate our results using, for example, surveys combined with econometric techniques to test the patterns that we proposed in the results section.

Appendix

Table 5 Case company overview

Code	Industry	Founded in	Number of employees	Number of interviews
Alpha	Entertainment	2000 – now	>100	2
Beta	Consumer goods	1950–1999	>10,000	6
Gamma	Sports	Before 1900	>100	3
Delta	Manufacturing	1900–1949	>10,000	6
Epsilon	Industrial manufacturing	1900–1949	>1000	5
Zeta	Industrial manufacturing	1950–1999	>10,000	5
Eta	IT services	1950–1999	>50,000	18
Theta	Industrial manufacturing	Before 1900	>10,000	5
Iota	Information security	Before 1900	>10,000	10
Kappa	IT services	1950–1999	>10,000	8
Lambda	Sports	1900–1949	>100,000	12
My	Logistics	2000–now	>1000	7
Ny	Industrial manufacturing	Before 1900	>50,000	6
Xi	Entertainment	Before 1900	>100	7
Omikron	Industrial manufacturing	1950–1999	>10,000	9
Pi	Industrial manufacturing	Before 1900	>100,000	12
Rho	Consumer goods manufacturing	Before 1900	>10,000	9

Table 6 Coding procedure for causal conditions and outcome

Fuzzy value/ dimension	0 (fully out)	0.33 (more out than in)	0.66 (more in than out)	1 (fully in)	Krippendorff's alpha
Structural separation	No new structures were created to carry out digital innovation activities	Digital innovation activities take place in newly created digital business units	Digital innovation activities partly take place in spin-offs while the main organization coordinates these activities	Digital innovation activities mainly take place in spin-offs while the main organization may partly coordinate these activities	0.90
Centralization of decision-making	A team lead or no specific role is responsible for governing the DT strategy	A manager or business unit leader is responsible for governing the DT strategy	A team of C-level executives and/or managers is responsible for governing the DT strategy	A C-level executive (CEO, CDO, CIO, …) is mainly responsible for governing the DT strategy	0.80
Strategic outsourcing	Implementing the DT strategy does not rely on any external partnerships	External partnerships are used to implement certain key aspects of the DT strategy; the main implementation effort is done by the organization	Implementing the DT strategy relies mostly on external partnerships, the organization implements certain aspects on its own	Implementing the DT strategy relies predominantly on external partnerships	0.83
Threat of digital disruption	The organization's core business does not face any considerable threats of being disrupted in the foreseeable future by rival products/services based on digital technologies	The organization's core business might face a considerable threat of being disrupted by rival products/services based on digital technologies in the next 5–10 years	The organization's core business faces a considerable threat of being disrupted by rival products/services based on digital technologies in the next 3–5 years	The organization's core business faces an imminent threat of being disrupted by rival products/services based on digital technologies	0.84
Digital service innovation	No new services based on digital technologies services were put onto the market	Services based on digital technologies were put onto the market, but they are mostly based on incremental innovation of already existing services	Services based on digital technologies were put onto the market and they are mostly based on radical innovation, partly departing from the service concepts of already existing services	Services based on digital technologies were put onto the market, they are based on radical innovation, entirely departing from the service concepts of already existing services and they are new to the organization's industry	0.81

Table 7 Exemplary coding procedure for the construct strategic outsourcing

Fuzzy value	Illustrative quote(s)	Reason for assignment
1	"We found service providers who work for us. We have one for the entire back-end. We have one for the entire front-end"	At Xi, virtually all the innovation activities are carried out by service providers and freelancers. Xi partly coordinates these activities ("juggling"), but does not implement any activities on its own
	"Then there is the backend provider […] But I also have the front-end provider, and all those app providers, and the streaming providers" "We juggle with 50 freelancers. Both on the programming side as well as on the production side of things. The directing team, they are all freelancers" *All quotes from case Xi*	
0.66	"We work a lot with external consultants"	My's DT strategy depends a lot on partnerships and external consultants. However, My also has its own digitalization department that coordinates these activities and they have fundamental know-how about their own applications
	"We care a lot about working with partners. We do not have the know-how for all topics. We know how our business works and we also have the know-how for the applications that we use daily and a bit more. For a lot of topics though, it is very helpful to get know-how from the outside" "Usually, during such an innovation process we include the digitalization and the IT department. We also do a lot with external consultants" "We do not have any in-house software developers and the things that we implement are actually always custom software, this means that we need to get help from external developers" *All quotes from case My*	
0.33	"We did not [engage in acquiring targeted partnerships]. […] This is also because, due to our organization's diversity in that area, we can do everything on our own. That's why there has not been any partner where we said, okay, now we go with that one regarding this topic. But these are things we need to do in the future […] This is a part, where we still have difficulties. Until now, we used to be the champion and could always do it on our own, "we can do everything", and engaging strongly in partnerships has not been part of the organization's political agenda." "We wanted to profit from partners who could provide the software and a part of the digital platform. We arrived at two partnerships: one is actually Anonymized, […] and there is the content management system, which is Anonymized2, a Swiss provider. And building upon these two and an Anonymized3 tool we composed what you can now see on the open online shop" *All quotes from case Kappa*	Kappa has engaged in partnerships to acquire building blocks for its service innovation. However, these partnerships are limited and due to the organization's mentality of do-it-yourself, the organization has not engaged in further partnerships
0	"Basically, we would like to engage in cooperation and partnerships, but we are coming from a very low baseline"	As of now, Iota has not engaged in any partnerships to implement its DT strategy
	"I believe that there are many out there who would be interesting for us. Iota is just starting to look for partners and to understand that this is not necessarily something bad" "I believe Iota is too afraid. Iota does not dare to trust that someone else can bring us benefits and not damage us in some way. I believe it's simply because we are afraid to let someone else into the organization" *All quotes from case Iota*	

Table 8 Exemplary coding procedure for case Rho

Dimension	Fuzzy value	Reason for assignment	Illustrative quote/description
Structural separation	1	Innovation activities are mainly conducted in startups that are independent of the main organization	"What we do at Rho is create, when we have new ideas like 3D printing etc., we create ventures that stand alone. They are basically startups and they have the freedom to show their business value over the next 2 years"
Centralization of decision--making	0.33	The DT strategy is mainly led and governed by the head of digital manufacturing (HDM). While the HDM reports to the COO, they coordinate all strategy activities	"I'm the head of digital manufacturing and since I am the program manager responsible for designing, building, and deployment of the digital backbone as well as the IT part and the business part and I report to the COO as the head of manufacturing. So, in Rho the whole digital transformation is part of operations, so they report to the COO while you have some companies where the digital program reports to CIO but in this case, we chose to report to the operations function for a specific reason"
Strategic outsourcing	0.66	Rho is focused on implementing its strategy through partnerships, while some innovation activities are still carried out by the main organization	"What we see is that the area is becoming too big to only [be] handle[d] by Rho so we have quite a lot of strategic partnerships over there"
Threat of digital disruption	1	The core business of Rho is under an imminent threat of digital disruption	"I think we are running ahead because we have to. Our current business is stopping in a few years. The biggest worry is, can we do it fast enough?"
Digital service innovation	0	As of today, no services based on digital technologies have been introduced to the market by Rho	

Table 9 Fuzzy-set membership score assignment table

Case	Structural separation	Centralization of decision-making	Strategic outsourcing	Threat of digital disruption	Digital service innovation
Alpha	0	1	1	0	0.33
Beta	0.33	0.66	0.66	0.33	0.66
Gamma	0.33	0.66	1	0	0.33
Delta	0.33	0.66	0.66	0	0.66
Epsilon	0	0.66	0.66	0.33	0.33
Zeta	1	0.33	0.66	1	0
Eta	0.66	1	0.33	0.33	1
Theta	1	0.66	1	0	0.33
Iota	0.33	1	0.33	0.33	0.66
Kappa	0.33	1	0	0.33	0.66
Lambda	0.66	0.66	0	0.66	0.33
My	0.33	1	0.66	0.33	0.33
Ny	0	0.33	0.33	1	0.33
Xi	0	1	0.66	0	1
Omikron	1	0.66	0.66	0	0.66
Pi	0.66	1	0.33	0.33	0.66
Rho	1	1	1	0.66	1

Table 10 Truth table for successful digital service innovation

Structural separation	Centralization of decision-making	Strategic outsourcing	Threat of digital disruption	Successful digital service innovation	Number of cases	Raw consistency	PRI consistency
1	1	0	0	1	2	1.00	0.99
0	1	0	0	1	2	0.99	0.96
1	1	1	0	1	2	0.92	0.75
1	1	1	1	1	1	0.88	0.75
0	0	0	1	0	1	0.79	0.00
1	1	0	1	0	1	0.78	0.33
0	1	1	0	0	7	0.72	0.50
1	0	1	1	0	1	0.33	0.00

Table 11 Truth table for unsuccessful digital service innovation

Structural separation	Centralization of decision-making	Strategic outsourcing	Threat of digital disruption	Unsuccessful digital service innovation	Number of cases	Raw consistency	PRI consistency
0	0	0	1	1	1	1.00	1.00
1	0	1	1	1	1	1.00	1.00
1	1	0	1	1	1	0.89	0.67
1	1	1	0	0	2	0.75	0.25
1	1	0	0	0	2	0.73	0.10
0	1	1	0	0	7	0.67	0.40
0	1	0	0	0	2	0.67	0.02
1	0	1	1	0	1	0.63	0.25

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Appendix H. Platform Openness: A Systematic Literature Review and Avenues for Future Research (P8)

Platform Openness: A Systematic Literature Review and Avenues for Future Research

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Abstract. Open platforms such as Facebook or Android have stimulated innovation and competition across industries. Information systems literature has analyzed platforms from a variety of perspectives. The aim of this paper is to synthesize and integrate extant interdisciplinary research on the concept of platform openness. Towards this end, we conducted a literature review and analyzed the results with deductive and inductive coding approaches. We identified five distinct themes: measurement frameworks, implementation mechanisms, drivers for opening and closing platforms, trade-offs in designing openness, and the impact of changing openness on ecosystems. We propose three avenues for future research: finding the optimal degree of platform openness, integrating perspectives on accessibility and transparency, and analyzing the influence of openness and other factors with configurational theories. This paper contributes to research on platforms by laying out the main themes and perspectives in the research stream of platform openness and by identifying areas for future research.

Keywords: Platform Openness, Digital Platforms, Platform Ecosystems

1 Introduction

Digital platforms have transformed entire industries by leveraging the concept of open innovation [1] and have stimulated generativity[1] and competition [2, 3]. The cases of the social network platforms MySpace and Facebook are prototypical examples for the competitive advantages of open platform strategies. While MySpace kept their system closed, trying “to create every feature in the world” [4] on their own, Facebook decided in 2007 to open themselves to a worldwide pool of third-party developers, allowing them to build applications on top of the social networking platform [5]. Six months later, 8.000 third-party applications had been added and one year later, Facebook surpassed MySpace in terms of unique monthly visitors [6, 7]. When Apple initially released the iPhone with its iOS[2] operating system in 2007, it was closed to external developers but soon after, Apple released an official Software Development Kit (SDK)

[1] We refer to generativity as “a technology’s overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences” [2].

[2] Until 2010: iPhone OS

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and set up a distribution channel for third-party applications, the Apple AppStore [8]. Google's Android operating system entered the market of mobile platforms later but was released under an open source license and came with a less restrictive application marketplace. [9]. In 2010, Android first surpassed iOS in terms of worldwide smartphone sales and has remained the dominating mobile platform since then (with a market share of 87.8 % as of 2017) [10].

These real-world examples show the strategic role played by platform openness. Information Systems (IS) literature has analyzed the phenomenon of platforms from a variety of perspectives [3]. The concept of platform openness is commonly referred to as placing restrictions on the development, commercialization, or use of a platform [11]. More specifically, platform openness is controlled by platform owners through the use of platform governance mechanisms, such as "deliberate regulations and rules about access and boundary control" [12]. In IS literature, platform openness has started to gain traction in the last years but each study focuses on different aspects [11-17]. This is aggravated by the fact that relevant insights are also to be found in the neighboring literature streams of management [18-22] and computer science [23-25]. Hence, IS research lacks an integrated view of different, inter-disciplinary perspectives on platform openness. Due to the fragmentation of knowledge on platforms, scholars have called for consolidating extant research perspectives (see, e.g., de Reuver, Sørensen and Basole [3]).

The purpose of this paper is to synthesize the current state of research and to integrate different perspectives on platform openness in IS literature and neighboring literature streams. To this end, we conducted a systematic literature review and analyzed the resulting publications with deductive and inductive coding approaches. We find that literature focuses on technological accessibility but neglects the perspective of transparency. Furthermore, we identify five distinct themes: measuring platform openness, mechanisms for implementing openness, drivers for opening up or closing down, trade-offs in designing the degree of openness, and the impact of changing degrees of openness on platform-centric ecosystems.

The remainder of this paper is structured as follows. The first section describes the design of the literature review and the employed coding approach. The second section structures the analyzed publications with a deductive coding scheme based on different research perspectives. Subsequently, we present and discuss the identified research themes. Finally, we present and discuss areas for future research and conclude the review.

2 Design of the literature review

For conducting our literature review, we followed the guidelines of Webster and Watson [26]. Drawing on the typology of literature reviews developed by Paré, Trudel, Jaana and Kitsiou [27], our review constitutes a descriptive review since our goal was to synthesize and represent the current state of the art of research on platform openness. We restricted our review to the openness of digital platforms following the conceptualization of de Reuver, Sørensen and Basole [3] as “purely technical artefacts where the platform is an extensible codebase, and the ecosystem comprises third-party modules complementing this codebase”. We focused on the journals included in the *AIS Senior Scholars’ Basket of Journals*. To include the perspective of management, we also selected the journals *Management Science* (MS) and *Organization Science* (OS). We conducted a search with the term “platform AND open*” on titles, abstracts, and keywords and screened the abstract of 53 publications, resulting in eleven selected articles. If the relevance for our review was unclear after reading the abstract, we read the full article. In a second step, we extended our search to highly ranked IS conferences and the IEEE Explore Digital Library to include the perspective of computer science. We restricted our search to the more specific term “platform AND openness” in order to get a manageable set of publications, resulting in 685 potentially relevant articles. Again, we screened the abstracts in order to decide whether to include the article, resulting in 14 selected publications. Afterwards, we performed a forward and backward search on the articles that were selected so far, leading to the inclusion of another 48 articles. Finally, our sample comprised 73 relevant articles (see **Table 1**).

Table 1. Summary of the literature search process

<table>
<tr><th colspan="2">Outlet</th><th>Search</th><th>Hits</th><th>Selected</th></tr>
<tr><td rowspan="3">Top journals</td><td>AIS Basket of Eight</td><td rowspan="3">“platform AND open*”
in
Title | Abstract | Keywords</td><td>34</td><td>8</td></tr>
<tr><td>OS</td><td>8</td><td>1</td></tr>
<tr><td>MS</td><td>11</td><td>2</td></tr>
<tr><td rowspan="6">IS conferences</td><td>ICIS</td><td rowspan="7">“platform AND openness”
in
Title | Abstract | Keywords</td><td>28</td><td>5</td></tr>
<tr><td>ECIS</td><td>24</td><td>3</td></tr>
<tr><td>PACIS</td><td>12</td><td>3</td></tr>
<tr><td>HICSS</td><td>351</td><td>2</td></tr>
<tr><td>WI</td><td>7</td><td>0</td></tr>
<tr><td>AMCIS</td><td>35</td><td>0</td></tr>
<tr><td rowspan="6">Other outlets</td><td>IEEE Xplore</td><td>228</td><td>1</td></tr>
<tr><td>Journals</td><td rowspan="5">Forward and backward search</td><td>-</td><td>20</td></tr>
<tr><td>Conferences</td><td>-</td><td>18</td></tr>
<tr><td>Dissertations</td><td>-</td><td>2</td></tr>
<tr><td>Books</td><td>-</td><td>4</td></tr>
<tr><td>Other</td><td>-</td><td>4</td></tr>
<tr><td colspan="3">Total</td><td>738</td><td>73</td></tr>
</table>

In a next step, we iteratively coded the articles, using both a deductive and inductive approach [28]. Our deductive scheme was adapted from the guidelines of Bandara, Furtmueller, Gorbacheva, Miskon and Beekhuyzen [29] and comprised definition and measurement frameworks of platform openness, employed research methodologies, future work, and distinct levels of openness. Regarding our inductive approach, we engaged in open coding, axial coding, and selective coding to capture and distill concepts emerging from our sample of publications [28]. Based on 50 definitions of platform openness from our article sample, we clustered recurrent themes and extracted three distinct levels and two dimensions in order to classify extant research perspectives. Furthermore, five distinct research themes emerged throughout our open coding process[3]. Based on our classification and the identified themes, we derived promising avenues for future research. **Table 2** gives an overview of the results of our literature review, our approach to generate these results, and the respective section of this paper.

Table 2. Overview of the results of this literature review

Section	*Results*	*Approach*
3	Classification of extant research	Inductive and deductive coding of identified literature
4	Central themes in extant research	Inductive and deductive coding of identified literature
5	Avenues for future research	Analysis of classification table from section 3 and identification of unanswered questions in central themes from section 4

3 Research perspectives on platform openness

Of our analyzed articles, 68 % employ an explicit definition of platform openness (see, e.g., Eisenmann, Parker and Van Alstyne [11], Boudreau [18], Anvaari and Jansen [23], Arakji and Lang [31]) while only 30 % use or introduce a qualitative or quantitative framework for measuring openness (see, for example, Benlian, Hilkert and Hess [13], Ondrus, Gannamaneni and Lyytinen [17], Anvaari and Jansen [23]). In terms of research methodologies, we distinguish between qualitative, quantitative, mixed, design science, and conceptual research approaches [29]. A 33 % of the papers are based on qualitative research methods, such as single or multiple case studies conducted with, for example, app stores [14, 32] or mobile payment platforms [33, 34]. Quantitative research methods are employed in 31 % of the papers, comprising mostly econometric analyses [7, 15], surveys [35], and simulations [31, 36]. Conceptual and mixed approaches are represented with 19 % [37] and 13 % [38], while design science strategies are only used in 4 % of the analyzed publications [16].

Based on different definitions of platform openness, we identified three distinct levels and two dimensions. Openness can be implemented on three levels: organization, technology, and users. The organizational level "relates to the strategic involvement of key stakeholders who control the platform and provide the platform services to different user groups" [17]. The technology level refers to the provisioning of "technical means

[3] For instance, the theme "trade-offs in designing the degree of openness" was derived from codes such as "Decisions to open a platform entail tradeoffs between adoption and appropriability" [11] or "[..] it may be a trade-off between attracting a developer community […] and ensuring high standards" [30].

for complementary providers (i.e. companies that provide alternative technology, products or services for the platform) to access the core functions of the platform" [39].

Table 3. Identified research perspectives on platform openness

Article	*Organization*		*Technology*		*Users*	
	Acces-sibility	Trans-parency	Acces-sibility	Trans-parency	Acces-sibility	Trans-parency
Top journals and IS conferences						
Benlian, Hilkert and Hess [13]			X	X	X	X
Boudreau [18]	X		X			
Boudreau [20]			X			
Casadesus-Masanell and Llanes [7]			X		X	
Foerderer, Schuetz and Kude [40]			X	X		
Furstenau and Auschra [41]			X		X	
Gawer [37]			X			
Ghazawneh and Henfridsson [14]					X	X
Hilkert, Benlian, Sarstedt and Hess [42]			X	X	X	X
Karhu, Gustafsson and Lyytinen [43]			X			
Kazan and Damsgaard [34]	X				X	
Kuebel and Zarnekow [44]	X		X		X	X
Kwon, Oh and Kim [36]					X	
Niculescu, Wu and Xu [45]			X	X		
Nikou, Bouwman and de Reuver [46]			X			
Ondrus, Gannamaneni and Lyytinen [17]	X		X		X	
Park, Lee and Lee [47]			X		X	
Parker and Van Alstyne [48]			X		X	
Parker and Van Alstyne [21]			X		X	
Parker, Van Alstyne and Jiang [15]			X		X	
Schreieck, Wiesche and Krcmar [49]			X			
Song, Baker, Wang, Choi and Bhattacherjee [38]			X			
Wessel, Thies and Benlian [12]					X	
West [50]	X	X	X		X	
Other papers						
	14	6	54	11	33	5
Total articles	19	7	62	15	40	9

On the user level, openness "is defined by the level of discrimination that the platform exercises against different segments of the potential customer base" [17]. Furthermore, openness can be categorized as either providing accessibility or transparency [23, 44, 51]. Accessibility focuses on the degree of discrimination against different roles and determines whether providers, third-party developers, or end users are allowed to join and access the platform [23, 51, 52]. Transparency, on the other hand, relates to the "understanding of what is happening and why" and thus determines whether platform-related governance decisions are comprehensible [23, 51]. On each of these levels, a platform can be open or closed. Furthermore, for each of these levels, the platforms' degrees of accessibility and transparency can be determined. On the technology level, for example, accessibility refers to the degree to which third-party developers are allowed to contribute to the platform by building new applications. Transparency, on the other hand, refers to the degree to which it is made understandable to these developers how and under what conditions third-party applications can be created and distributed through channels like the platform's application marketplace. Similarly, on the user level, accessibility reflects the possibility for users to participate on a platform (such as Uber), while transparency refers to how and to what extent the rules for participating are made comprehensible. The resulting coding matrix of our publication sample shows that most papers focus on accessibility on the technology and user level, while the dimension of transparency on all the levels is mostly neglected, especially on the user and organization level (see **Table 3**).

4 Central themes in research on platform openness

4.1 Measuring platform openness

Platform openness should not be measured as a binary variable, but rather depicted as a continuum [50]. As already introduced earlier, Eisenmann, Parker and Van Alstyne [11] distinguish between four distinct roles in ecosystems (sponsors, providers, complementors, and end users) towards which platforms can be open or closed. Still, even in platforms that are seemingly open towards a specific role, openness may still be restricted to a certain degree. The source code of the operating system Linux, for example, is accessible to everyone, but contributors need to adhere to strict governance processes comprising code review and quality appraisal [18, 24]. The framework of architectural openness developed by Anvaari and Jansen [23] considers this distinction. The architecture of a platform is divided into four layers: kernel, middleware, native applications, and extended applications. The framework shows whether it is possible to modify, extend, or integrate each layer and whether permission by the platform owner is needed for these activities.

Other frameworks focus on specific architectural aspects. Schlagwein, Schoder and Fischbach [16] propose a matrix-based framework for measuring the openness of platform resources along the dimensions of access and control. Access to resources can be exclusive, on a group-basis, or open. Control of resources can be exercised by the platform owner, by a group, or by an external actor. Ghazawneh and Henfridsson [14] focus on distribution channels and present a typology for digital application marketplaces. They distinguish between closed, censored, focused, and open marketplaces with different regulatory designs. Taking the perspective of complementors, Benlian, Hilkert and Hess [13] develop an instrument for measuring complementors' perceived platform openness along the dimensions of technical platform, distribution channel, accessibility, and transparency.

4.2 Mechanisms for implementing openness

For structuring mechanisms for implementing openness, we draw on the notion of horizontal and vertical openness by Eisenmann, Parker and Van Alstyne [11]. Horizontal openness refers to allowing rival platform's users to interact with the own platform or allowing additional parties to participate in the platform's commercialization or technical development. Vertical openness refers to granting third-party developers access to resources for developing complementary applications.

For implementing horizontal openness, platform owners choose to establish interoperability with other platforms in order to increase their market potential, either as part of a competitive or collaborative strategy (see, for example, the interoperability agreement between the instant messaging services of Yahoo and Microsoft) [11, 17]. Another strategy, that is especially attractive for mature platforms, consists of licensing the own platform to additional providers while retaining control over the platform's technology (see, e.g. Microsoft Windows) [11]. Going even further, platform sponsors may also give up ownership over technology and invite partners for joint sponsorship and development (see, for example, the Linux operating system or other open source software projects) [11, 18, 50].

Vertical openness is implemented through boundary resources [49, 53], i.e. the "software tools and regulations that serve as the interface for the arm's length relationship between the platform owner and the application developer" [8]. In practice, this includes technical boundary resources such as Application Programming Interfaces (APIs), SDKs and non-technical boundary resources such as technical documentation and support or the provided community [54-56]. Furthermore, distribution channels such as app stores are offered to facilitate the diffusion of third-party complements [14]. From a policy perspective, platform owners can restrict access to resources, e.g., by charging usage fees or by reserving access to selected groups of developers [18, 57]. In addition, they can exercise content control on distribution channels through prescreening, review, and approval processes [14, 58, 59].

4.3 Drivers for opening up or closing down

Platform owners decide to open up platform boundaries when seeking to stimulate growth by increasing their user base [17]. A larger end user base leads to higher market shares while a higher developer base allows the platform owner to access external resources and stimulate innovation even or especially when lacking own competencies to innovate [60, 61]. In the case where changing the level of openness is complicated through technological or cultural constraints owners tend to more liberally open the platform when expecting an increasing developer base [15, 17]. The need to comply with or the uncertainty about legal regulations may also be factors to open or close a platform (see, e.g., the lawsuit provoked by Microsoft's decision to bundle Windows with Internet Explorer) [41, 53, 60].

The degree of openness is not a fixed, static choice, but may vary over time, shifting from closed to open or vice-versa [30, 62]. Platform-to-platform competition, for example, where each platform intends to attract more developers may incentivize platform owners to increase openness [7, 22]. On the other hand, certain features of a platform may become so valuable over time that the platform owner does not gain any more benefits by keeping these parts fully open [15]. This can be observed at the practical examples of platforms such as LinkedIn, Twitter, or Instagram. In 2015, all three of these platforms announced the discontinuation of a large portion of their formerly open APIs, mentioning, among others, competitive threads to their businesses [63-65]. This led to the shutdown of several third-party application who could not afford the transition to the companies' partner programs or whose application use cases did not meet new terms of service [66].

4.4 Trade-offs in designing the degree of openness

Two central trade-offs need to be balanced by platform owners: adoption vs. appropriability[4] [15, 50] and diversity vs. control [18, 30, 68]. First, as already shown, higher openness leads to adoption by complementary developers. Higher openness however also reduces switching costs and increases inter-platform competition, thus making it more difficult to appropriate profits [50]. Second, higher openness leads to more diversity of complementary applications through open innovation. On the other hand, the platform owner may lose control over the quality of applications and be faced with complex coordination of resources and strategic interests [18, 20]. During the so-called "Atari shock", for example, a high number of low-quality games for the video gaming platform Atari that exercised no content control at all led to its eventual demise [69].

4.5 Impact of changing degrees of openness on platform-centric ecosystems

On the sponsor level, higher platform openness leads to the necessity of increasing modularity and more complex system architectures on the technology level [70]. In collectively sponsored platforms, increased openness on the sponsor layer may be a source of conflict resulting from deciding on the inclusion of new sponsors [33]. Sponsors and providers may also benefit from lower development costs through effectively outsourcing innovation [15, 71].

Several qualitative and quantitative studies show that higher openness leads to increasing adoption among complementors and a high quantity and variety of complementary applications [7, 17, 19, 44, 59, 72-75]. Puvvala, Dutta, Roy and Seetharaman [54] support these results and show the importance of provisioning tooling and reasonable license costs. A case study on the crowdfunding platform Kickstarter

[4] We refer to appropriability as "the ability of different stakeholders to retain for themselves the financial benefits that arise through the exploitation of an innovation" [67].

shows that increased openness on the complementor side may lead to a destabilized ecosystem [12]. After relaxing the screening processes for new campaigns on their platform, campaign success rates decreased and competition between project creators increased because of an altered ratio of campaigns to backers. A particular challenge lies in determining the right degree of openness. While granting access to complementary developers is associated with a rising innovation rate, after a certain threshold the rate decreases again in a curvilinear manner due to excessive competition between developers [18, 20].

On the user level, Müller, Kijl and Martens [32] argue that stricter content control leads to higher quality of third-party applications but on the other hand, higher competition induced by low control also leads to lower prices for end users. In terms of end user adoption, Hagiu [76] and Moon and Choi [9] suggest that lower openness may induce higher use adoption due to increasing competition. Finally, the openness towards third-party developers does not influence adoption among end consumers, as shown by Nikou, Bouwman and de Reuver [46].

5 Avenues for future research on platform openness

In this section, we point out and discuss central avenues for future research that appear promising based on our literature review. First, we call for further research on finding the optimal degree of platform openness. Second, we suggest integrating perspectives on accessibility and transparency. Third, we discuss the adoption of novel research methodologies in the context of organizational and technical configurations and the role of platform openness.

The findings of Boudreau [18] and Parker, Van Alstyne and Jiang [15] characterize the relationship between innovation and openness as curvilinear, suggesting that platform openness can be optimized [13]. However, little is known about the factors that influence the threshold at which innovation decreases again. The evidence presented by Boudreau [18] is based only on data on handheld computing systems from 1990-2004 and has since then not been verified nor replicated using data on more recent platforms. As of today, recent examples of platforms with varying degrees of openness (see, as already discussed: Hofer-Shall [63], Instagram [64], Trachtenberg [65]) provide data that allow for reexamining the question of optimal openness and its accompanying conditions. The results could be valuable for theoretical advances on platform research as well as for practical guidelines on effective platform governance.

As our coding has shown, few articles consider the transparency dimension on openness, such as technical documentation, communication with end users, or transparency of market mechanisms. Yet research has demonstrated that aspects of transparency considerably influence platform adoption among complementors [54, 77, 78]. Hence, integrating perspectives on accessibility and transparency regarding platform openness promises to be a fruitful research area. For example, different best practices regarding the implementation and promotion of transparency could be identified through a multiple-case analysis of successful platforms. This could yield insights on the design of successful platform ecosystems for end users and complementors, ultimately resulting in higher platform adoption.

Several studies have identified and discussed drivers and impacts of changing degrees of openness. However, we argue that the complex causal interplay of these drivers and organizational and technical preconditions in the firms and platforms influence the degree of openness, rather than stern linear relationships (see Vis [79] for a detailed discussion). For this reason, we call for the use of research methods that take into account equifinality and complex non-linear relationships, such as fuzzy-set Qualitative Comparative Analysis (fsQCA) [80]. FsQCA with platforms as unit of analysis has been employed by, for example, Dellermann and Reck [81], Dellermann and Reck [82] and Dellermann, Jud and Reck [83] for analyzing user loyalty, platform governance, and perceived risk. Future research could examine the effect of the interplay of openness and other factors such as the number of sides or the amount of partners on successful or unsuccessful platform launches [84], deriving relevant insights for practitioners.

6 Conclusion

The goal of this paper was to synthesize the current state of research on platform openness and to identify avenues for future research. Literature analyzes platform openness on different levels and dimensions, but neglects aspects of transparency. The main themes comprise measurement frameworks, implementation mechanisms, drivers for opening and closing platforms, trade-offs in designing openness, and the impact of changing openness on ecosystems. Based on our results, we propose three distinct issues for future research: finding the optimal degree of platform openness, integrating perspectives on accessibility and transparency, and analyzing the interplay of openness and other factors with novel research methods.

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Appendix I. The Role of Openness and Extension Modularization in Value Capture for Platform-Based Digital Transformation (P9)

The Role of Openness and Extension Modularization in Value Capture for Platform-Based Digital Transformation

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Abstract. Digital transformation is radically changing the way companies conduct business and compete in established markets. In particular, a growing number of companies are switching from predominantly product-focused to platform-based business models. However, it remains unclear how these platforms should be designed to enable platform owners to maximize value capture. In this study, we investigated the interactions between platform openness and extension modularization and their influence on value capture in the context of digital transformation. To do so, we combined a case survey strategy with a configurational approach using fuzzy-set Qualitative Comparative Analysis. We found that there is no single condition necessary to achieve a high degree of value capture. Furthermore, our results show the importance of closedness and tight coupling of platforms and their applications. Finally, we confirmed the importance of interface conformance to high value capture. In addition, our results contribute to both theory and practice and provide implications for future research into the role of digital platforms in digital transformation.

Keywords: Digital transformation, digital platforms, configuration theory

1 Introduction

Digital technologies are radically changing today's business environments and ecosystems. The widespread availability of these technologies has given birth to a multitude of start-ups, entering markets that were traditionally dominated by established companies. Recently, these companies have begun digital transformation initiatives to implement new business models, increase internal efficiency, and enhance customer experience [1]. In particular, more and more companies have begun switching from predominantly product-focused to service-based models centered on digital platforms [2]. Thus, the source of value creation is shifting from traditional dyadic, one-on-one relationships with partners to more complex, interconnected ecosystems with digital platforms at their centers [3]. Many established companies cannot draw on prior experience regarding the design and maintenance of digital platforms and thus, many platform-based endeavors have failed [4]. One particular challenge for platform owners lies in capturing part of the value that is created on a platform and its ecosystem by complementors [5]. Extant literature suggests that design choices such as the openness of the platform and the modularization of its extensions or applications influence the degree of value that can be captured [5]. For example, an open platform might increase the number of available applications and the potential value that can be captured [6]. On the other hand, a rather closed platform may be more easily governed by its owners. This may be realized through the enforcement of stricter regulations controlling exactly how value may be captured by platform owners [7]. However, extant literature has only theoretically hypothesized the nature of these relationships. To the authors' best knowledge, no empirical study has yet investigated the specific interaction between platform design and value capture. In order to close this research gap, our guiding research question is as follows: *In the context of digital transformation, how do design choices, such as platform openness and extension modularization, influence the degree of value capture to the platform?*

To answer this question, we adopted a configurational viewpoint. We conducted a case survey of digital platform case studies using scholarly and practice-oriented sources and subsequently analyzed the results with fuzzy-set Qualitative Comparative Analysis (fsQCA) [8, 9]. We identified both single necessary conditions and sufficient configurations of conditions for achieving high degrees of value capture.

2 Platform-Based Digital Transformation

2.1 Value Capture and Platform Design

The widespread availability of digital technology has had a profound impact on companies and their environments. New technologies, such as the blockchain or the Internet of Things, have radically changed the processes of established companies and their business models as they try to defend their shares of traditional markets that are currently being conquered by start-ups [1, 10]. In particular, many companies are adopting digital platform-based business models and service offerings [3]. Accordingly, some scholars have observed a transformational shift from product-centric to service-centric offerings that are based on digital platforms. Since most established companies are novices regarding the design and maintenance of digital platforms, they face a multitude of challenges [2]. One particular challenge lies in capturing the monetary value that is co-created on these platforms [5]. Extant research suggests that the potential value capture is profoundly influenced by digital platform design choices [5, 7]. Therefore, we focus on design choices made by the platform owner regarding relationships with third-party developers and applications, namely, platform openness and extension modularization. For the remainder of this paper, the terms "application" and "extension" are interchangeable.

Platform Openness. Openness is a crucial feature of any platform design. It can generally be defined according to the categories of accessibility and transparency [11]. *Accessibility* indicates a platform's degree of discrimination regarding different actors and their access to the ecosystem [11]. A platform owner can vary the degree of accessibility to control who is and who is not allowed and under what conditions they have access to the platform [12]. For example, a platform owner may choose to only provide boundary resources such as application programming interfaces (APIs) or software development kits (SDKs) to those third-party developers that pay a certain licensing fee or deny them access if their applications receive consistently bad ratings [13]. *Transparency* indicates the degree to which users understand “what is happening and why” [11]. In particular, this determines whether governance-related decisions are made transparently and comprehensively for all users. A platform owner may, for example, provide extensive documentation regarding their boundary resources or communicate the conditions that third-party apps need to fulfill to be listed in a platform application marketplace [14].

Platform openness may have both a positive and negative influence on value capture: a more open platform may attract a larger number of developers and fewer restrictions may simultaneously increase the number of platform applications along with potential value to be captured [6]. However, the platform owner may have difficulty enforcing the capture of such value in the absence of strict regulation [7]. A closed platform, on the other hand, due to stricter rules regarding the inclusion of third-party developers may decrease the number of applications, potentially resulting in less value to be captured. Still, stricter control may increase the quality of permitted apps, ultimately resulting in a larger user base and increased value [15].

Extension modularization. *Extension modularization* describes the client-side design choices made by a digital platform. Following Tiwana [16], extension modularization can be assessed using two subcategories: loose coupling and interface conformance. Both can be applied either to each single extension or to the entire ecosystem [16]. *Loose coupling* refers to whether platforms and their applications have minimal dependence on each other and the necessity of these dependencies [17]. In particular, loose coupling implies that a change in the digital platform does not generate a ripple effect that requires all third-party applications to make accommodating changes and vice versa [16]. Thus, the system remains relatively stable. On tightly coupled platforms, on the other hand, applications heavily depend on the platform and are severely affected whenever changes occur [18]. Loosely coupled platforms may provide a higher degree of freedom to application developers, thus increasing the stability of applications and ensuring a constant degree of value capture. Still, tightly coupled platforms may also result in higher value capture since they give platform owners the possibility to exert stricter control on its relationship with third-party developers, similar to more closed platforms. Furthermore, tightly coupled platforms typically emphasize “an increased understanding of each other’s needs, a close relationship, a low degree of information asymmetry, and the ability to tailor products or services to strategic needs” [18]. These factors may eventually reinforce and improve the relationship between platform owner and third-party developer, facilitating a higher degree of value capture.

Interface conformance, the second subcategory of extension modularization, relates to the degree to which extensions conform “to the interface specifications explicitly specified by the platform owner,” such as APIs or proprietary protocols [16]. Therefore, it measures whether applications interact with the platform through clearly specified, stable, and well-documented interfaces [19]. Based on extant literature, we assume that interface conformance has a positive effect on value capture in general since it fosters high quality in its applications, resulting in higher user adoption or acceptance and, ultimately, a higher degree of value capture available to the platform owner [16].

2.2 Research Model

We investigate how different design choices influence the degree of value capture achieved by digital platforms in the context of digital transformation. Regarding value capture, we refer to monetary value and define value capture as "'the appropriation and retention […] of payments made by consumers in expectation of future value from consumption' that one member of a value system can claim for itself" [5]. We argue that the interactions between the predictor variables are of particular interest and have not been investigated yet. During our comprehensive review of the existing literature, we have found that these predictors may have both positive and negative effects on outcomes, depending on the specific context. Operating under the assumption that there are a number of different paths that may lead to success, we have adopted a configurational perspective. In our study, a platform owner achieving a high degree of **value capture** represents success. As predictor variables, we added two design choices characteristic of digital platforms to our research model: **platform openness** and extension modularization. We further divided extension modularization into two subcategories: the degree of **coupling** and **interface conformance**. These three explanatory factors along with our chosen outcome represent our research model. We summarize this in **Fig. 1**.

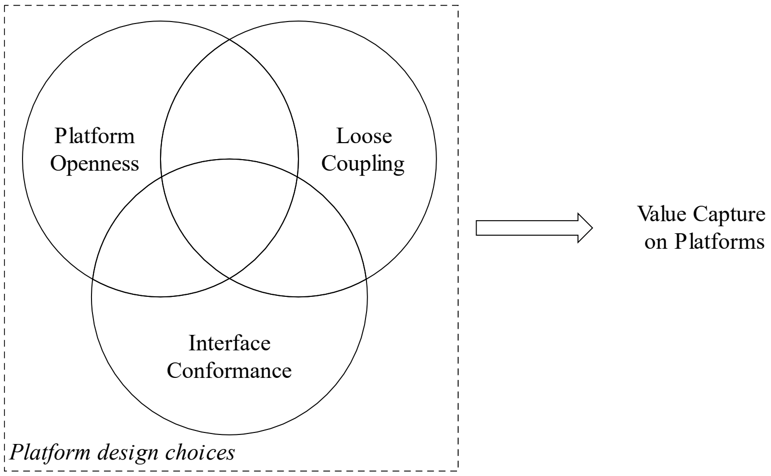

Fig. 1. Configurational research model

3 Methodology

We believe that an in-depth perspective based on case studies is an appropriate approach to explore the complex causal relationships in our research model. Since it is highly resource-intensive to conduct in-depth case studies, we made use of the large number of existing case studies already available in scientific databases, thus adopting a case survey strategy [8]. Furthermore, we adopted a configurational perspective since we assumed that there are various paths leading to success and complex interactions between the specific factors in our research model. Therefore, we created a coding scheme based on fuzzy values for conducting the case survey and analyzing the resulting data matrix with fsQCA [9]. Before we started collecting case studies, we defined appropriate inclusion criteria [8]. In our analysis, since we focused on digital platforms that were specifically introduced during an established company's digital transformation process, we defined inclusion criteria to ensure accordingly appropriate coverage. Thus, we included cases only if (1) the narrative sufficiently described the introduction of a digital platform into an existing company's business model, (2) the digital platform was introduced by an established company as part of a digital transformation strategy, and (3) the digital platform offered third-party developers the possibility to develop their own complementary applications using resources provided by the platform owner. Considering these criteria, we developed an appropriate search string and then applied it to searches of various databases. We selected the following databases for our search: EBSCOhost, Emerald Insights, Google Scholar, Web of Science, and Scopus. After an initial screening of the results, we applied our inclusion criteria. Any case study that did not fulfill these criteria was excluded from the set. Afterward, a set of 20 case studies remained, which formed part of our analysis.

After collecting our set of 20 cases, we began the coding process. We developed a coding scheme based on the research model introduced earlier, comprising the dimensions of platform openness, loose coupling, interface conformance, and value capture. We followed established guidelines for the use of qualitative data such as case studies or archival data in qualitative comparative analysis [20]. Thus, for each dimension, we defined a "theoretical ideal" that represented "the best imaginable case in the context of the study that is logically and socially possible" [21]. Furthermore, we used a fuzzy five value scheme to code each case against the theoretical ideal, as recommended by Iannacci and Cornford [22], when underlying data may be "too weak to support fine-grained distinctions." Two researchers independently coded all cases using the defined coding scheme. Subsequently, both researchers prepared a coding report that contained detailed information about the case, the chosen fuzzy values, as well as quotes from the text supporting the choice of said fuzzy values. The researchers then compared their reports to each other. Disagreements in coding lead to both researchers re-reading the cases and reconciling disagreements through a consensus approach as recommended by Larsson [8]. The resulting fuzzy values for each case and the theoretical ideals for each dimension are summarized in **Table 1**.

After coming to an agreement regarding the coding of all cases, the researchers proceeded to analyze the agreed-upon fuzzy values. For this step, we employed fsQCA, a configurational research method. While regression-based approaches usually postulate that a certain predictor variable is both necessary and sufficient for a given outcome, configuration theory posits that predictors may be either sufficient or necessary, both, or neither. To further reinforce this difference, configuration theory uses the term "condition" rather than "predictor". To evaluate the quality of solutions, fsQCA is based on two "parameters of fit": consistency and coverage. Consistency captures "how consistently empirically observed configurations are linked to the outcome and thus provide information regarding the model's validity" [23]. We also considered an alternative measure of consistency: Proportional Reduction in Consistency (PRI), which eliminates the influence of cases that are subsets of both the outcome and its negation [24, 25]. Coverage represents the percentage of cases of a certain outcome that are explained by the chosen configurational model [9].

Table 1. Fuzzy membership values for openness and application modularization

Case / Dimension	Openness [11]	Extension modularization [16, 17]		Value capture [5, 26]
		Loose coupling [16, 17]	Interface conformance [16, 17]	
	(Ideal type: Platform resources are available and accessible for everyone without restrictions; documentation and governance rules are transparent)	(Ideal type: Platform and applications are loosely coupled, with a small number of necessary and no unnecessary interdependencies)	(Ideal type: Applications interact with the platform using interface standards and protocols that are clearly specified, standardized, and stable)	(Ideal type: Platform owner is able to capture most of the value that is co-created on the platform by third-party developers and the platform owner)
APIBank [27]	1	0.49	1	0.25
DBS [28]	0	1	1	1
Intuit [29]	0.75	0.49	0.75	1
CommCo [30]	0.49	0.75	0.25	0.25
Advantech [31]	1	1	1	1
Cisco [32]	0	0.25	1	1
Siemens [33]	1	0.75	1	1
ABB [34]	0.75	0.75	1	0.25
GE [35]	0.75	1	0.75	1
Telekom [36]	1	0.75	0.75	0.25
Telenor [37]	0.75	0.49	1	1
China Mobile [38]	0	0.49	1	0.75
Signify [39]	1	1	1	1
Royal Philips [40]	1	1	1	1
Aker BP [41]	0.75	1	1	1
Maersk [42]	1	1	1	1
Trafiklab [43]	0.75	1	0.75	0
Volvo [44]	0	0.25	0.25	1
Lego [45]	0.75	1	1	0
Aadhaar [46]	0.75	0.75	1	0.25

To conduct our analysis, we used an R library developed by Thiem and Dusa [47] that supported all steps of fsQCA. As recommended by Schneider and Wagemann [48], we first performed a necessity analysis to identify any single conditions that are necessary for achieving the outcome. We then employed the commonly accepted consistency threshold of 0.9. In the next step, we used the R library to construct a truth table of all potential combinations of conditions and outcomes. Each truth table row was assigned a consistency measure indicating how well the cases represented the given table row. Next, we applied thresholds for consistency (0.8) and frequency (1). Thresholds for (PRI) consistency reduced the truth table by eliminating all rows with consistency values that did not reach the given threshold. With 0.8 for raw consistency and 0.75 for PRI consistency, we exceeded the lower bound of 0.75 for both consistency measures [24, 48]. After further reducing and simplifying the truth table, three solution types remained: the complex, parsimonious, and intermediate. As recommended by Fiss [49], we focused on the intermediate and parsimonious solutions and used them to identify core and peripheral conditions. Core conditions have a strong causal relationship with the relevant outcome, while peripheral conditions surround core conditions and have a weaker causal relationship with the outcome [49].

4 Results

The results of our necessity analysis reveal interface conformance as a candidate condition for high value capture and loose coupling for low value capture (see **Table 2**). However, in both instances, relevance and coverage are rather low which puts their nature of necessity in doubt. Thus, we proceeded to analyze the results of sufficiency to further investigate the necessity of our candidate conditions and to identify sufficient conditions.

Table 2. Results of necessity analysis

	High value capture			**Low value capture**		
	Consistency	Relevance	Coverage	Consistency	Relevance	Coverage
Openness	0.66	0.61	0.69	0.83	0.43	0.37
Loose coupling	0.78	0.53	0.72	0.96	0.34	0.38
Interface conformance	0.91	0.35	0.73	0.88	0.17	0.3
~Openness	0.39	0.93	0.85	0.29	0.74	0.27
~Loose coupling	0.32	0.98	0.95	0.29	0.83	0.37
~Interface conformance	0.13	0.96	0.7	0.21	0.93	0.5
Commonly applied consistency threshold: 0.9 [25]						

Our sufficiency analysis yielded three distinct configurations for achieving high degrees of value capture on digital platforms (see **Table 3**). For the negation of the outcome, i.e., achieving low degrees of value capture, we could not identify configurations that passed our thresholds of consistency. Regarding the positive outcome, we observed a robust consistency level of 0.87, well above the commonly accepted threshold of 0.75 [48]. The coverage level of 0.47 demonstrates that our solution explained almost half of the observed outcome. The first configuration represents closed platforms with a low degree of low coupling, which was also a core condition. Interface conformance is irrelevant for this configuration, which confirmed our earlier assumption that it was not a necessary condition. Volvo represents an example for this case [44]. The second configuration shows closed platforms with a high degree of interface conformance. Both conditions are core conditions while the degree of coupling does not play a major role in the achievement of the outcome. This configuration is represented by, for example, DBS [28]. The third and last configuration depicts platforms with a low degree of loose coupling and a high degree of interface conformance. In this configuration, platform openness is irrelevant. An example for this configuration can be found in the case of APIBank [27].

Table 3. Results of sufficiency analysis

Conditions	**High value capture**		
	1	**2**	**3**
Platform openness	⊗	⨂	
Loose coupling	⨂		⨂
Interface conformance		●	●
Raw consistency	1.00	0.86	0.94
PRI consistency	1.00	0.83	0.91
Raw coverage	0.23	0.34	0.29
Unique coverage	0.04	0.14	0.09
Solution raw consistency	0.87		
Solution PRI consistency	0.83		
Solution coverage	0.47		

Black circle: presence of a condition; crossed-out circle: absence of a condition; empty row: may be either present or absent; large circle: core condition; small circle: peripheral condition; raw consistency threshold: 0.8; PRI consistency threshold: 0.75; frequency threshold: 1.

5 Discussion

5.1 Cross-configurational Patterns

Our results show different interesting patterns across the identified configurations. First, it is interesting to note that we could not find any necessary conditions for high value capture. This implies that there is no single success condition for achieving high value capture. On the contrary, there are various configurations that all lead to the desired outcome. Furthermore, we also confirmed the positive effect of interface conformance, since the presence of this condition forms part of two sufficient configurations. Still, it is not a relevant factor in the first identified configuration. Interestingly, we could not ascertain high degrees of platform openness nor loose coupling as being sufficient elements. On the contrary, closed platforms and tight coupling appear to be parts of sufficient configurations, mostly even as core conditions with high empirical relevance. For example, a closed platform with tight coupling is a sufficient configuration for high value capture. Thus, we assume that platform owners can maximize value capture by keeping a platform closed and exercising strict control over what third-party applications may be developed on it. Furthermore, a tight coupling approach seems promising for maintaining closer relationships with developers and maximizing value capture. While closedness and tight coupling in combination are sufficient, either condition may also be combined with interface conformance to achieve high value capture.

5.2 Contributions and Limitations

This study contributes to existing research on digital platforms and digital transformation in several ways. First, we answered calls for research taking a configurational perspective instead of the traditional econometric and qualitative approaches [50] of previous studies. Furthermore, we responded to a call for research by de Reuver, Sørensen and Basole [51] that proposed further analyses of design choices for digital platforms. Our study is a first exploration of the interrelationship between value capture and design choice for platforms in the context of digital transformation. Thus, we showed several avenues for future research. Finally, practitioners may use our findings to optimize the design of their own platforms to maximize value capture.

Our research is not free from limitations that need to be addressed. One such limitation is the relatively low value of solution coverage, indicating a potentially low empirical relevance of the solution. However, as Schneider and Wagemann [25] note, the "empirical importance expressed by coverage is not the same as the theoretical or substantive relevance of a sufficient condition." Thus, even solutions with low coverage can still be interesting for the purpose of theory building. We argue that this specifically applies to our findings since this is the first study that uses configuration theory to explore the interaction between openness and application modularization and their effects on value capture. Future research could include further conditions that are theoretically relevant to identify additional configurations.

Further limitations result due to our use of a case database. First, the number of cases is relatively low (20). This restricts the number of conditions that could be included in our research model since a high number of conditions would result in a high number of logical remainders. Since theoretical knowledge regarding our chosen research model is rather low, it is difficult to eliminate these remainders. Second, the case studies were originally conducted with very different goals. The degree to which they provide information about the conditions of our study may vary. However, we tried to account for this fact by having two independent coders. In summary, we call for further research by conducting in-depth case studies and increasing the set of studies that may be investigated to analyze the phenomenon of value capture. This increased set could also be used to test the results that were derived in this paper.

6 Conclusion

This study aimed to identify successful platform configurations with respect to the design choices of openness and extension modularity, in the context of digital transformation. Therefore, we conducted a case survey combined with an fsQCA approach, using a set of scholarly and practice-oriented case studies. Our analysis revealed three distinct configurations of successful design choices. In particular, our results demonstrate that no single condition is necessary and that there are several paths to success. Our analysis also revealed three configurations of platforms with high degrees of value capture and showed the effectiveness of closed platform design using a tight coupling approach. Our study contributes to theory and practice by providing a first exploration into the influence of platform design on value capture for platforms in digital transformation.

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