Adoption of digital innovations in organizations – a configurational perspective

Adoption digitaler Innovationen in Unternehmen – eine konfigurative Perspektive

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Preface

Decisions and processes regarding adoption, whether by organizations or individuals, occur in interaction with their environment. These influences accompany the journey, provide support, and promote the considerations and processes of the adopters. Similarly, a dissertation does not take place in a vacuum but is supported by many individuals. Due to this fact, I would like to sincerely thank all the supporters of this dissertation.

First and foremost, my greatest thanks go to my doctoral advisor, Prof. Dr. Alexander Fliaster, who supported the entire journey with his competence and confidence, providing clear direction and structure and fostering my development. I am deeply grateful for the research opportunities and freedoms I enjoyed during my dissertation. At the same time, like a lighthouse, his guidance and support helped me never lose orientation and confidence. I would also like to thank him for the joint research projects, which gave me the chance to delve deeply into the world of science and be guided during my time at the Chair of Innovation Management. With his support, I was able to significantly develop myself over the past few years.

Furthermore, I would like to sincerely thank Prof. Dr. Björn Ivens and Prof. Dr. Eric Sucky for their participation in the doctoral committee.

I also deeply thank my colleagues who accompanied me on this journey and became friends. First, I would like to thank Karolina Bähr for her support from the first to the last day. The same thanks go to Bettina Mayr, Madeleine Schwarzmann, Michael Kolloch, Fabian Reck, and Christoph Brielmaier for their companionship along the way. I would also like to thank Elke Rockmann for her outstanding administrative and personal support.

Lastly, I want to thank my family and friends for their love and support throughout the entire period. Especially I want to thank my parents Martina and Wilfried, Maximilian as well as Maike.

Summary

Adopting digital innovations is crucial for companies in the context of digitalization as it enables them to adapt and reinvent their business models, processes, and products. This is vital for a company's long-term survival. Key questions arise regarding the antecedents of adoption, the decision-making process, implementation, and the role of partners such as stakeholders and individuals. Previous research has predominantly focused on adopting quantitative methods like regression and qualitative case studies. However, three types of research questions have been neglected so far. Firstly, general adoption research has not sufficiently cross-fertilized existing adoption models. Additionally, different stakeholders like customers have not been adequately considered. Secondly, within the context of digital innovation adoption, questions remain about the influence of specific digital characteristics, the resulting implications, and the interface between digital and sustainable trends. Thirdly, the configurational approach, mainly through qualitative comparative analysis, is gaining relevance as it allows for examining interactions and the interplay of various factors. Here, conjunction, asymmetry, and equifinality are essential in causal complexity.

This cumulative dissertation addresses these gaps through six papers that contribute to answering open questions in the three outlined areas. The dissertation begins with a review of innovation research, adoption research, and digital technologies. Building on this, I derive my research questions and provide an overview of the research methodologies used in this work. After an introduction of the individual articles, the second part contains the papers of the dissertation. Here, the articles compromise antecedents and preconditions of adoption, as well as internal and external factors influencing the adoption decision. The concluding epilogue highlights the key findings and discusses the contributions and implications.

By utilizing QCA, this dissertation can offer a new perspective on adoption research and provide detailed insights into the adoption process. It becomes evident that interconnections exist among individual factors and antecedents and in the interplay between adopting companies and partners, such as stakeholders and participants in co-creation processes. Furthermore, QCA demonstrates how adoption can be achieved and how individual companies and people make adoption decisions due to the interplay of different factors.

Outline

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AI	Artificial Intelligence
AVE	Average Variance Extracted
BDA	Big Data Analytics
CMB	Common Method Bias
CR	Composite Reliability
DOI	Diffusion of Innovations Theory
EGOS	European Group for Organizational Studies
EO	Entrepreneurial Orientation
fsQCA	fuzzy set Qualitative Comparative Analysis
ICIS	International Conference on Information Systems
ICT	Information and communication technologies
IS	Information Systems
KI	Künstliche Intelligenz
ML	Machine Learning
QCA	Qualitative Comparative Analysis
SDG	Sustainable Development Goals
SDT	Self Determination Theory
TACT	Technology affordances and constraints theory
TOE	Technology Organizational Environment

I. Synopsis – Prologue

1. Introduction to the dissertation and overview of the prologue

Adoption is multifaceted, complex, and dependent on various factors. Therefore, it is not surprising that companies have different reasons and motives for implementing and utilizing innovations within the organization. In addition, adoption occurs at different speeds, with the help of various partners and actors, and in different contexts (Lyytinen & Damsgaard, 2011; Rogers, 2003; van Oorschot et al., 2018). Consequently, adoption, alongside independent development, represents a central element for long-term business success.

Digitalization is currently regarded by both theory and practice as one of the most important drivers for business success (Cefis et al., 2023; Nambisan et al., 2017; Ransbotham et al., 2020). By 2024, 92% of Fortune 500 companies in the USA have already used or tested artificial intelligence (AI) (openAI.com, 2024). In this context, digital technologies like AI often serve as general-purpose technologies and are applied in various scenarios at both the product and process levels within companies (Autio et al., 2018). This reveals a wide range of application possibilities that companies must align with their economic goals, strategies, environments, and capabilities (Ransbotham et al., 2020). Nevertheless, from a scientific perspective, it is still unclear to what extent various underlying factors contribute to the adoption of digital innovations in companies, what role third parties play in these adoption processes, and what role other trends such as sustainability play in relation to digitalization (Fliaster & Kolloch, 2017; Frambach & Schillewaert, 2002; Howells, 2006; Sun et al., 2024; Yoo et al., 2012).

The dissertation focuses on examining the adoption of digital innovations in an organizational context across six papers. It is divided into three sections: the prologue, the paper section, and the epilogue. In the prologue, I introduce the structure of my thesis and my underlying motivation. I identify the research gaps that guide the work from existing research in innovation management, especially concerning adopting digital innovations. I clarify the methodology used in the foreground and the epistemological perspective. In addition, I showcase the publications and highlight the procedure. In the central part, the articles compromise the antecedents and preconditions of adoption, the adoption decision from an intra-organizational, and from a perspective considering the business environment.

Additionally, details about the publication steps for each article are provided. In the concluding epilogue, I answer the research questions mentioned at the beginning with the articles' findings and put them in context with each other. I discuss the results found in the context of existing research, derive implications, and critique the papers' limitations. Finally, I conclude with remarks on adopting digital innovations in organizations.

The prologue is subdivided into four sections. Firstly, I introduce this dissertation and present an overview of the prologue (chapter 1). Secondly, I reveal the fundamental contributions of innovation management to corporate success and provide a summary of innovation management in general (chapter 2). Thirdly, I focus on the core themes of my dissertation. Here, an overview of adoption and implementation as organizational tasks is provided, considering internal, cross-organizational, external, and technology-related influencing factors (chapter 3). In addition, I spotlight characteristics of digital innovations and their integration in the corporate context (chapter 4 & 5). Based on this, I derive the research questions of this thesis and explain the methodologies of the dissertation (chapters 6 & 7). I present the research perspective and the epistemological framework of the thesis. Here, I pay special attention to the configurational viewpoint and highlight the qualitative comparative analysis (QCA). Fourthly and finally, I introduce the publications of the dissertation and highlight the research question, framework, findings, and contributions (chapter 8).

2. Innovation management research: a short overview

In academic discourse and practice, there is fundamental agreement that innovation management contributes significantly to a company's success (Cardozo et al., 1993; Fliaster, 2007; Rogers, 2003; Tushman & O'Reilly, 1996). For instance, innovation is crucial for a company's long-term survival (Burr, 2014; Fliaster, 2007; Slater et al., 2014; Wolfe, 1994). As Mone et al. (1998) demonstrated, innovation capabilities are essential for corporate performance. Recent studies provided a nuanced view, illustrating that the interplay of factors, including the type of innovation, process, organizational characteristics, context, and timing is essential for business success (e.g., Damanpour et al., 2009; Huang et al., 2016).

Numerous results from consulting firms also suggested that innovation activities are essential to corporate success. For instance, Davison et al. (2023) showed that the most successful quantile of companies focuses on innovation in value generation, such as the business model, the ecosystem and technology used, operational innovation, and continuous transformation. They emphasized that this quantile achieves a 13-fold performance premium, combining profit margin and revenue growth. The Boston Consulting Group highlighted in their 2023 innovation report that 79% of the companies surveyed see innovation as one of their three most important goals. A closer look into these results reveals that companies are prioritizing innovation more than in the past and are using it in both the cost reduction in processes and the implementation of new products and services. In addition, leading innovative companies are increasingly focusing on implementing and using radical innovations (Manly et al., 2023).

Researchers approach and define innovation from various angles, such as a process or an outcome perspective. In his pioneering work, Schumpeter (1961) emphasized novelty while distinguishing between the distinct types of products, processes and production methods, markets, suppliers, and organizational structures. Apart from this viewpoint, other aspects, such as its origin within organizations and networks (Pittaway et al., 2004), successful implementation (Hobday, 2005; Klein & Knight, 2005), and dissemination (Holland, 1997), are highlighted. Van de Ven et al. (2007) underscored nonlinear and dynamic activities that cause the transition between divergent and convergent phases. Lam (2005) distinguished organizational innovativeness into three streams in their literature review. The first stream focused on the relationship between organization structures and innovativeness, the second stream emphasized knowledge creation and organizational learning, and the third stream emphasized the change and adaptation within organizations. Crossan and Apaydin (2010) investigated previous definitions of innovation and based on these insights, defined innovation as follows: "production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. It is both a process and an outcome" (p. 1155).

The field of innovation management holds a rich historical significance and encompasses a broad and deep body of literature. Wolfe (1994) marked a pivotal moment in structuring innovation management research with his groundbreaking work. Prior research results were characterized as inconclusive, inconsistent, and lacking in explanatory power (Bigoness & Perreault, 1981; Damanpour, 1988; Downs & Mohr, 1976; Kimberly & Evanisko, 1981; Rogers, 2003), as Wolfe (1994) noted. He outlined the three distinct research foci depicted in Figure 1: diffusion and adoption, organizational innovativeness, and implementation processes, which explore the diffusion and adoption of innovations over time and space, determinants of innovation within organizations, and the implementation processes within firms. This dissertation focuses on diffusion and adoption.

While Wolfe (1994) identified three arenas within innovation management, Crossan and Apaydin (2010) clustered organizational innovation within a multi-dimensional framework. In doing so, they differentiated between innovation terms, which include leadership (e.g., upper echelon theory) (e.g., Garms et al., 2019; Gerstner et al., 2013; Hambrick & Manson, 1984; Reck & Fliaster, 2019) managerial level (e.g., resource-based view and dynamic capabilities) (e.g., Amabile et al., 1996; Damanpour, 1991; Miles & Snow, 1978; Nonaka & Takeuchi, 2007), and business processes (e.g., process theory) (e.g., Cooper, 2019; Davies et al., 2018; Rogers, 2003). In the context of the dimensions of innovation, a distinction was also made between innovation as a process (e.g., adoption) (e.g., Rogers, 2003) and innovation as an outcome (e.g., incremental and radical innovation) (e.g., Davila et al., 2006; Gopalakrishnan & Damanpour, 1997; Wang & Ahmed, 2004). Crossan and Apaydin (2010) pointed out that the conceptualization of 'innovation as a process' is still underdeveloped.

Diffusion of innovation research	Organizational innovativeness research	Process theory research
• Research question: What is the pattern of diffusion of an innovation through a population of potential adopter organizations? • Addresses the diffusion of over time and/or space	• Research question: What determines organizational innovativeness? • Addresses the determinants of the innovativeness of organizations	• Research question: What are the processes organizations go through in implementing innovations? • Addresses the process of innovation within organizations

Figure 1 Overview of research approaches in the innovation management (Wolfe, 1994; p. 407 minor design modifications).

Besides the work of Crossan and Apaydin (2010), a holistic investigation of innovation management has yet to be published in top-tier management and innovation outlets in recent years. Instead, recent literature reviews have focused on specific theories at the heart of innovation management, such as business model innovation (Spieth et al., 2022) and the framing of innovation (Reynolds et al., 2023). Additionally, topics like digital innovation (Kohli & Melville, 2019), technologies such as artificial intelligence (Gama & Magistretti, 2023), and phenomena like sustainable innovations (Cillo et al., 2019) have been explored. While the fundamental themes in innovation management research remain relevant, contemporary discussions have enriched these with topics such as digitalization and sustainability.

Thus, to gain a comprehensive understanding of the current innovation management research landscape, I analyzed recent publications across leading business management and innovation management journals for the years between 2013 and 2023 (Furrer et al., 2008). This process was guided by the most recent VHB JOURQUAL3 ranking (2015) available at the time of analysis (in winter 2023) and by the availability on https://www.webofscience.com. Table 1 provides an overview of the considered journals.

In the initial phase, metadata from those innovation management journals were collected via the Web of Science. Subsequently, Python was used to process the keywords. In the first step, a matrix was created that includes the authors, journals, titles, keywords, and years, among other data (Furrer et al., 2008; Schonberger et al., 2018). After checking for duplicates, special characters were removed, and lemmatization and stemming were performed to reduce words to their stems. Here, I applied the methods ‘WordNetLemmatizer’ and ‘PorterStemmerStop’ from the ‘nltk-package’ (3.8.1) (Nltk, 2024). Stop words were also removed. Subsequently, the absolute frequencies of the keywords, as well as the bigrams and trigrams—pairs and triplets of words—were calculated. Finally, trend analyses were conducted. Here, the smoothing of trend data is performed using a moving average (length of 3). The moving average reduces short-term fluctuations and highlights long-term trends in time series data. I used the method ‘rolling’ from the ‘pandas-package’ (Version 2.2) (Pandas, 2024). In the context of the prologue, particular focus was placed on the trigrams. The figures were generated from the respective data matrices. Figure 2, Figure 3, and Figure 4 illustrate the frequency of the keywords, bigrams, and trigrams, while Figure 5 displays the temporal trend.

The findings from the keyword, bigram, and trigram analyses are used to present the landscape of innovation management literature over the past few years. A fine-grained examination reveals several dimensions, emphasizing the pivotal role of 'technology', 'performance', 'knowledge', and 'networks'. These core elements are not only predominant across individual keywords but are also intertwined into the bigrams and trigrams, showcasing their central role in the discourse on innovation.

Table 1 Overview of considered innovation management journals for the innovation management literature.

Journal	**Ranking**
Research Policy	A
Journal of Product Innovation Management	A
Technological Forecasting and Social Change	B
Industry and Innovation	B
R&D Management	B

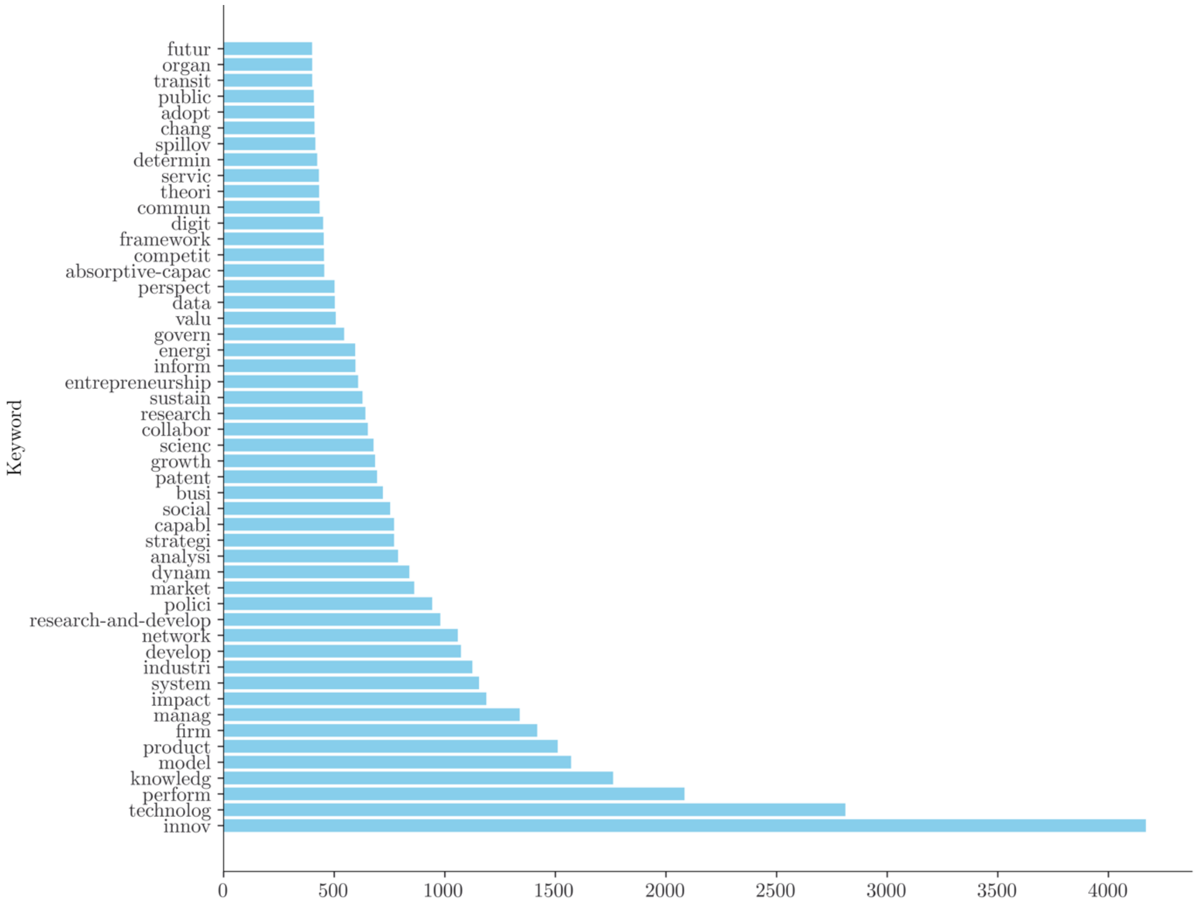


Figure 2 Overview of keywords in innovation management journals between 2013 and 2023 (own illustration).

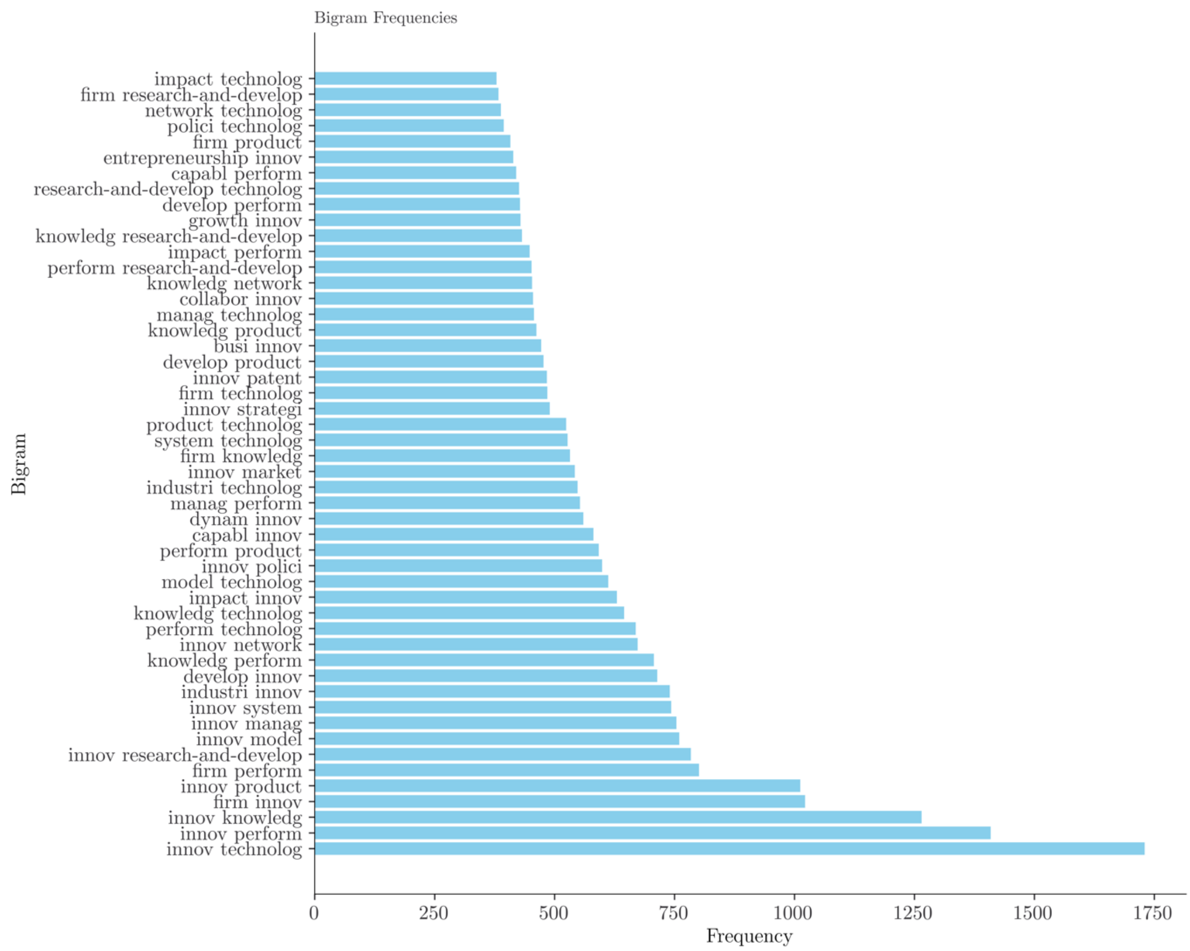


Figure 3 Overview of bigrams in innovation management journals between 2013 and 2023 (own illustration).

The bigrams analysis refines our understanding by highlighting firm performance, product development, and innovation systems as critical focus areas. This granularity reveals the nuanced interplay between organizational outcomes and innovation processes. The trigram and trend analysis adds another layer of depth, highlighting the significance of specific phenomena and theoretical frameworks.

Foremost among these trends is the 'technology and digitalization usage' pattern, which is underscored by the mentions of digital and technology (e.g., Nambisan et al., 2017). The prominence of these terms signals a decisive move towards embracing digital technologies, not just as tools for operational efficiency but as pivotal elements in crafting novel innovation strategies and business models.

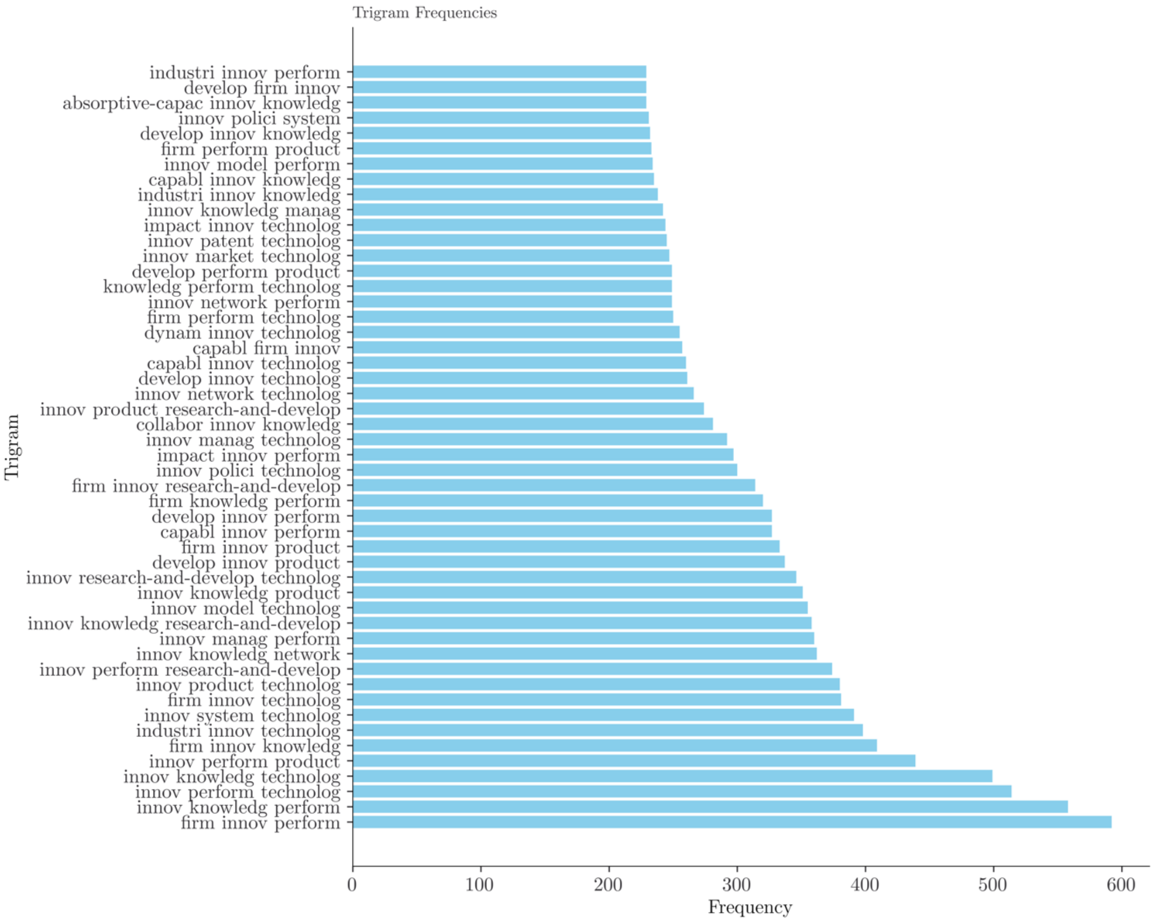


Figure 4 Overview of trigrams in innovation management journals between 2013 and 2023 (own illustration).

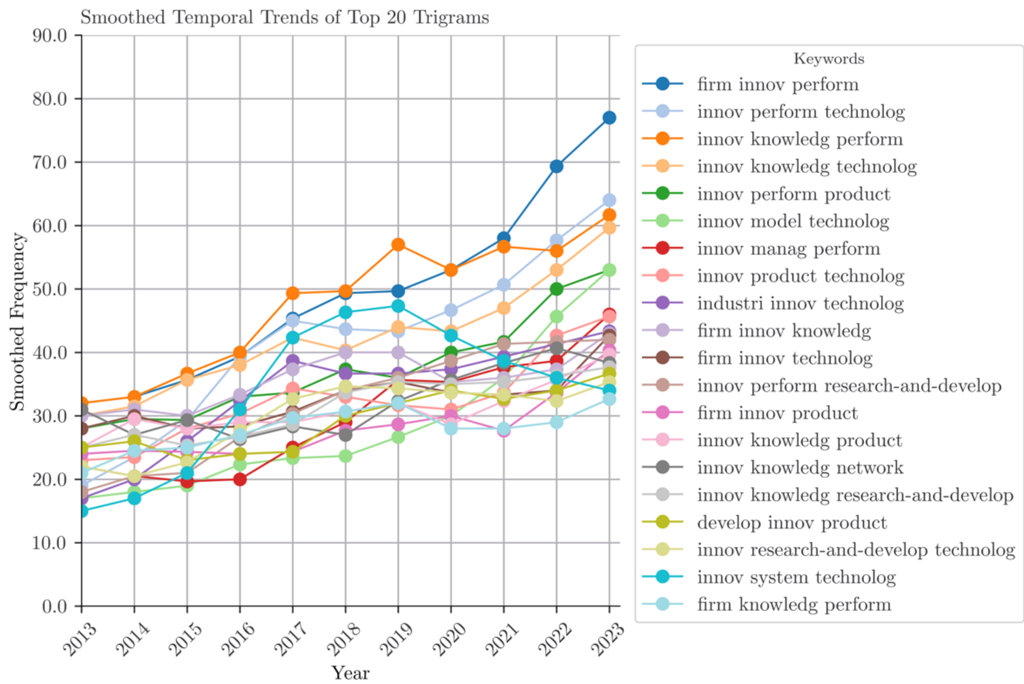


Figure 5 Trend analysis of trigrams in innovation management journals between 2013 and 2023 (own illustration; colored).

The increasing importance of 'opening and integration of innovation system' is revealing a shift towards more open and collaborative approaches to innovation, as evidenced by discussions around open innovation and the systemic nature of innovation systems (e.g., Suominen et al., 2019). This trend underscores a growing recognition of the need to integrate diverse stakeholders within the innovation ecosystem to harness collective creativity and drive technological advancements forward.

Simultaneously, there is a notable emphasis on ‘capabilities and adaptability' (e.g., Janssen et al., 2016). Terms such as dynamic capabilities highlight the increasing importance of agility and the ability to rapidly adapt to changing technological landscapes. This reflects an understanding that the sustained competitive advantage in today's fast-paced environment depends on an organization's capacity to evolve and innovate continuously.

Lastly, the 'focus on knowledge exchange and learning' is highlighted by the analysis, indicating a robust discourse around knowledge transfer, learning, and knowledge management (e.g., Castaneda & Cuellar, 2020). This trend accentuates the role of knowledge as a key resource in the innovation process, emphasizing the significance of learning mechanisms and knowledge exchange in fostering innovation.

Integrating these trends into the broader narrative, the analysis paints a picture of a field that is at once grounded in its core precepts and dynamically evolving to meet the challenges and opportunities of the digital age. The emphasis on openness, adaptability, digital transformation, sustainability, and knowledge-centric practices illustrates a comprehensive shift in how innovation is conceptualized, adopted, and implemented. These trends define the current landscape of innovation management research and signal directions for future exploration as scholars and practitioners alike seek to navigate the complexities of fostering innovation in organizations.

3. Adoption and implementation as organizational tasks

As demonstrated in the previous chapter, the adoption and implementation of innovations have long played an essential role in innovation management. Nevertheless, numerous unanswered research questions still exist in this field. Thus, the core focus of this dissertation is the adoption of innovations. The following section focuses on the organizational adoption of innovations. Previous literature has emphasized the necessity of adoption for the survival of organizations (van Oorschot et al., 2018). Consequently, it is not surprising that adoption research has significantly gained importance in recent decades, not only in innovation management but also in other areas such as marketing and logistics (Frambach & Schillewaert, 2002; Kennedy & Fiss, 2009; Lagorio et al., 2022; Rogers, 2003; van Oorschot et al., 2018).

The origin of diffusion and adoption studies can be traced back to the emerging social sciences, sociology, and anthropology over a century ago (Rogers, 2003). Tarde (1903), a French sociologist, introduced the Laws of Imitation, which are considered foundational in the emergence of adoption research (Rogers, 2003; van Oorschot et al., 2018). Simmel (1908) introduced the concept of 'the stranger'. Initially, he understands the stranger not as a wanderer but as someone who comes, stays, and introduces new qualities previously unknown. Rogers (2003) build on this perspective to show that innovators and adopters can be viewed as specific types of strangers. However, the recognition of adoption and diffusion research on a broader scale emerged only after Everett Rogers' Diffusion of Innovations Theory (DOI) in 1962 (Rogers, 1962). Rogers (2003) defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (p.17).

Furthermore, he defines adoption as "a decision to make full use of an innovation as the best course of action available" (Rogers, 2003, p. 173). In addition to Rogers (2003), several important contributions to organizational adoption emerged within the last decades. Van Oorschot et al. (2018) revealed the most cited and well-recognized articles in the field of adoption research. Table 2 depicts those articles. Additionally, Table 3 lists well recognized adoption theories and frameworks from an innovation perspective.

Following the seminal work of Rogers (1962), published in five editions, Tornatzky and Klein (1982) made a significant contribution with their meta-analysis on innovation characteristics in adoption and implementation. This was in response to the criticism raised by Downs and Moore (1976). Downs and Moore (1976) distinguished between primary and secondary attributes, with primary attributes considered objective and secondary attributes perceived. In this context, they pose fundamental questions about the extent to which perceived secondary attributes could be viewed as predictors of the adoption outcome.

Table 2 Most cited review, meta-analysis, and overview publications on the adoption of innovation in chronological order (van Oorschot et al., 2018; minor design modifications).

Author	**Title**	**Type**	**Field**
Tornatzky and Klein, 1982	Innovation characteristics and innovation adoption-implementation – a meta- analysis of findings	Meta-analysis	Not sector specific
Feder et al., 1985	Adoption of agricultural innovations in developing countries	Survey	Agricultural innovation
Gatignon and Robertson, 1985	A propositional inventory for new diffusion research	Review	Not sector specific
Damanpour, 1991	Organizational innovation - A meta-analysis of effects of determinants and moderators	Meta-analysis	Organizational innovation
Wolfe, 1994	Organizational innovation – review, critique and suggested research directions	Review	Organizational innovation
Geroski, 2000	Models of technology diffusion	Survey	Not sector specific
Frambach and Schillewaert, 2002	Organizational innovation adoption – a multi-level framework of determinants and opportunities for future research	Review	Organizational innovation
Legris et al., 2003	Why do people use information technology? A critical review of the technology acceptance model	Review	ICT innovation
Venkatesh et al., 2003	User acceptance of information technology: Toward a unified view	Survey	ICT innovation
Greenhalgh et al., 2004	Diffusion of innovation in service organizations: Systematic review and recommendations	Review	Health care innovation

Table 3 Summary of key adoption (own illustration).

Theory or frameworks	**Autor**	**Year**
Diffusion of innovation	Rogers	1962; 2003
Bass model	Bass	1969
Theory of reasoned action	Ajzen & Fishbein	1980
Theory of planned behavior	Ajzen	1985
Technology acceptance model	Davis	1989
Technology-organization-environment framework	DePietro et al.	1990
Technology acceptance model 2	Venkatesh & Davis	2000
Unified theory of acceptance and use of technology	Venkatesh et al.	2003

Tornatzky and Klein (1982) emphasized that Downs and Moore (1976) had downplayed the importance of subjective factors and ignored insights from social psychology and related fields. Furthermore, Tornatzky and Klein (1982) highlighted that those seemingly objective criteria, such as innovation costs, also depended on the potential adopter's perception and were, thus, subjective despite being initially presented as objective. Tornatzky and Klein (1982) also argued that perceived innovation characteristics could predict the adoption and implementation of various innovations consistently across different contexts. The basis for this was the context and homogeneity among organizations. Therefore, if the relationship between innovation characteristics and diverse, innovative attributes was consistent, it could be assumed that innovation attributes contributed to an explanation. Thus, they hypothesized that innovation characteristics could predict the adoption and implementation of various innovations. Their analysis highlighted compatibility, relative advantage, complexity, cost, communicability, profitability, and social approval. Furthermore, they investigated the significance of trialability and observability within this framework.

Building on this discussion and the critique of Downs and Mohr (1976), Damanpour (1991) conducted a meta-analysis of organizational adoption studies and revealed that "the effects of determinants on organizational innovation are not necessarily unstable across different studies" (p.582). In addition, he showed that the results for organizational adoption studies are comparable to other fields or organizational behavior. Thus, the findings show that the critique proposed by Downs and Mohr (1976) did not indicate unstable results. Therefore, Damanopur (1991) concluded that organizational adoption research is reasonable. Additionally, he argued to integrate different dimensions of variables in the frameworks such as organizational, individual, and environmental.

In their literature review, Frambach and Schillewaert (2002) proposed a structure for organizational adoption, differentiating two levels of decisions: the organization and an individual within the organization. The authors integrated adoption research from the organizational, marketing, and management literature. Finally, they provided avenues for future research, such as network activities, value chain actors within the adoption, and the digital context.

In the last two decades, several studies on organizational adoption were published, which led to a tremendous but fragmented body of knowledge (e.g., Gupta et al., 2007; Keupp et al., 2012). Several critical reviews were conducted within these decades. Wisdom et al. (2014) reviewed the literature on theories and constructs in organizational adoption. They identify patterns over different research models within the adoption and implementation processes. They highlighted the usage of organizational structure and size, leadership, compatibility, and attitude toward innovation as recurring themes. Within the adoption level, they structured four constructs (Note: Wisdom et al. (2014) mention five levels; however, since their research background is healthcare, they emphasized client characteristics separately, which is not present in general organizational adoption research from a managerial perspective). They differentiated between external influence and the socio-political system, the organizational characteristics (employee, leadership support, culture), innovation, and individual characteristics.

Recently van Oorschot et al. (2018) conducted a literature review within innovation adoption, using a bibliometric approach and co-citation analysis. They revealed that four clusters of research groups around the seminal book 'Diffusion of Innovations' by Rogers (2003) and almost all work on organizational adoption relies on this work. The four clusters depend on different theories, focus on different mechanisms, and are depicted in Figure 6.

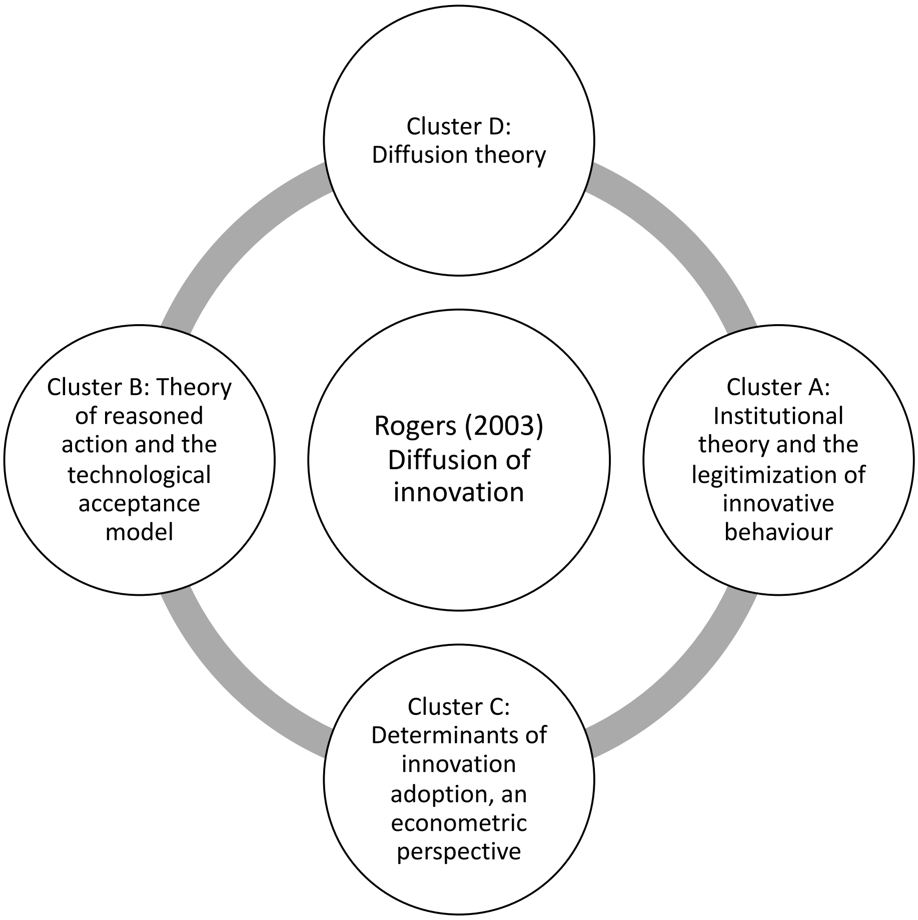


Figure 6 Research streams and corner stones around the diffusion of innovation theory (van Oorschot et al., 2018).

Cluster A is the "institutional theory and the legitimization of innovative behavior" (van Oorschot et al., 2018, p. 6). The central focus of these papers is the firms' behavior within the adoption of specific innovations. Therefore, integrated theories comprise the behavioral theory of the firm (Cyert & March, 1963), the institutional theory (Meyer & Rowan, 1977; DiMaggio & Powell, 1983), absorptive capacity (Cohen & Levinthal, 1989), dynamic capabilities (Teece et al., 1997), and network externalities theory (Farrel & Saloner, 1985).

Cluster B is the "theory of reasoned action and technological acceptance model" (Oorschot et al., 2018, p. 7). Papers within this cluster rely on the technology acceptance model (Davis, 1989), the technology acceptance model 2 (Venkatesh & Davis, 2000), and the unified theory of acceptance and use of technology (Venkatesh et al., 2003).

Cluster C applies an economic perspective to "determinants of innovation adoption" (Oorschot et al., 2018, p. 7). These papers connect to the critique of Downs and Mohr (1976) and rely on the perspective of Tornatzky and Klein (1982). By doing so, these papers create middle-range theories and often apply the technology-organizational-environment (TOE) framework (DePietro et al., 1990) and the information system adoption framework (Iacovou et al., 1995).

Cluster D focuses on the “diffusion theory” (Oorschot et al., 2018, p. 10) and mainly relies on mathematical modeling. From a theory perspective, these papers either focus on policy-making perspectives (mainly in the context of agricultural innovations) (Feder et al., 1985) or network ties (Granovetter, 1973).

In addition to their clusters of adoption research, van Oorschot et al. (2018) reviewed trends in the organizational adoption literature and reveal the five trends “drivers and impediments of information technology adoption”, “the adoption of technology standards”, “organizational rationales associated with innovation adoption”, “modeling the diffusion process”, and “adoption of agricultural innovations” (p.11). Table 4 combines the theoretical cornerstones with the research trends and indicates the qualitative relevance according to 49 reviews analyzed by van Oorschot et al. (2018).

Besides these comprehensive literature reviews, several papers focus on specific fields, aspects, and theories. Stornelli et al. (2021) explored the landscape of advanced manufacturing technology adoption, investigated barriers and enablers and classified inno-

Table 4 Combination of theoretical cornerstones of adoption research and research trends (van Oorschot et al., 2018).

		Research trends				
		Drivers and impediments of information technology adoption	Adoption of technological standards	Organizational rationales associated with innovation adoption	Modelling the diffusion process	Adoption of agricultural innovations
Theoretical cornerstones	Cluster A: Institutional theory and the legitimization of innovative behaviour					
	Cluster B: Theory of reasoned action and the technological acceptance model					
	Cluster C: Determinants of innovation adoption, an econometric perspective					
	Cluster D: Diffusion theory					

Note: the grey shading indicates the qualitative relevance; the darker it is, the more frequently it is mentioned vation types within this domain. Yang et al. (2021) focused on adopting digital technologies within supply chains, dissecting drivers, processes, and the consequential impacts on organizational operations. Additionally, Brous et al. (2020) shed light on the intricate balance between benefits and risks associated with IoT adoption in organizational settings. These studies collectively provide foundational insights into the challenges and opportunities of integrating specific technologies within organizational structures.

Greenhalgh et al. (2004) and Légaré et al. (2008) approached adoption through the lens of innovation attributes. Greenhalgh et al. (2004) studied Rogers' innovation attributes within the health service delivery industry, unraveling the intricacies that influence the diffusion and sustainability of innovations in this sector. Légaré et al. (2008) dissected Rogers' attributes as facilitators and barriers in the implementation of decision-making processes within clinical practice. Furthermore, Kapoor et al. (2014) contributed a nuanced understanding of innovation attributes, categorizing them into eight distinct groups, encompassing the factors of ease of operation, image, cost, riskiness, voluntariness, result demonstrability, and social approval. Thus, the authors clarified their roles in the adoption process.

Oliveira and Martin (2011) consolidated diverse IT adoption models in their comprehensive literature review. Their work synthesized these models and explored their integration and application, incorporating theories like institutional theory and interorganizational systems. This consolidation provided a nuanced understanding of the theoretical frameworks underpinning technology adoption within different organizational contexts.

Therefore, the existing body of research on adoption is extensive, with various reviews synthesizing prior studies within distinct contexts. Moreover, diverse factors significantly influence the adoption process, with their importance varying based on the context and the specific object of adoption. Additionally, apparent trends are emerging in research, such as the adoption of digital innovations.

In addition to the existing literature reviews, I analyzed recent publications across leading business and innovation management journals, like the keyword analysis performed for innovation management. This approach mirrors the methodology described in Chapter 2, but the scope of journals under consideration was expanded. Table 5 provides an overview of the considered journals.

Table 5 Overview of considered innovation management journals for the adoption literature.

Partial Rating	**Ranking**	**Journals**
General Business Administration	A+	American Economic Review
		Econometrica
		Academy of Management Journal
		Journal of Political Economy
		Administrative Science Quarterly
		Academy of Management Review
		Management Science
	A	Strategic Management Journal
		The RAND Journal of Economics
		Journal of Industrial Economics
		Experimental Economics
		Academy of Management Annals
		Journal of Management
		Journal of Management Studies
		Journal of Economics & Management Strategy
		Organization Studies
Technology, Innovation, and Entrepreneurship	A	Research Policy
		Journal of Business Venturing
		Entrepreneurship Theory and Practice
		Journal of Product Innovation Management
		Strategic Entrepreneurship Journal
	B	IEEE Transactions on Engineering Management
		Journal of Small Business Management
		Energy Policy
		Small Business Economics
		Industrial and Corporate Change
		Technological Forecasting and Social Change
		The Journal of Technology Transfer
		Industry & Innovation
		R&D Management
		Economics of Innovation and New Technology

It is worth mentioning that this selection was also guided by the general VHB JOURQUAL 3 (https://vhbonline.org/service/vhb-jourqual/vhb-jourqual-3/gesamtliste) as well as the ranking part TIE (https://vhbonline.org/fileadmin/user_upload/JQ3_TIE.pdf) and the availability of metadata via Web of Science (https://www.webofscience.com/wos/woscc/basic-search). Subsequently, only articles that list the word stem of 'adoption' as a keyword were included. Figure 7, Figure 8, and Figure 9 illustrate the keywords, bigrams, and trigrams, while Figure 10 and Figure 11 display the temporal trends of keywords and bigrams. In this analysis, only combinations containing the word 'adoption' were considered due to the adoption filter.

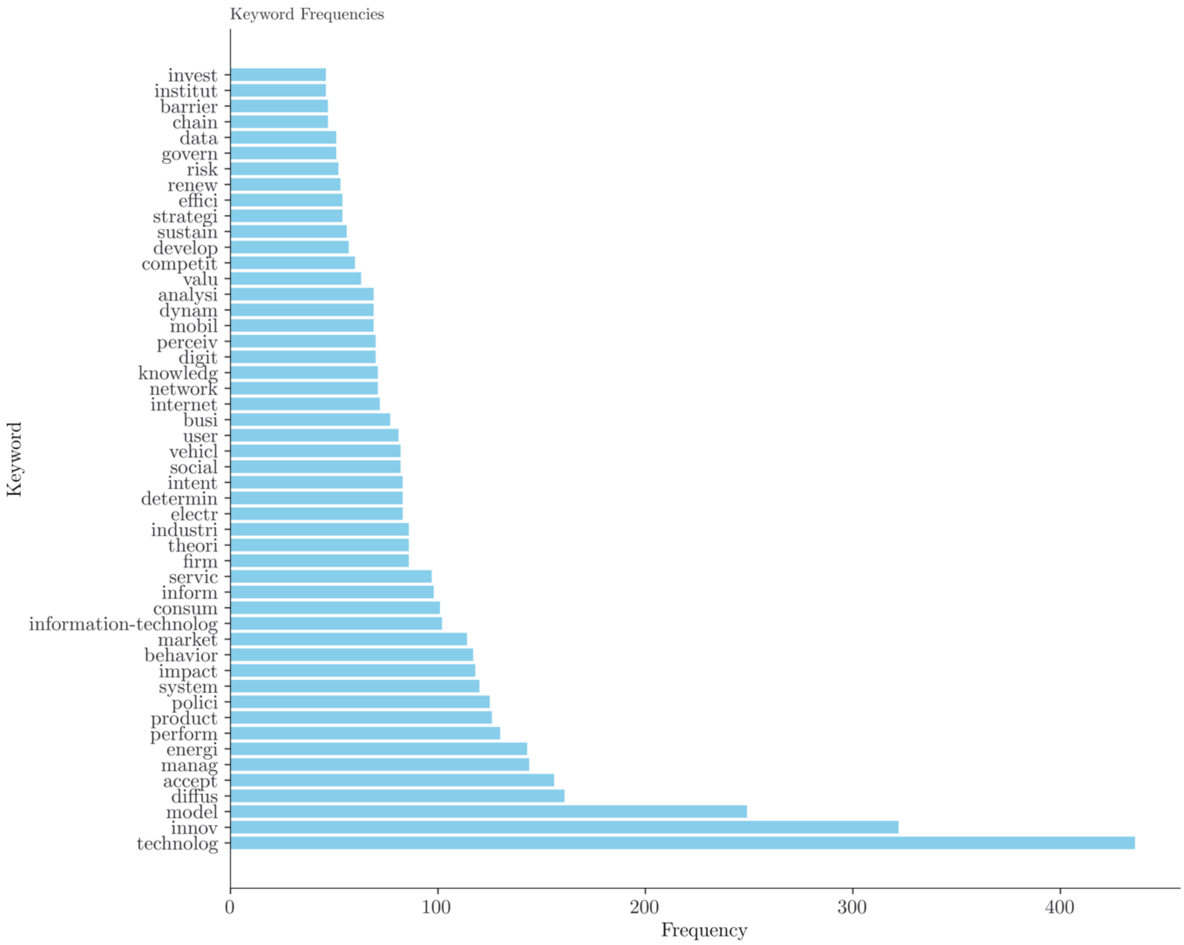


Figure 7 Overview of keywords in the context of adoption in management and innovation management journals between 2013 and 2023 (own illustration).

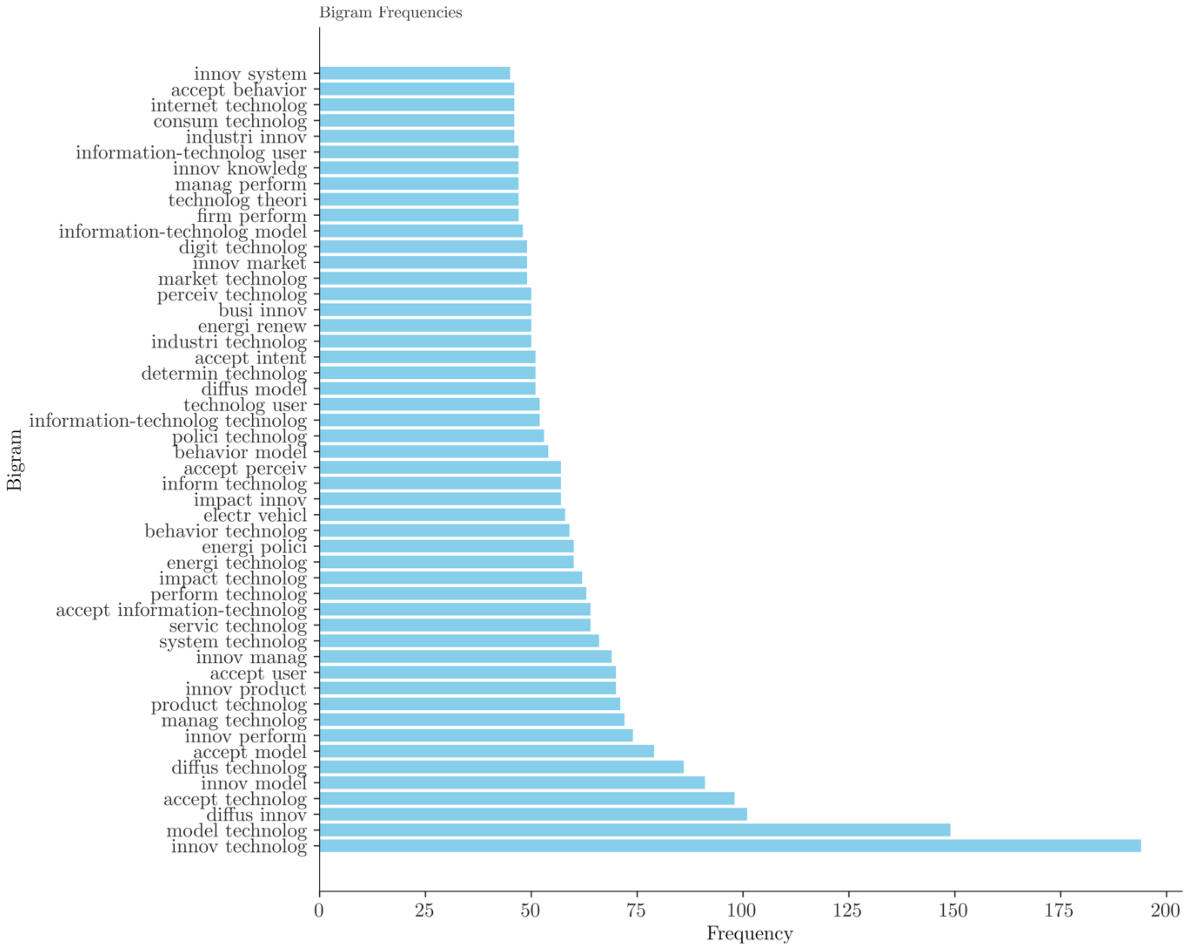


Figure 8 Overview of bigrams in the context of adoption in management and innovation management journals between 2013 and 2023 (own illustration).

This comprehensive analysis delineates the multifaceted research on adoption within leading management and innovation management journals, revealing core patterns and themes across studies. The focus on the objects of adoption, including general technologies and management innovations, underscores the importance of digital innovations and green sustainability efforts. This reflects a broader societal and organizational pivot towards digitalization and sustainability, mirroring the urgent global dialogue on technological advancement and environmental movements.

Simultaneously, the analysis highlights key theoretical frameworks guiding the understanding of adoption processes, such as the technology acceptance model, the theory of planned behavior, and the diffusion of innovations theory. These frameworks are instrumental in elucidating the various factors influencing adoption, emphasizing the critical

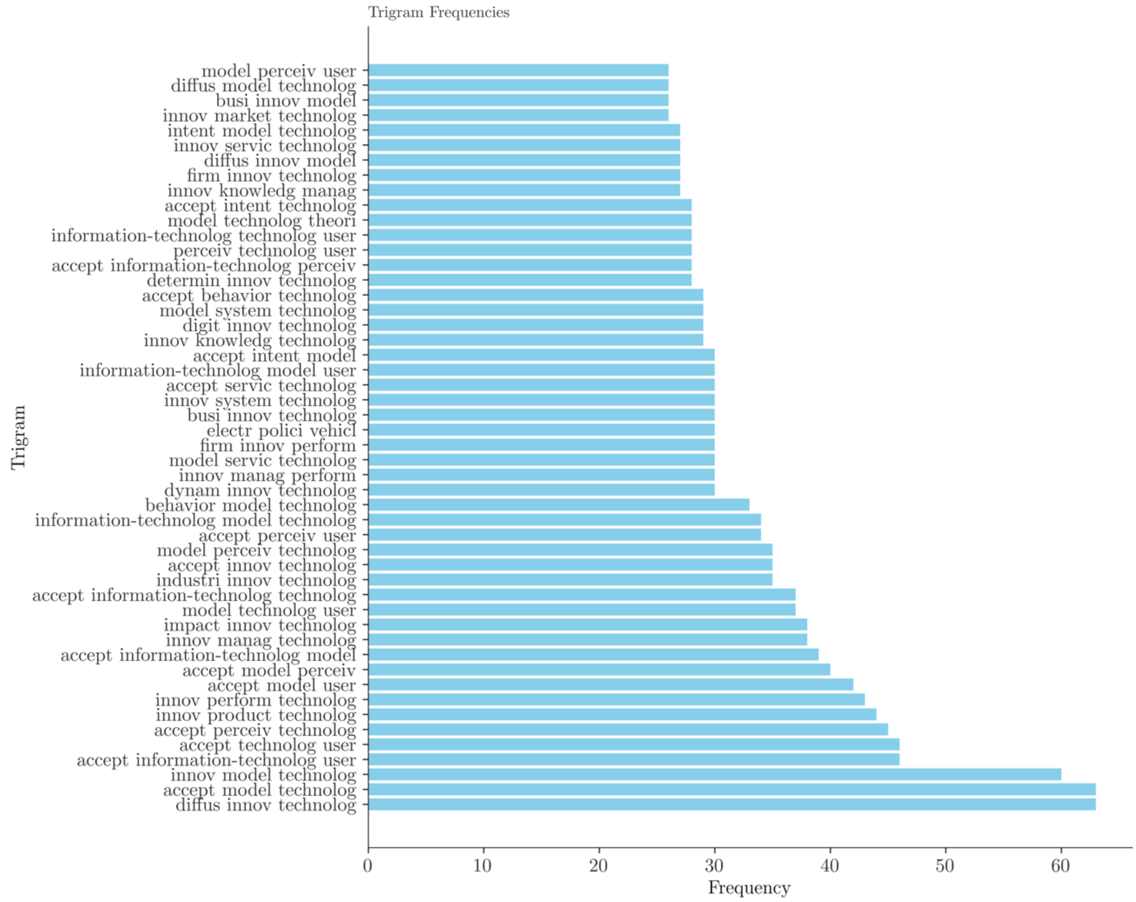


Figure 9 Overview of trigrams in the context of adoption in management and innovation management journals between 2013 and 2023 (own illustration).

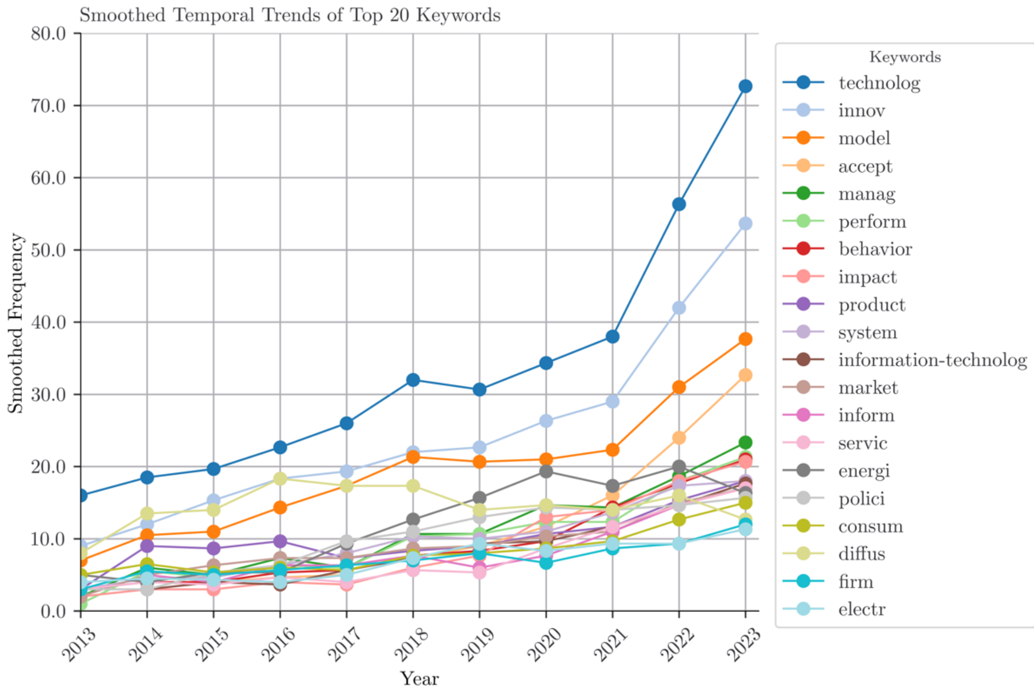


Figure 10 Trend analysis of keywords in the context of adoption in management and innovation management journals between 2013 and 2023 (own illustration; colored).

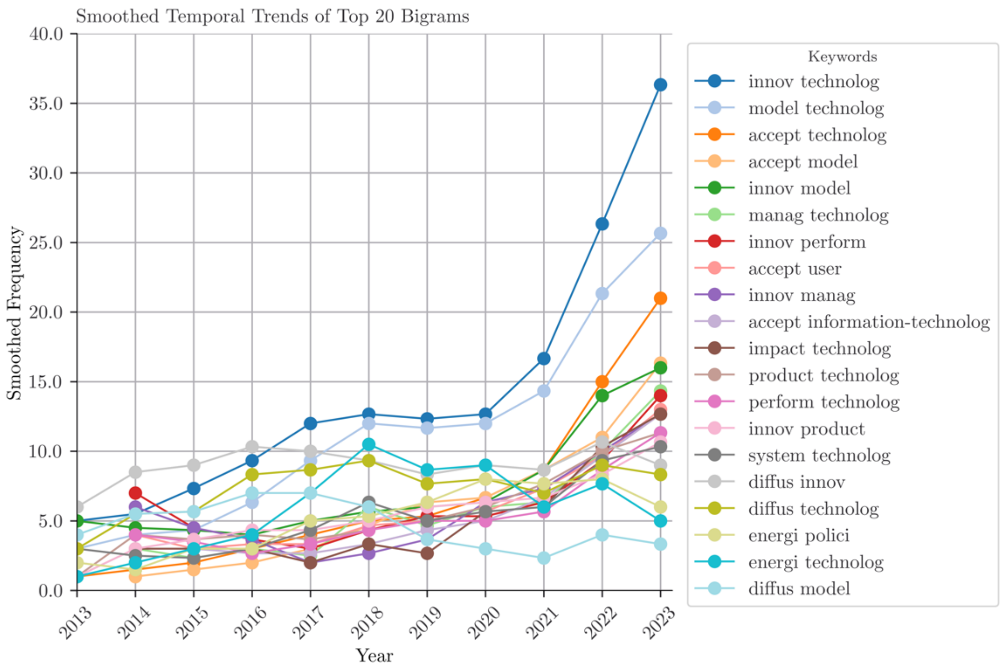


Figure 11 Trend analysis of bigrams in the context of adoption in management and innovation management journals between 2013 and 2023 (own illustration, colored).

role of adopter perceptions and the consequential impact on performance. This analysis enriches the conceptual understanding of adoption dynamics and provides a robust methodological lens through which adoption phenomena can be examined.

Additionally, by considering bigrams and trigrams, the role of adopter perception and its influence in the interplay was examined. This reveals understandings of adoption by individuals—users and consumers—and within organizations. This shows the complex interplay between technological innovations and human and organizational actors, highlighting the nuanced ways adoption processes unfold across different contexts and scales.

The trend analysis emphasizes the importance of digitalization and sustainability as focal objects of adoption (e.g., Singh & Sahu, 2020). This trend not only signifies a shift in the thematic priorities of adoption research but also aligns with broader strategic imperatives organizations are exposed to today. The integration of digital and sustainable innovations into organizational strategies embodies a critical junction for future research, providing a fertile ground for exploring how organizations navigate the adoption of these transformative innovations.

Organizational adoption emerges as an essential theme, intertwined through the analysis (e.g., Gangwar et al., 2014). This dimension accentuates the strategic and operational considerations organizations deal with when adopting new technologies and practices. It underscores the evolving nature of organizational strategies in response to the dual imperatives of digital transformation and sustainability, highlighting how these themes are increasingly central to the discourse on adoption. The emphasis on organizational adoption serves as a cornerstone, connecting theoretical insights with practical applications. In addition, it underlines the significance of adaptive, strategic approaches to manage technology adoption in contemporary organizational landscapes.

In conclusion, the landscape of adoption research is characterized by a growing engagement with the themes of digitalization and sustainability, emphasizing their growing prominence in academic and practical domains. While exploring adoption within organizational contexts reveals a rich heritage of scholarly inquiry, the continuous evolution of technological landscapes and societal priorities presents new challenges and opportunities. Emerging analytical approaches, such as configurational analyses, offer promising avenues to unravel these complexities, paving the way for novel insights into adopting innovations. This evolving research agenda highlights the dynamic interplay between technology, society, and organizations, inviting a continued exploration of the mechanisms and outcomes of adoption in an increasingly digital and sustainable world.

4. Digital technologies in an organizational context

In the realm of management research, digitalization has become a key topic within management research over the past decade (Becker et al., 2019; Becker & Schmid, 2020; Hanelt et al., 2020; Hund et al., 2021; Felch et al., 2019; Freisinger et al., 2023; Ivens et al., 2024; Leischnig et al., 2016; Reck & Fliaster, 2022; Sucky & Asdecker, 2019; Vial, 2019; Yoo et al., 2012). Originating in the domain of information system management (e.g., Nambisan et al., 2017; Yoo et al., 2012), the integration of digitalization into management research (e.g., Menz et al., 2021) and innovation management research (e.g., Autio et al., 2018; Beltagui et al., 2020; Gama & Magistretti, 2023; Konya-Baumbach et al., 2019) represents a significant evolution. Despite the attention given to digitalization, it is evident that its defining characteristics are multifaceted and multidimensional (Appio et al., 2021). This complexity partly stems from its pervasive influence across various sectors and organizational levels. Additionally, different streams of research emphasize varying aspects of digitalization, viewing the phenomenon through distinct lenses and perspectives (Berger et al., 2019; Broekhuizen et al., 2021; Cennamo et al., 2020; Legner et al., 2017; Nambisan et al., 2019; Rindfleisch et al., 2017; Vial, 2019; Zangiacomi et al., 2020).

In the field of digitalization, scholars focused on several key areas. Firstly, there is an in-depth examination of the digitalization process itself and the unique characteristics of digital innovations, as highlighted by studies like Yoo et al. (2012). Researchers like Hund et al. (2021) explored digitalization's various elements and complex interrelationships. Secondly, other studies emphasize the management of digital innovations and the effects of digitalization within organizations (Kohli & Melville, 2018; Menz et al., 2021; Nambisan et al., 2017; Vial, 2019). Thirdly, the scope of inquiry extended to broader themes like digital transformation (Hanelt, 2021; Appio et al., 2021), the adoption of specific digital technologies (e.g., Mariani et al., 2023), and detailed investigations into individual artificial intelligence applications (Gama & Magistretti, 2023). This wide range of research interests underscores the multifaceted nature of digitalization in organizations.

The field of digitalization boasts a rich variety of literature, encompassing comprehensive reviews, empirical articles, and editorials that discuss the complexities of defining key concepts like digital innovations, digital innovation management, and digital transformation (Appio et al., 2021; Hund et al., 2021; Kohli & Melville, 2018; Nambisan et al., 2017; Vial, 2019). Despite this extensive body of work, a discernible pattern emerges as a shared foundational basis across various studies, leading to notable thematic overlaps. Recognizing this, the following sections will undertake a thorough examination of these definitions, aiming to untangle the intricacies of digital innovation.

Central to digital innovation is the understanding that it exceeds traditional planning, organization, strategy, and implementation modifications. Instead, it fundamentally transforms the essence of innovation by integrating digital and physical components in novel ways (Lyytinen et al., 2016; Nambisan et al., 2020; Yoo et al., 2012). This transformation is not merely additive but represents a paradigmatic shift in how innovation is conceived and executed. Hund et al. (2021) reviewed 227 articles across eight disciplines related to digital innovations and found that only a tiny fraction (29 articles) offered explicit definitions of digital innovation. Most of these definitions draw upon the foundational framework proposed by Yoo et al. in 2010, which describes digital innovations as "new combinations of digital and physical components" (p.725). This seminal concept has shaped much of the subsequent discourse, with other definitions either echoing this notion, focusing on the digital context's specific keywords, or examining the broader impacts of digital innovations.

Building on their foundational work, Hund et al. (2021, p.5) offered a nuanced, three-layered conceptual framework to understand digital innovations better, as depicted in Figure 12. Their framework begins with the 'digital object', defined as purely technical entities. It then expands to 'digital technology', a digital object imbued with socially recognized meaning. The pinnacle of this framework is 'digital innovation', characterized by integrating digital technology to create value in novel and unprecedented ways. Hund et al. (2021) encapsulated digital innovation as "the creation or adoption and exploitation of an inherently unbounded, value-adding novelty (e.g., product, service, process, or business model) through the incorporation of digital technology" (p.6).

Six key points anchor this definition, each elucidating a different facet of digital innovation, ranging from its inherent novelty to its capacity for value creation. Figure 13 explains these aspects. These six key points delineate the multifaceted nature of digital innovation and provide a framework for understanding its complexities, adaptive nature, and diverse manifestations within organizational contexts.

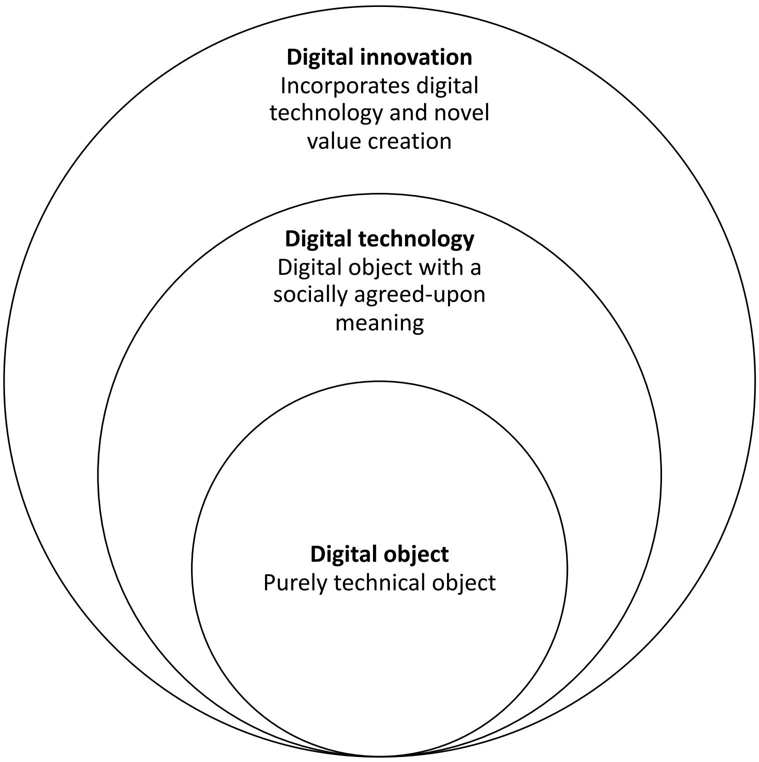


Figure 12 Three-layered conceptual framework of digital innovations (Hund et al., 2021; minor design modifications).

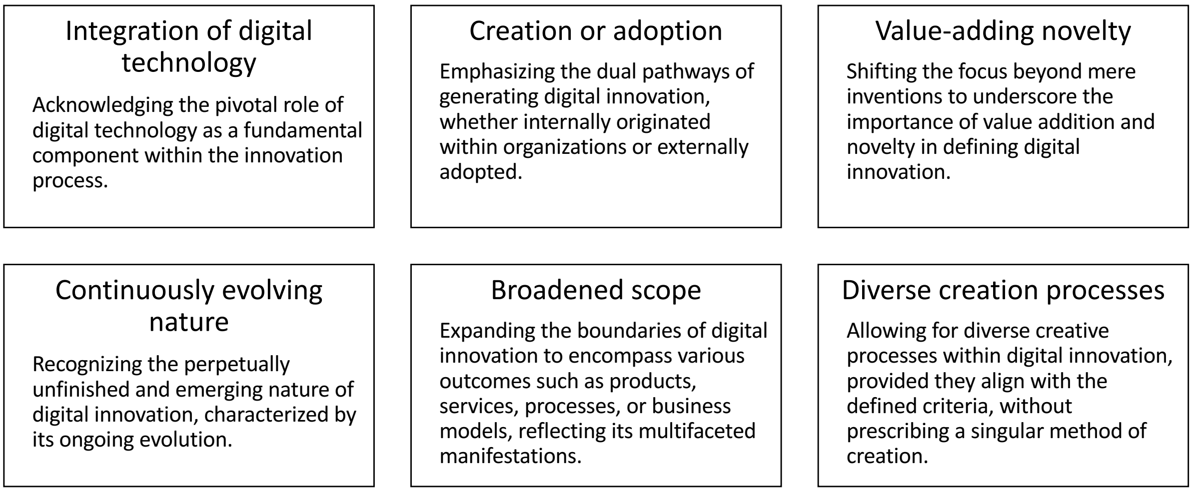


Figure 13 Facets of digital innovation (Hund et al., 2021).

The complex nature of digital innovation is further illuminated in the work of Kohli and Melville (2018), shown in Figure 14. They articulated that digital innovation involves a spectrum of four activities, each contributing uniquely to the innovation process. The first activity is initiation, which covers the identification of opportunities and decision-making processes. The second activity is development, which involves designing, adopting, and implementing new solutions. The third activity, implementation entails installing new systems, training users, and providing incentives. The fourth activity is exploitation, where existing systems and data are leveraged for new purposes.

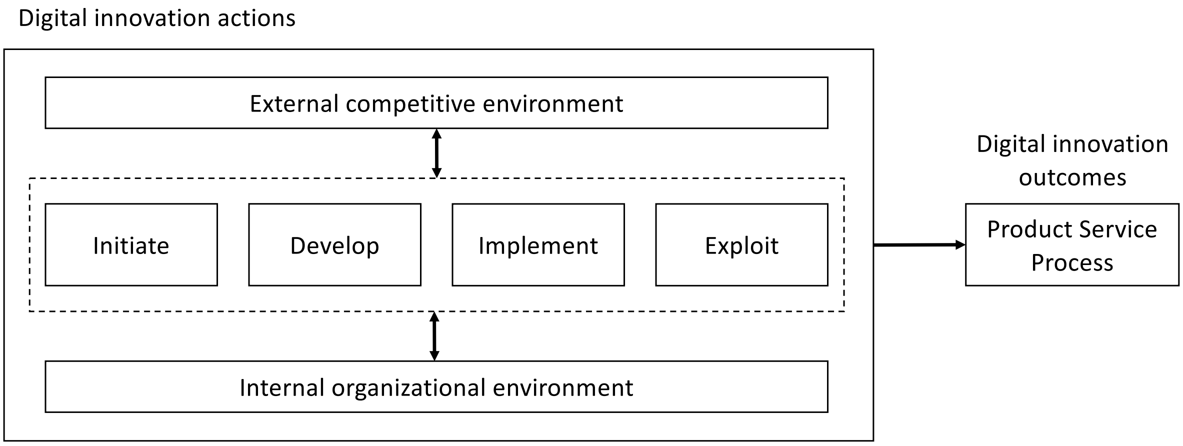


Figure 14 Theoretical framework of digital innovations (Kohli & Melville, 2018; minor design modifications).

Kohli and Melville (2018) noted that these activities may not be uniformly present in all digital innovation endeavors. They also highlighted that these activities do not necessarily follow a linear progression and can often overlap, making it challenging to separate them in practice. This non-linearity and intertwining nature of activities underscores digital innovation's inherent complexities and dynamic aspects.

Kohli and Melville (2018) underlined the critical role of organizational structures and practices in digital innovation. They argued that while digital innovation is often viewed as a strategic initiative within IT services, its successful implementation is deeply intertwined with the existing organization. This includes business strategies, company culture, and operational norms. The influence of the organizational context on digital innovation initiatives is significant, and likewise, these initiatives can profoundly impact the organizational context. As evidenced by Fichman et al. (2014), digital innovation harbors the potential to revolutionize organizations, by facilitating the emergence of novel business models.

Vial (2019) offered a nuanced examination of digital transformation, paralleling his exploration with digital innovation. He noted a significant scarcity of explicit definitions within the literature, finding that only 28 out of 282 papers provided clear definitions. From his analysis, Vial (2019) discerned three distinct patterns in defining digital transformation. Firstly, he observed that most definitions focus on digital transformation related to organizational changes. Secondly, he noted variations in definitions, particularly concerning the types of technologies involved and the nature of the transformation process, as reflected in diverse perspectives across studies (Andriole, 2017; Horlacher et al., 2016; Piccinini et al., 2015; Westerman et al., 2011). Thirdly, Vial (2019) pointed out commonalities among these definitions, especially in the frequent reference to 'digital technologies'.

Building on these insights, Vial (2019) conceptualized 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" (p. 121). This definition captures the core of digital transformation, emphasizing its goal of driving substantial improvements within an entity by harnessing and integrating various technological elements.

In summary, there is a broad orientation toward the existing definitions by Yoo et al. (2010). Building on this foundation, recent works by authors such as Hund et al. (2021) and

Vial (2019) conceptualized digitalization in the organizational context, establishing a unified basis. Thus, I follow the previous definition of digital innovations of Hund et al. (2021) and the digital transformation of Vial (2019). This foundation enables the conceptualization of digital technologies from an organizational perspective and the structuring of procedural concepts with activities and outcomes.

5. Characteristics of digital technologies

The unique characteristics of digital technologies were first discussed in a workshop titled 'Digital Challenges in Innovation Research' in 2008. Yoo et al. (2010) later elaborated on the insights gained from this workshop, forming the foundation for subsequent considerations of underlying innovations. They mainly focused on the following statement: "properties of digital materiality and the emergence of loosely coupled digital service architectures have stimulated waves of digitalization that are fundamentally re-shaping innovations in products, services, and organizational forms" (Yoo et al., 2010, p. 13).

In essence, it is established that the characteristics of digital innovations can be divided into object and process-related attributes (e.g., Kolloch & Reck, 2018; Yoo et al., 2010; 2012). Object or outcome-related properties pertain to the unique aspects of innovations and encompass convergence and digital materiality. These properties include products and services, business models, and new processes (in this context, 'processes' are understood as new outcomes resulting from a development process) (Garcia & Calantone, 2002). Process-related properties refer to new characteristics emerging in the innovation process itself. These properties relate to developing and disseminating new technologies, encompassing the four attributes of heterogeneity, generativity, locus of innovation, and pace (Yoo et al., 2010). Figure 15 provides an overview of these properties.

It is noteworthy that following the initial introduction of the six characteristics, subsequent articles particularly emphasize the three characteristics of convergence, generativity, and digital materiality (Ciriello et al., 2018; Yoo et al., 2012). Thus, these three characteristics are described in detail. 'Digital materiality' is the connection between the digital and physical worlds. In this interaction, both realms influence and transform each other (Law & Urry, 2004; Orlikowski & Scott, 2008; Robey et al., 2003). According to Yoo et al. (2012), 'convergence' refers to continuously integrating diverse technologies through digital data and

Outcome-related characteristics of digital innovations

Convergence

Continuous integration of diverse and heterogeneous technologies through homogenization of digital data; multi-modality of technologies; layered, loosely coupled connections across devices, networks, services, and contents

Digital Materiality

Inseparability of digital material from social and physical interactions; embedding of digital capabilities into physical artifacts; emergence of digital service architecture for previously non-digital products and services

Process-related characteristics of digital innovations

Heterogeneity

Integration of diverse forms of data, information, knowledge, and tools; intensified need to coordinate across multiple social and technical worlds; increased horizontal integration across different stacks of digital service architecture

Generativity

Design characteristics of digital representations that foster recombination and modification of different elements in digital service architectures; diffusion of digital tools and low-cost communication enabling wakes of innovations

Locus of Innovation

Geographical and social dispersion of innovation sites and processes due to low communication and storage cost; increasing movement of innovation activities toward the periphery of the innovation network

Pace

Increase in the clock speed of innovation cycles due to programmability and convergence, recombination as a mode of innovation, and a common digital infrastructure facilitating distributed innovation activities

Figure 15 Characteristics of digital innovations (Yoo et al., 2012; minor design modifications).

their exchange. This concept encompasses three key dimensions: first, the interlinking of different products to create new values; second, the amalgamation and enrichment of non-digital and digital products, services, and processes; and third, the merging of previously separate companies and industries.

'Generativity' describes "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain 2006, p. 1980). In this context, the focus is on innovations' mutability and developmental possibilities. This continuous technological change catalyzes further developments and transformations (Yoo et al., 2012).

Beyond these generic characteristics, digital innovations afford new dimensions of options through a psychological phenomenon. Gibson (1979), a perceptual psychologist, laid the foundation for affordances. Affordances represent the sum of all potential actions available to a creature in its environment based on its presence, capabilities, and experiences. While Gibson's work primarily focuses on living beings, such as animals and humans, Hutchby (2001) and Stoffregen (2003) extended these concepts to the business context. Building upon this, the field of information systems has found numerous points of connection. Applying the principle of "affordances for organizing" (Zammuto et al., 2007, p. 753), they employed this perspective at the intersection of IT and organizational systems, arguing that opportunities arise from the interplay between organizational and IT-specific characteristics. Furthermore, several studies integrated a sociotechnical perspective (Herterich et al., 2023; Leonardi, 2013; Markus & Silver, 2008; Meske & Amojo, 2020; Osmundsen et al., 2022). Expanding on this, Majchrzak and Markus (2012) defined technology affordance as "an action potential, that is, to what an individual or organization with a particular purpose can do with a technology or information system" (p. 1).

Consequently, it becomes evident that the fundamental possibilities emerging from generativity and convergence are more layered and mutable and depend on the specific companies, users, and contexts involved. For digital innovations, this results in new potentials and dimensions that fundamentally differ from non-digital innovations.

Several perspectives and implications emerged from this discussion. Lyytinen (2021) perceived digital technologies as the driving force behind the digital innovation process. Gawer (2021) underscored that the generativity of digital innovations and an increased focus on platform activities can limit a company’s control over its innovation processes. Similarly, Nambisan (2022) highlighted that generativity opens opportunities for companies beyond their core business, leading to the exploration of new markets, resources, and partnerships. Researchers pointed out that this generative aspect tends to amplify incremental innovations (Hron et al., 2022). These rapid and dynamic developments are observed at the macro-level (Leiponen et al., 2022) and the micro-level (Malhotra & Majchrzak, 2022), indicating that the influence of generativity permeates various aspects of innovation.

In addition to the fundamental properties of digital technologies, researchers emphasized the distinct facets of specific technologies, such as AI. Fundamental conceptualizations in this area are explored in the following paragraph. Von Krogh (2018) conceptualized AI through two primary applications: 'problem solving' and 'decision making.' Decision-making is understood as concluding existing data. Problem-solving encompasses various courses of action to address challenges. Activities like autonomous driving are examples of decision-making (Schwarting et al., 2018). Problem-solving, conversely, involves companies' core activities that AI can realize (Ben-Menahem et al., 2016).

Raisch and Krakowski (2021) based their conceptualization on the groundbreaking works at the intersection of digitalization and organizations by Brynjolfsson and McAfee

(2014), Davenport & Kirby (2016), as well as Daugherty and Wilson (2018). They highlighted two seemingly paradoxical aspects: automation and augmentation. Automation refers to transferring tasks traditionally performed by humans to machines, while augmentation denotes the collaborative synergy between humans and machines, including AI. These facets, automation and augmentation, are intertwined and, although they might appear contradictory, are mutually dependent on each other. Raisch and Krakowski (2021) argued that within the management domain, the interdependent nature of augmentation and automation as dual AI applications creates a paradoxical tension across time and space. They advocated for overcoming the perceived contradiction between automation and augmentation in current literature. They suggested viewing augmentation as both a driver and a result of automation.

In their editorial, Bogers et al. (2022) emphasized the coevolution of technologies, highlighting the significance of interconnectivity and linkage. This aspect becomes evident in platforms' various levels of interconnectedness (Legenvre et al., 2022). The research by Leiponen et al. (2022), which examines blockchain technology, illustrated the networking, dependencies, and integration of digital technologies within their environments. In addition to this technical perspective, Lyytinen (2021) focused on embedding technology in social systems, examining both its autonomous nature and the influencing factors at play.

The diverse discussions surrounding the characteristics of digital technologies indicate that they differ fundamentally from previous innovations. Consequently, I highlight that organizations must adapt to these new requirements while capitalizing on new opportunities. As a result, it also becomes evident that existing scientific knowledge, such as adopting innovations from other innovation contexts, may not necessarily be directly applicable to digital innovations. Instead, these concepts need to be understood and reevaluated considering the digital context.

When considering the influence of digital innovations within an organizational setting, it becomes evident that these innovations have extensive and varied impacts, affecting structural, organizational, strategic, and financial aspects. A vital aspect of this transformation is the shift in the innovation agency, characterized by less predefined and more distributed approaches (Nambisan et al., 2017). According to Nambisan et al. (2017), distributed innovation agency refers to a scenario where a dynamic and often unexpected collection of actors with diverse goals and motives—frequently beyond the control of the primary innovator—participate in the innovation process. These collectives are also highly dynamic, as actors (individuals, organizations) can join or leave. At the same time, their goals evolve, new competencies are required, motivations shift, complementary capabilities need to be acquired, new constraints and opportunities arise, or varying contributions become recognized (Lusch & Nambisan, 2015).

Yoo et al. (2012) argued that the affordances of digital technologies change innovation management in three ways. First, digital technologies appear in digital platforms, enabling organizations to innovate in new ways. On the one hand, organizations can innovate platforms and not only single components. Therefore, they create ecosystems or integrate their innovations into existing ecosystems. On the other hand, organizations create digital capabilities and deploy those within the organization. Thus, platforms are extended by further functions applied in various internal and external applications. To use these digital platforms holistically, organizations must adapt regarding control, standardization, and integration levels.

Second, digital innovations are characterized as distributed innovations, which are developed over various organizations. These distributed innovations rely on heterogeneous knowledge of different actors and foster forms like online communities and open innovation. Organizations must manage the heterogeneous knowledge resources to use the innovations successfully. Furthermore, organizations enable partners to innovate and combine or integrate these innovations. Consequently, new industrial structures such as 'long tail' (Anderson, 2008) and 'superstars' (Brynjolfsson et al., 2010) lead to new mechanisms and interactions between the actors. Finally, the distribution of innovations leads to new digital risks that can affect organizations (Ciborra, 2006). Here, organizations must recognize these risks and prepare accordingly.

Third, Yoo et al. (2012) highlighted the combinatorial aspect of digital innovations. Thus, the understanding of innovation as a creative combination is widely accepted (Tidd & Bessant, 2018). In the context of digital innovations, digital artifacts enable the organization and partners to almost limitless recombination. Thus, organizations must take this digital modularity into account and innovate accordingly. Consequently, borders soften up, and innovations can be applied in new unforeseeable contexts throughout the lifecycle.

Furthermore, digital innovations diffuse through social networks, contagion, and digital channels. Due to the recombination and modular aspects, innovations will modify and evolve through this process. Besides these structural aspects, organizations create an environment fostering ‘constrained serendipity’ (Faraj et al., 2011). Finally, organizations solve the complexity of innovation processes caused by combinatorial facets.

Summarizing these aspects, organizations modify existing processes, develop new capabilities, and modify the understanding of innovation. Verhoef et al. (2021) postulated four strategic imperatives that organizations should consider. First, organizations require digital resources like digital capabilities and assets Second, organizations make their structure more flexible and foster agility. Third, organizations formulate strategies for digital growth. Fourth, organizations change metrics and goals to measure.

6. Research questions of the thesis and thematic relevance of own research

In this section, I identify the gaps in existing research, thereby positioning my work. Throughout the prologue, I have introduced the dissertation and provided an overview of innovation management in general. In doing so, I have highlighted current key themes and presented them comprehensively. Furthermore, I have explained the fundamentals of organizational adoption and implementation. Subsequently, the focus shifted to digital innovations, where I categorized and detailed the specific characteristics of digital technologies and provided a short outlook on specific digital technologies, such as AI. Based on this, I have outlined the impacts of these digital technologies on organizations.

The existing literature reveals three research gaps within the organizational adoption of digital innovations. First, it can be noted that despite numerous theories and specific perspectives, such as the technology acceptance model, the theory of planned behavior, and the diffusion of innovation, studies have hardly considered a profound integration of the different perspectives (van Oorschot et al., 2018). Although the TOE framework, with its dimensions of technology, organization, and environment, provides a ready and open framework for integrating new perspectives, this advantage of flexibility almost never materializes. Instead, most studies refer to the initial framework by DePietro et al. (1990). Second, the gaps relate to digital innovations and their organizational adoption. The questions regarding the antecedents, adoption decisions influenced by strategic, internal, and external factors, the role of third parties, and the consequences of the adoption come to the forefront. The third gap is methodological. While existing adoption research has primarily utilized qualitative and quantitative analysis methods, a configurational approach—simultaneously examining and focusing on the interaction of various influencing factors—was rarely explored. Therefore, in the following sections, I will first illuminate the substantive and methodological aspects of these research gaps. Figure 16 depicts the underlying structure of the dissertation's research gaps.

Upon examining seminal literature reviews, one is immediately drawn to the work of Frambach and Schillewaert (2002), who categorized research into adoption decisions and technology acceptance (e.g., Davis, 1990; Venkatesh et al., 2003). They distinguished between adoption as an organizational decision and acceptance, which refers to an individual's uptake of the innovation within the organization. In their literature review, Wisdom et al. (2014) noted that research alternately focuses on theories of the adoption process and theories related to implementation. They underscored the need for clear definitions and express that the factors considered in understanding adoption must be revised. They pointed out a discrepancy in the perceived importance of various adoption factors. For instance, while Damanpour and Schneider (2009) emphasized the significance of the attributes of innovation, Klein and Sorra (1996) highlighted the importance of the fit between the innovation and the organization. Building on this, Wisdom et al. (2014) advocated for studies that provide clarification.

Despite the plethora of adoption theories, such as the diffusion of innovation theory, the TOE framework, the theory of planned behavior, the technology acceptance model, and the unified theory of acceptance and use of technology, there is a notable absence of in-depth integration of the various facets of adoption research across most studies. As individual

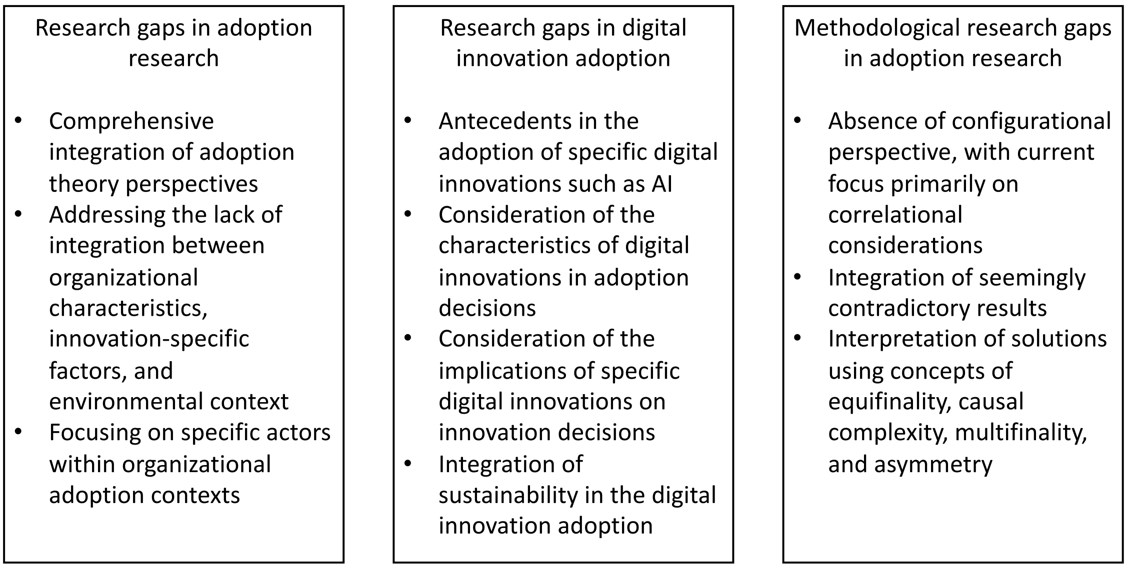


Figure 16 Underlying structure of the research gaps of the dissertation (own illustration).

theories do not sufficiently explain adoption, discrepancies arise regarding the predictive power of specific factors and the consistency of these factors across different studies (Sun et al., 2020; Sun et al., 2024). Nonetheless, synthesizing various theories has been limited to only initial attempts. For instance, within the context of the TOE framework, which examines factors across the three dimensions of technology, organization, and environment, the factors initially proposed by DePietro et al. (1990) are still predominantly considered. Consequently, integrating more recent theories and findings from adoption research is seldom employed. Instead, existing theories continue to be applied in various contexts. This is further evidenced by meta-reviews, such as the one by Hameed and Counsell (2014), which mainly identified attributes of innovation and cost as factors frequently considered.

As a result, research needs to take advantage of the opportunity for an in-depth integration of different theories. This oversight needs to be revised, considering that seminal management articles have called for the unification and connection of diverse perspectives (Furnari et al., 2021; Zollo et al., 2018).

Furthermore, the impact of networks and stakeholders on adoption represents a critical area for research (Frambach & Schillewaert, 2002). Despite significant steps in the field over recent decades, including various notable findings such as the role of stakeholders and their networks (Fliaster & Kolloch, 2017), the impact of network management practices (Reck et al., 2022), and the pressure from primary and secondary stakeholders (Shubham et al., 2018) the full extent of individual stakeholder influence on the adoption and implementation within companies remains unclear. For instance, the interplay between stakeholder-related factors, network-related factors, and company-internal factors in the context of adoption has yet to be fully elucidated.

Beyond the critical examination of adoption decisions, it is apparent that existing adoption research needs to track current developments within companies comprehensively and only tentatively attempt to integrate further innovation theories. While a recognizable trend indicates that innovations are increasingly conducted with partners and actors inside and outside the company, this reality is only partially reflected in adoption research (Howells, 2006; Kivimaa & Martiskainen, 2018). Intermediaries and customers play a pivotal role in developing and implementing innovations within a company (Howells, 2006). This is relevant for both process-related and product-related innovations. For instance, information, knowledge, and resources from third parties are leveraged to advance one's adoption processes.

It should be noted that these actors thus play a decisive role in adopting innovations (Kivimaa & Martiskainen, 2018; Rossi et al., 2022; Russo et al., 2018; Vidmar, 2020). Current research scarcely interlinks the underlying aspects of these contributions. For example, there is limited understanding of what motivates these actors to engage in specific adoption projects.

In the context of IT and digital adoptions, meta-analyses such as the one by Hameed and Counsell (2014) indicated that many studies focus predominantly on the attributes of innovation as delineated by Rogers (2003), examining the following six adoption characteristics: relative advantage, compatibility, complexity, trialability, observability, and cost. Gangwar et al. (2014) acknowledged that while these attributes of innovation play a significant role in adoption decisions, they alone are insufficient to explain adoption fully. Integrating diverse perspectives and various theories is essential to comprehend the adoption phenomenon.

In the previous chapter, I clarified how digital innovations diverge from traditional ones. I have demonstrated how an affordance perspective (Gibson, 1979) opens new possibilities in generativity and convergence. Notably, these specific characteristics have received limited attention in existing adoption research. This oversight is surprising given that these characteristics present new opportunities and requirements for companies, thereby exerting a considerable influence on adoption. Following the argument by Yoo et al. (2012) that these characteristics are fundamentally different from those in non-digital innovations, it becomes evident that their impact on adoption may be different. Therefore, a detailed consideration of digital characteristics in adoption studies is warranted.

Concerning the possibilities and requirements, it is imperative to clarify the motives and reasons within companies for adoption. While numerous case studies in the existing adoption research explain adoption processes (Frambach & Schillewaert, 2002; Wisdom et al., 2014), the specifics of digital innovation adoption must be more specific.

Although the points mentioned above stem from the characteristics of digital innovations, the research stream around digital sustainability deals with questions at the intersection of sustainability and digitalization. Researchers are exploring how digital technologies can contribute to a sustainable future. In the context of adoption, this theme is pertinent as companies increasingly navigate the complex demands of green and social sustainability, efficiency, and growth. Certain digital technologies possess characteristics that are applicable across both sustainable and economic dimensions. The extent to which these underlying dimensions influence adoption, namely whether digital or green characteristics drive adoption, remains largely unexplored. Although research on the triple bottom line addresses these issues, it has yet to be sufficiently examined from an adoption and digital innovation perspective.

Having considered the general facet of adoption and the perspective of digital innovation, I focus on the methodology in the field of adoption research. Traditional adoption studies draw on a rich heritage of qualitative and quantitative analysis methods from various scientific disciplines such as anthropology, sociology, health care, communication, geography, and management (Berelson & Freedman, 1964; Coleman, 1957; Rogers, 1961; Rogers & Shoemaker, 1971). Case studies, for example, have been widely employed in adoption research and have significantly contributed to the current body of knowledge (Rogers, 2003). Those methods are also employed in recent studies like Khanagha et al. (2013), Kurnia et al. (2015), and Noel et al. (2021). Quantitative methods have been extensively used to investigate adoption decisions and implementations, with many studies in information system research and sustainability research applying these approaches (see the reviews van Oorschot et al., 2018; Sun et al., 2024). According to the prevailing logic, qualitative methods are used for discovering new phenomena, and quantitative methods are used for validation.

A closer examination of the quantitative methods reveals that they typically follow a correlative logic, employing methodologies such as structural equation modeling, partial least squares, and regression analysis (Gangwar et al., 2014; Sun et al., 2024). Although these studies have contributed significantly to the understanding of adoption, unanswered questions and partial inconsistencies among the findings remain. Meuer and Rupietta (2017) and Fiss (2011) pointed out that by keeping specific values constant, these models imply that variables compete, leading to linear and additive effects. Sun et al. (2024) structured the significant and insignificant effects from previous studies regarding the dimensions of the TOE framework. Table 6 depicts these findings.

Table 6 Inconsistent findings related to the TOE framework within the literature (Sun et al., 2024; minor design modifications).

	Significant findings	**Insignificant findings**
Technological factors	(Ang & Cummings, 1997; Chen et al., 2015; Hsu et al., 2012; Lai et al., 2016; Liang, Huang, et al., 2007; Mishra et al., 2007; Venkatesh & Bala, 2012; Wang & Ahmed, 2009; Zhu et al., 2003; Zhu et al., 2004; Zhu, Dong, et al., 2006; Zhu & Kraemer, 2005; Zhu, Kraemer, et al., 2006)	(Chan & Chong, 2012; Chang et al., 2007; Grover, 1993; Oliveira et al., 2014; Picoto et al., 2014; Wei et al., 2015; Wright et al., 2017)
Organizational factors	(Ang & Cummings, 1997; Chang et al., 2007; Chen et al., 2015; Hsu et al., 2012; Lai et al., 2016; Liang, Huang, et al., 2007; Liang, Saraf, et al., 2007; Oliveira et al., 2014; Picoto et al., 2014; Wei et al., 2015; Wright et al., 2017; Zhu et al., 2003; Zhu, Dong, et al., 2006; Zhu & Sarkis, 2007)	(Chan & Chong, 2012; Grover, 1993; Mishra et al., 2007; Venkatesh & Bala, 2012; Wang & Ahmed, 2009; Zhu et al., 2004; Zhu, Kraemer, et al., 2006)
Environmental factors	(Ang & Cummings, 1997; Chang et al., 2007; Chen et al., 2015; Grover, 1993; Hsu et al., 2012; Lai et al., 2016; Liang, Saraf, et al., 2007; Mishra et al., 2007; Picoto et al., 2014; Venkatesh & Bala, 2012; Wang & Ahmed, 2009; Wright et al., 2017; Zhu et al., 2003; Zhu, Dong, et al., 2006; Zhu & Kraemer, 2005; Zhu, Kraemer, et al., 2006; Zhu & Sarkis, 2007)	(Chan & Chong, 2012; Oliveira et al., 2014; Wei et al., 2015; Zhu et al., 2004)

Despite the field being traditionally dominated by 'net effect thinking' (Ragin, 2008), numerous indications and researchers argued that linear relationships and independent causes are insufficient. DePietro et al. (1990) emphasized that individual conditions do not act in isolation but, in combination, lead to adoption, further clarifying the influence of context and its interplay with other dimensions. Other literature reviews, such as those by Frambach and Schillewaert (2002), criticized studies for considering only individual factors and linear relationships. Lyytinen and Damsgaard (2011) explicitly called for a configurational analysis using QCA in the context of inter-organizational adoption in information system research. In a theoretical article, they argue for the necessity of configurational investigation, focusing on configurations of different adopter groups, which, similar to clusters, exhibit various conditions that facilitate the adoption. They called for a closer examination of the characteristics of individual adopter groups and the differences between them, emphasizing the influence of configuration on adoption.

Lyytinen and Damsgaard (2011) asserted that our social world is based on 'inter-connected structures' (p. 497) and underscored that configurational examination is widely applied in management and organizational research, contributing significantly to various fields. For instance, Mintzberg's (1983) logic of five clusters of archetypes of organizational features is based on configurations. Chesbrough and Spohrer (2006) identified combinations of network services based on the conditions of organization, innovation, technology, and business. Similarly, Porter's (1985) generic competitive strategies also represent configurations.

In addition to theoretical arguments for the necessity of a configurational examination of organizational adoption, there are empirical ones. Meta-studies have found that individual factors sometimes have a significant influence and other times do not yield contradictory results (Gangwar et al., 2014). While measurement inaccuracies and data collection issues may account for this, the configurational perspective provides an explanatory argument. The characteristic of multifinality posits that the same factor can lead to different outcomes depending on the context. Thus, the role of the presence of a condition does not allow for inferences about the absence of the condition (Schneider & Wagemann, 2012). Gangwar et al. (2014) demonstrated this for factors such as relative advantage, organizational size, top management support, compatibility, competitive pressure, and government pressure, showing that conditions often lead to more diverse outcomes than initially anticipated.

Furthermore, Sun et al. (2020) and Sun et al. (2024) published initial configurational studies on companies' adoption intention in the context of digital innovations, empirically demonstrating that different configurations of conditions influence adoption intention. However, it is essential to note that only some studies in the organizational context have employed QCA in the context of organizational adoption thus far. Insights into the interplay of conditions in specific dimensions, such as stakeholder influence, strategic considerations, characteristics of digital innovations, and decision-makers' motives, still need to be improved.

In summary, within the context of adoption, there are several unanswered questions at the fundamental level of general adoption, specifically in digital innovations. From a methodological lens of configurational analysis, an intriguing field for research emerges, one that has received limited attention in the existing literature on innovation management. Thus, the methodological questions are subsequently linked with the theory-related questions from adoption theory in general and adoption in digital innovations, forming a triad that complements and depends on each other. This dissertation aims to contribute to the described areas by integrating these three dimensions of inquiry.

7. Research approach, methodological focus, and epistemological framework

This dissertation employs two analytical methods. Predominantly, the included papers use fuzzy-set Qualitative Comparative Analysis (fsQCA) to investigate higher degrees of complexity and reveal different combinations of conditions. Additionally, one paper applies a multi-case study approach. While the strengths of QCA lie in identifying interactions and the interplay of various conditions, thus facilitating the examination of configurations in the context of organizations (Fiss, 2007; Fiss, 2011; Ragin, 2008; Woodside, 2013), multi-case studies provide the opportunity to explore complex processes, decisions, and situations in-depth (Yin, 2018; Eisenhardt, 1989; Eisenhardt, 2021). In the following, I will introduce both methods' fundamental principles and characteristics and highlight the configurational design in detail.

Qualitative comparative analysis

In social sciences and management literature, a prevailing focus has been on analyzing isolated effects, a practice critiqued by Ragin (1987, 2008) and Fiss (2007; 2011) for its lack of contextuality and interconnectedness. Addressing this gap, Ragin (2008) proposed a methodology that discerns patterns while remaining sensitive to individual cases. QCA has gained increasing interest in management research, offering novel insights and a valuable alternative perspective (Fiss, 2007, 2011; Thornton et al., 2019). The growing body of literature in this area is further highlighted by comprehensive reviews conducted by Rihoux et al. (2013) and Wagemann et al. (2016), who cataloged the surge in publications employing QCA. Kraus et al. (2018) conducted a literature review and revealed the development of fsQCA articles in business and management research. Figure 17 depicts the development. This trend reflects the method's capacity to navigate the complexity and multidimensionality inherent in management and innovation, marking a pivotal shift in the field's analytical framework.

The methodological landscape of QCA has different variants, each suited to different research contexts and data types (Schneider & Wagemann, 2012). Among the most prominent are crisp-set QCA, which relies on dichotomous data (Ragin, 2008), and fsQCA, which uses ordinal and continuous data (Ragin, 2000). Additionally, other variants address specific research needs. These include multi-value QCA for multinomial data (Cronqvist & Berg-Schlosser, 2008; Thiem, 2015), temporal QCA for time series data (Caren & Panofsky, 2005; Fischer & Maggetti, 2017), and two-step QCA (Schneider, 2019), which differentiates between

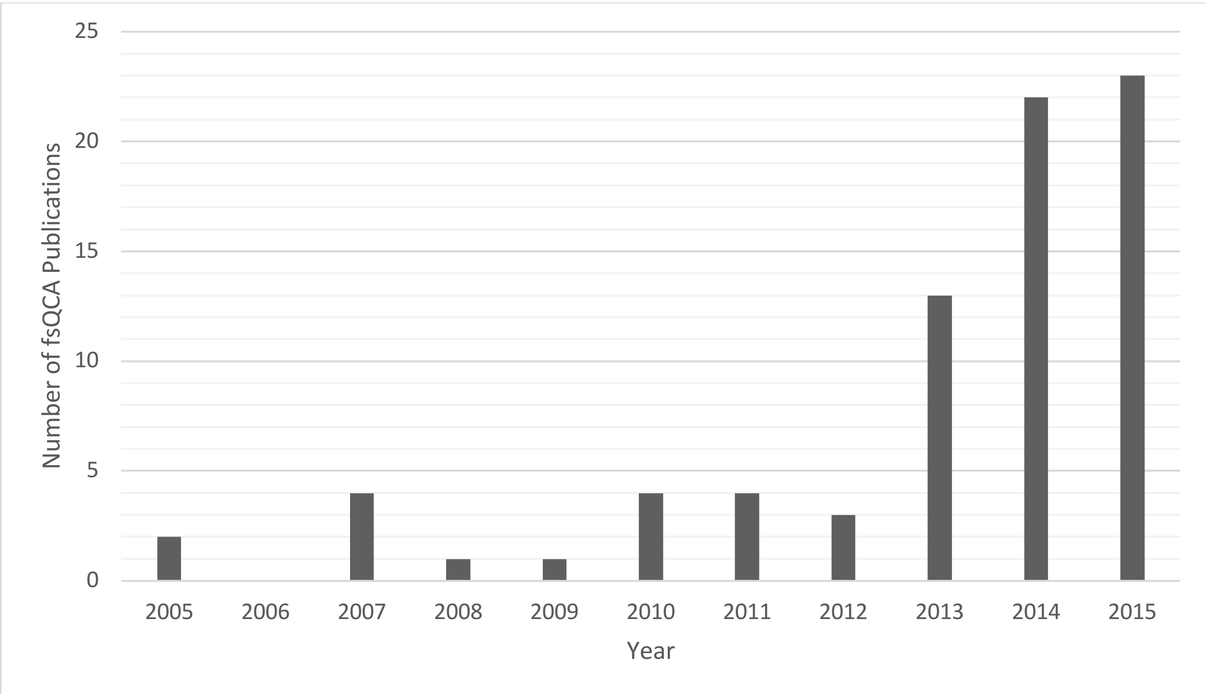


Figure 17 Development of fsQCA articles in business and management research, 2005–2016 (Kraus et al., 2018, minor design modifications).

remote and proximate conditions and employs a stepwise analytical approach. This methodological diversity reflects QCA's flexibility, adaptability to various research questions and contexts, and capability to explore complex phenomena in management and innovation studies.

From a theoretical perspective, it is essential to note that QCA is primarily designed for theory evaluation rather than theory testing. Ragin (1987) and Schneider and Wagemann (2012) emphasized that QCA's fundamental aim is based on causal complexity and conjunctural, equifinal, and asymmetric causation. Consequently, QCA explores how much its findings confirm initial theory-driven hunches. Building upon these considerations, Furnari et al. (2021) proposed a three-stage approach comprising the stages of Scoping, Linking, and Naming (see Figure 18). Stage 1, scoping, “aims at delimiting the attributes that explain a phenomenon while simultaneously doing justice to the complexity that surrounds it” (Furnari et al., 2021, p. 784). The second stage, linking, focuses on “explaining how the different elements of the configuration relate to one another to produce the outcome in an analytical way” (Park et al., 2020, p. 1498). The final stage, naming, “helps to shape and communicate the meaning of the configurations that explain a phenomenon” (Furnari et al., 2021, p. 789). Table 7 briefly describes these steps and outlines the key elements of the heuristic.

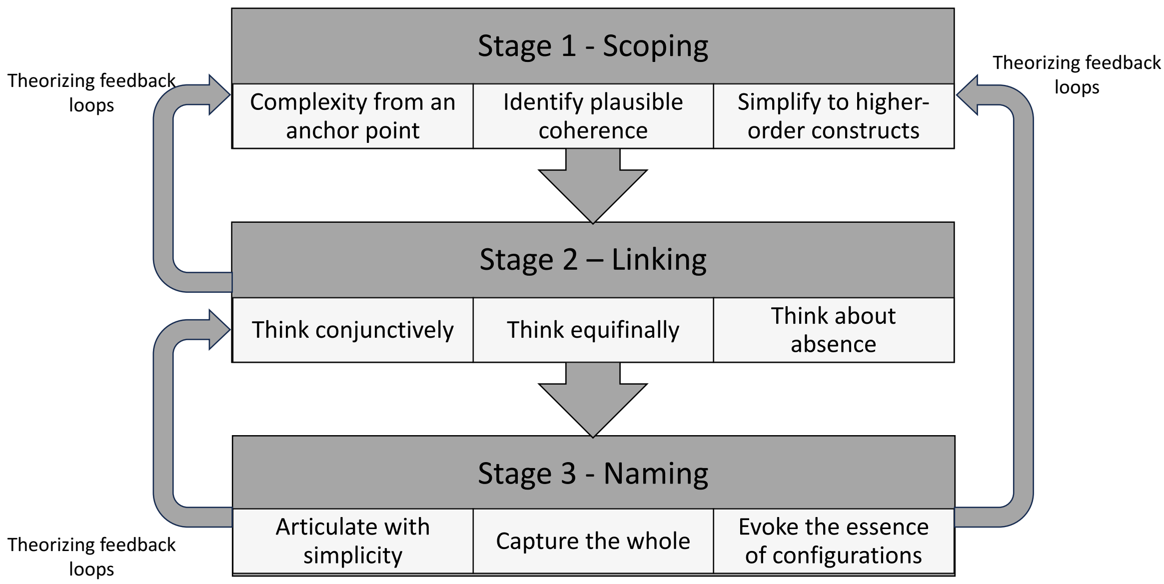


Figure 18 Configurational Theorizing Process (Furnari et al., 2021; minor design modifications).

Table 7 Stages and heuristics of the configurational theorizing process (Furnari et al., 2021; minor design modifications).

Stage	Description of stage	Heuristics	Description of heuristics
Scoping	Identifying relevant attributes that may plausibly form configurations	Complexify from an anchor	Use a key explanatory attribute as an "anchor" for identifying other connected attributes
		Identify plausible coherence	Develop hunches about possible themes orchestrating the attributes into configurations
		Simplify to higher-order constructs	Aggregate attributes into higher-order constructs depending on their conceptual similarity or their connection with an orchestrating theme
Linking	Specifying how the attributes connect with one another in specific configurations	Think conjunctively	Think about the specific types of interdependence links among attributes (contingency or complementarity)
		Think equifinally	Think about the multiple configurations that may be equally effective in explaining the phenomenon
		Think about absence	Think about how the absence of attributes connects with the presence of attributes in configurations
Naming	Labelling configurations to evoke their orchestrating themes and overall meaning	Articulate with simplicity	Use simple verbs and terms to verbalize the linkages among the attributes of configurations
		Capture the whole	Craft an overarching narrative across configurations (for the whole configurational theory) to convey the central theme shared by configurations
		Evoke the essence of configurations	Label each individual configuration to evoke its orchestrating themes

In order to understand QCA, it is essential to briefly introduce its fundamental characteristics. Multifinality refers to the phenomenon where one condition can lead to several effects. Equifinality implies that one outcome can have multiple explanations. QCA also acknowledges asymmetric causality and does not assume unit homogeneity, indicating that causality is not static or uniform across cases (Greckhamer et al., 2018). Consequently, QCA is case-sensitive and holistic in its approach. However, it is essential to note that QCA offers limited historical generalization, focusing on specific contexts and configurations (Schneider & Wagemann, 2012; Rihoux & Ragin, 2009).

Multi-case study

While most contributions in this dissertation utilize QCA, the empirical evaluation of one article is based on a multi-case study approach (Eisenhardt, 1989; Eisenhardt, 2021; Yin, 2018). Multi-case studies are particularly suitable in contexts involving complex processes and decisions, which is also true with the antecedents of digital innovations such as AI. Using multi-case studies allows for identifying similarities and differences through comparison based on a selection of cases. This comparison is facilitated by a theoretically guided case selection, informed by previously derived factors and dimensions, enabling theoretical generalization.

On an abstract level, the approach is structured into three steps: definition and design, preparation, data collection and analysis, and analysis and conclusion (Eisenhardt, 1989; Ozcan & Eisenhardt, 2009; Yin, 2018). The first step involves defining the theoretical framework, case selection, and methodology. The second step consists of data collection and analysis within each case, utilizing public data sources like websites, publications, news articles, press releases, archive data, and public interviews, or conducting own interviews if necessary. In the third step, cross-case conclusions are drawn, theories are modified, implications are derived, and cross-case findings are presented. This approach allows for generating generalizable results (Graebner & Eisenhardt, 2004) and a theoretical-conceptual oriented generalization to illuminate and further develop theories (Yin, 2013).

Epistemological perspective of qualitative comparative analysis

After explaining the two methodologies and their unique characteristics, this section will now outline the epistemological perspective of the configurational studies. This discussion will primarily focus on the foundational characteristics of QCA and their implications for epistemology, as QCA underpins most of the articles examined in this research.

Schneider and Wagemann (2010, p. 398) emphasized that "in order to do justice to its underlying epistemology, it needs also to be understood – and applied – as a research approach in a broad sense". Accordingly, researchers must consider various requirements, including research design, case selection, condition specification, and calibration. Thus, the structured analysis is crucial before and after the 'analytic moment' (Ragin, 2000). Over recent decades, the QCA methodology has evolved significantly, becoming more sophisticated in its procedures (e.g., Furnari et al., 2021; Greckhamer et al., 2018; Schneider & Wagemann, 2010; Wagemann & Schneider, 2015).

QCA is utilized in both descriptive and explanatory contexts, encompassing data summarization, typology identification, subset relation checks, hypothesis evaluation, conjecture testing, and theory development (Berg-Schlosser et al., 2009; Schneider & Wagemann, 2010; Thomann & Maggetti, 2020). Thomann and Maggetti (2020) outlined various approaches within QCA studies, which can be intensively case or condition-oriented and use inductive and explorative or deductive research methods.

Case-oriented applications focus on an in-depth analysis of specific cases with comprehensive contextual knowledge, which is essential for establishing measurement and internal validity. Consequently, most studies using this approach employ small samples (Berg-Schlosser & De Meur, 2009). Condition-oriented approaches define sets of conditions and are interpreted as patterns across cases without applying in-depth qualitative analysis of specific cases. This method is more commonly used in large sample contexts (Fiss et al., 2013; Greckhamer et al., 2013). The distance between the researcher and the case is a critical factor. At the same time, case-oriented applications depend on in-case knowledge, and condition-oriented approaches focus on cross-case inference and emphasize the relationships between sets, making theoretical considerations and conceptual relationships crucial (Thomann & Maggetti, 2020).

Deductive QCA studies primarily assess existing knowledge, whereas inductive and explorative approaches 'help the researcher generate some new insights, which may then be taken as a basis for further theoretical development or reexamination of existing theories' (Berg-Schlosser et al., 2009, p. 16). Therefore, in the inductive approach, modifying or generating new theories and creating novel insights are fundamental (Rohlfing, 2012).

From an epistemological perspective, it is noteworthy that QCA incorporates both positivism and constructivism elements, positioning it within a critical realist stance (Rutten, 2023). QCA's support for the positivist approach is evident in its systematic case analysis and identification of patterns and regularities. Using Boolean algebra and fuzzy-set theory within QCA allows for applying clear, empirically based criteria for classifying and comparing cases. This reflects the positivist pursuit of objectivity and generalizability.

Additionally, QCA supports the constructivist approach by emphasizing case studies and contextual analyses. It recognizes that complex social phenomena cannot always be explained through simple causal relationships and that understanding context and configurations is crucial. QCA facilitates a profound understanding of social reality by comparing various cases considering their respective contexts. By examining the interplay of different conditions (rather than isolated variables), QCA acknowledges the complexity of social phenomena, reflecting the constructivist view that reality is multi-layered and shaped by human interpretations.

Furthermore, scholars such as Byrne (2009), Gerrits and Pagliarin (2021), Gerrits and Verweij (2013), Pula (2021), and Rutten (2022) noted that interpretive approaches complement the perspective of critical realism, as they allow for the separation of empirical statements and causal claims. Rutten (2023) elucidated this by stating, "QCA makes causal claims as statements of sufficiency or necessity, which, empirically (as set relationships), are expressed as if-then statements (as regularities)" (p. 1710).

The positivist approach becomes more prominent in studies that consider multiple cases. This is because such studies tend to focus on identifying general patterns and regularities across a large number of cases, which aligns well with positivism's fundamental principles. Additionally, the emphasis on robustness checks to ensure the reliability of results further aligns with positivist principles.

In conclusion, it can be highlighted that the QCA extends beyond the 'analytical moment' described by Ragin (2000). It finds wide application in case- and condition-oriented approaches, revealing patterns across cases. Case-oriented applications rely on in-depth, within-case knowledge, whereas condition-oriented approaches emphasize cross-case inference. This approach adopts a perspective that incorporates elements from both positivism and constructivism, frequently aligning it with the critical realist philosophy.

8. Structure of the thesis and overview of the papers

After structuring the research gaps of this dissertation along three dimensions ‘unaddressed aspects in adoption research’, ‘research gaps in digital innovation adoption’, and ‘methodological research gaps in adoption studies’, I focus on the individual papers. This includes examining their characteristics, the data collection and analysis processes, the results and discussions, and their contributions towards answering the overarching research questions. All papers were written during my time at the Chair of Innovation Management, mostly in collaboration with co-authors and one independently.

Fundamentally, each publication in this dissertation addresses specific questions related to the research gaps previously identified. Notably, the focus of individual papers varies concerning the three dimensions, addressing different gaps. Some publications partially overlap in aspects of the research questions (‘methodological research gaps in adoption studies’). In contrast, others focus on specific issues (such as the role of stakeholders in adoption and decisions by third parties to assist in corporate adoption). The papers are structured content-wise, discussing prerequisites for adoption and then the adoption decision itself. This organization aligns well with the two main research foci in adoption research

(Rogers, 2003). Consequently, the articles initially explore the prerequisites and antecedents, followed by an examination of the adoption decision.

8.1. Publication 1: Application Potential and Impact of AI Service Innovations

In this publication, I study the potential applications, requirements, and consequences of adopting AI in the context of service innovations. Figure 19 depicts the structure and key findings. AI is used in the context of radical and incremental innovations. Additionally, it is applied in product and process contexts. Previous studies, as well as practical evidence, have shown that AI is applied in various industries and forces organizations to transform (Agrawal et al., 2018; Fountaine et al., 2019; Mc Afee & Brynjolfsson, 2017; Raisch & Krakowski, 2021). In doing so, the intersection of organization, management, and technology is crucial (Duchess et al., 1993). Although previous studies have proven the application potential within products and processes, both internal and external, a holistic consideration of application potentials and the requirements are not present (Dwivedi et al., 2021; Fountaine et al., 2019; Huang & Rust, 2018; Shrestha et al., 2019). This research addresses AI's success factors and potential applications in service innovations regarding organization structure, knowledge management, decision-making, leadership, and strategy.

I review the literature on AI in the organizational context, especially using the dimensions of organization structure, knowledge management, decision-making, leadership, and strategy (Agrawal et al., 2022; Fountaine et al., 2019; Mc Afee & Brynjolfsson, 2017; Raisch & Krakowski, 2021). In addition, the literature on service innovation provides insights regarding different typologies, highlighting the type of change (incremental vs radical) as well as the degree of change (process vs service) (Amara et al., 2009; Gallouj & Weinstein, 1997; Menor & Roth, 2007; Ostrom et al., 2010; Salunke et al., 2013; Snyder et al., 2016). This leads to a 2x2 matrix with four fields.

I use a multi-case study analysis and rely on typical cases within the four fields I derived from the theory (Eisenhardt, 1989; Eisenhardt, 2021; Yin, 2018). After carefully selecting the cases, I collected publicly available material using data sources like websites, publications, news articles, press releases, archive data, and public interviews. I analyzed 22 cases of AI service applications between 2015 and 2020.

Einsatzpotenziale und Auswirkungen von KI-Dienstleistungsinnovationen
-
Application Potential and Impact of AI Service Innovations

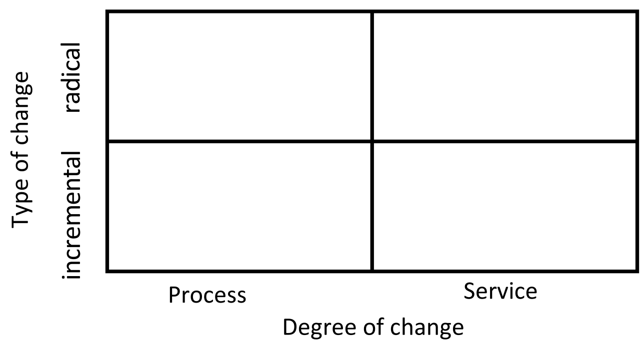
Research Question

What potential uses of AI service innovations exist as a basis for organizational implementation?

Theoretical Background

- Characteristics of artificial intelligence from an organizational perspective
- Characteristics of service innovations

Configurational Framework - Classification of AI service innovations



Empirical Design

- 22 cases of AI service applications between 2015 and 2020
- Careful selection of cases regarding AI classifications considering theoretical characteristics and practical relevance

Analysis & Method

- Multi case study analysis
- Public data like websites, publications, news articles, press releases, archive data, and public interviews

Results

- Identification of organizational success factor for the specific AI service innovations
- Differentiation between incremental and radical as well as process and service innovation

Contribution

- Definition of action fields in the adoption of AI service innovations
- Derivation of intensity according to the selected cases
- Creating a guide for AI Service Innovations adoption

Figure 19 Structure and key findings of research paper 1.

The study identified organizational success factors for the specific AI service innovations, considering the differences within the four fields of the matrix. I analyze the cases within the four fields and structure the findings regarding the impact of AI in service innovations concerning incremental processes, incremental services, radical processes, and radical services. I highlight the findings using the previously introduced lenses of organization structure, knowledge management, decision-making, leadership, and strategy. Building on these insights, I subsume the success factors in the four dimensions and highlight the fields of action and the intensity of adopting AI service innovations.

This study contributes to the insights into the adoption of AI service innovations. I revealed action fields for organizations and connected them to insights from the literature. Next, I acknowledged the type and degree of the innovations and took specific cases into account. Those cases provide a nuanced view and allow the structured typologies. Finally, I structured the action fields for the AI service innovation adoption.

8.2. Publication 2: Organizational Adoption of Big Data Technologies: A Configurational Analysis of Affordances, Constraints, and Strategic Fit

This publication deals with the interacting condition of the TOE framework regarding the adoption of digital technologies like big data. We enrich the TOE framework with the technology affordances and constraints theory (TACT) and the strategic fit theory. Figure 20 depicts the structure and key findings. The affordances of digital technologies like generativity and convergence (Yoo et al., 2012) provide a new set of potentials that can be leveraged due to the strategic fit (Bettis & Blettner, 2020; Venkataraman, 1989). However, previous studies have rarely considered those TACT and strategic fit theory in combination with affordances in the adoption context nor used a configurational perspective to study those. At the same time, configurational thinking is implicitly essential in the organization's strategic context (Furnari et al., 2021). This leads to our research question: "Which configurations of causal conditions lead to adopting big data analytics in business organizations using the perspective of technology affordances and constrains theory?"

Organizational Adoption of Big Data Technologies: A Configurational Analysis of Affordances, Constraints, and Strategic Fit

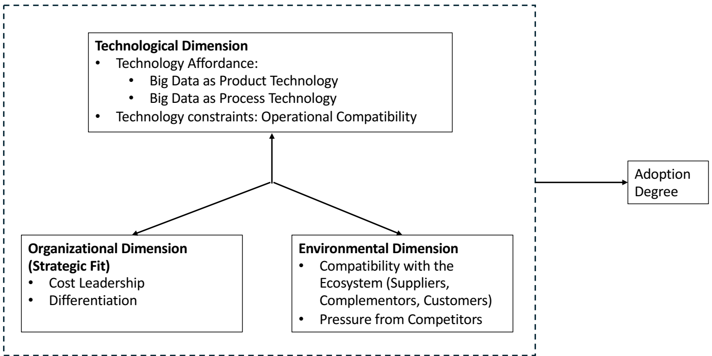
Research Question

Which configurations of causal conditions lead to adopting big data analytics in business organizations using the perspective of technology affordances and constrains theory?

Theoretical Background

- Technology affordances and constrains theory, affordance theory
- Adoption theory, technology-organization-environment framework
- Characteristics of digital technologies

Configurational Framework



Empirical Design

Quantitative survey with 83 responses of managers like CEOs and CDOs from German organizations

Analysis & Method

fuzzy set Qualitative Comparative Analysis

Results

- Identification of three distinctive solutions: Process Innovator – Reactive change taker, Product innovator – Proactive change maker, Ecosystem Innovator – Proactive change integrator

Contribution

- Emphasizing the fit between TOE-framework and configurational thinking
- Highlighting the role of digital affordances in the adoption and extension of the attributes of innovations
- Demonstrating the interacting conditions strategic fit & affordances

Figure 20 Structure and key findings of research paper 2.

Our study's background are the TACT, the strategic fit theory, and the technology affordances and constraints theory as well as the affordance theory in general (Autio et al., 2018; De Luca et al., 2021; Gibson, 1979; Majchrzak & Markus, 2012; Osmundsen et al., 2022; Venkataraman, 1989; Yoo et al., 2012; Zammuto et al., 2007). By doing so, we start with the technology adoption through the lens of tact and extend it with the insights from strategic fit. By doing so we focus on the internal and external fit perspective (Itami & Numagami, 1992; Zollo et al., 2018). Next, we combine the technology fit and operational compatibility (Karahanna et al., 2006). We combined those theories with the TOE framework and the adoption theory (DePietro et al., 1990; Rogers, 2003). This leads to our configurational framework with the three dimensions: 1. technology (technology affordances of big data as a product technology, technology affordances of big data as a process technology, and technological constraints – operational compatibility), 2. organizational dimension regarding the strategic fit (cost leadership, differentiation strategy), and the 3. environmental dimension (compatibility with the ecosystem, pressure from competitors).

We collected data with a survey and received 83 responses from managers like CEOs and CDOs from German organizations. Next, we used fsQCA to study the data (Fiss, 2007; Fiss, 2011; Furnari et al., 2021; Ragin, 2008). We identified three distinctive solutions. The – process innovator – reactive change taker is characterized by a low perception of product affordances but a high compatibility with the ecosystem. The product innovator –a proactive change maker – is defined by a high perception of product affordances, organizational compatibility, and the focus on a pure differentiation strategy. Finally, the ecosystem innovator – proactive change integrator – relies on a differentiation strategy and compatibility with the ecosystem.

Due to our findings, we can contribute to the starting discussion of the fit between the TOE framework and configurational thinking. In addition, we highlight the role of digital affordances in the adoption and extension of innovations' attributes. Finally, we demonstrate the interaction of strategic fit and affordances.

8.3. Publication 3: Integration of Artificial Intelligence in the Organizational Adoption – A Configurational Perspective

This publication studies the adoption of AI within organizations following the TOE framework's structure and applying specific AI characteristics, namely automation and augmentation (DePietro et al., 1990; Raisch & Krakowski, 2021). Figure 21 depicts the structure and key findings. Following DePietro et al. (1990), we structured the adoption factors into technology, organization, and environment. However, few studies have considered the AI-specific interacting characteristics of automation and augmentation (Bailey et al., 2019; Dwivedi et al., 2021; Raisch & Krakowski, 2021; von Krogh, 2018). The interaction is studied from a configurational perspective, which is implicitly also recognized by DePietro et al. (1990). This leads to our research question: "How do technology-specific, organizational, and environmental factors interplay, and in which configurations do they lead to the organizational adoption of artificial intelligence?"

We reviewed the literature on artificial intelligence and organizational adoption and identified the five themes of benefits and challenges (Duan et al., 2019; Dwivedi et al., 2021; Harfouche et al., 2017; Unhelkar & Arntzen, 2020), applications (Akter et al.; 2020; Keller et al., 2019), requirements and readiness (Alsheibani et al., 2018), influencing factors (Ambati et al., 2020; Paschen et al., 2020), and ethics, law, and security (Dwivedi et al., 2021; Nagbøl et al., 2021). We build our configurational framework using the TOE framework. In addition, we emphasize that, especially in information systems research, the TOE framework is at the center of attention (Oliveira & Martins, 2011; Zhu et al., 2006). However, we studied the previous literature and considered the recommendations regarding configurational studies (Furnari et al., 2021). Thus, we define the conditions within the three dimensions decisive in AI. Within the technology dimension, we include automation advantages, augmentation advantages, product/service applications, and process applications (Dwivedi et al., 2021; Raisch & Krakowski, 2021; Ransbotham et al., 2019). In the organizational dimension, we incorporate strategic orientation (Congden & Schroeder, 1996; Porter, 1980; Zollo et al., 2018), resources (DePietro et al., 1990), and entrepreneurial orientation (Lumpkin & Dess, 1996; Marshall et al., 2015; Pérez-Luño et al., 2011). The environmental dimension contains the condition of network support.

Integration of Artificial Intelligence in the Organizational Adoption – A Configurational Perspective

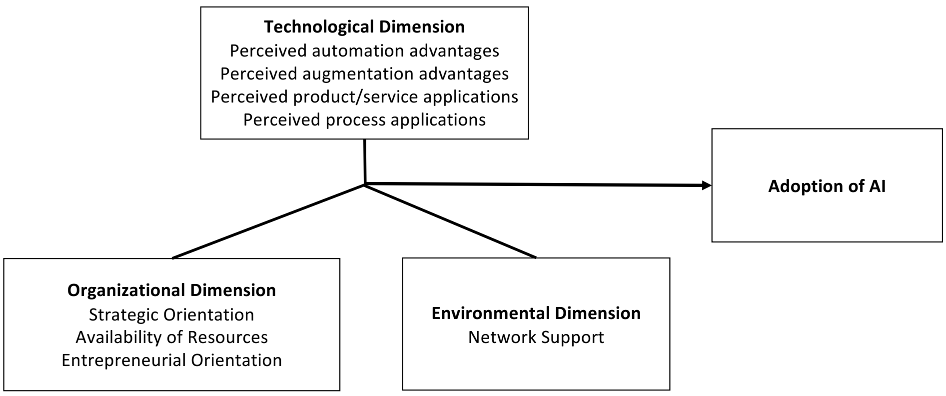
Research Question

How do technology-specific, organizational, and environmental factors interplay, and in which configurations do they lead to the organizational adoption of artificial intelligence?

Theoretical Background

- Adoption theory, technology-organization-environment framework
- Characteristics of artificial intelligence (automation – augmentation)

Configurational Framework



Empirical Design

Quantitative survey with 104 responses of managers like CDOs and head of IT being responsible for digitalization

Analysis & Method

fuzzy set Qualitative Comparative Analysis

Results

Identification of four distinctive solutions: internal integrator, supportive provider, powerful innovator, rising enthusiast

Contribution

- Emphasizing the fit between TOE-framework and configurational thinking
- Importance of all dimension of the TOE framework
- Highlighting the role of interacting AI-characteristics

Figure 21 Structure and key findings of research paper 3.

To answer our research question, we surveyed organizations. We received 104 answers from managers including Chief Digital Officers, directors, and head of IT, who were responsible for the companies' digitalization. We conducted fsQCA for the data analysis (Fiss, 2007; Fiss, 2011; Furnari et al., 2021; Ragin, 2008) and revealed four distinctive solutions. Within the first solution, the internal integrator, there are three sub-solutions. In general, organizations perceive the potential of automation and process applications and possess lots of resources. The second solution, the supportive provider, has no permutation. The organizations in this group have the core conditions of perceived automation, product and service applications, resources, and network support. Solution three, the decisive innovator, has no permutation, and organizations within this solution rely on perceived augmentation potential, product and service applications, resources, entrepreneurial orientation, and network support. The conditions of automation potential, product and service application, processes, resources, and network support define the rising enthusiast's final solution. We discuss the findings regarding the configurational perspective and the interactions of the conditions, the importance of the different dimensions, and the adoption rationales. In addition, we identify specific exemplary organizations or innovations for each solution. Finally, we emphasize the perceived potential in the characteristics of AI, which are essential for its adoption in this study.

8.4. Publication 4: Adopting Digital Technologies to Stay Green – A Configurational Analysis

Publication 4 studies adopting virtual power plants in biogas plants to sustain green energy production. Figure 22 depicts the structure and key findings. Previous literature has applied various perspectives to study the adoption of innovations. In doing so, studies applied economic, network-related, and green value-related rationales to explain adopting digital innovations within organizations (Ansari et al., 2010; George et al., 2021; Iyengar et al., 2011). While the economic perspective highlighted the efficiency and financial considerations, thus emphasizing the analytical actor (Dąbrowska et al., 2022; Nambisan et al., 2017; Oliveira et al., 2014), network perspectives emphasized the importance of social contagion and the influence of partners and peers (Angst et al., 2010; Fliaster et al., 2022; Iyengar et al., 2011). Finally, green and environmental considerations have been discussed in the adoption context for decades (Murillo Luna et al., 2008; Murillo Luna et al., 2011) and have been recently connected

Adopting Digital Technologies to Stay Green – A Configurational Analysis

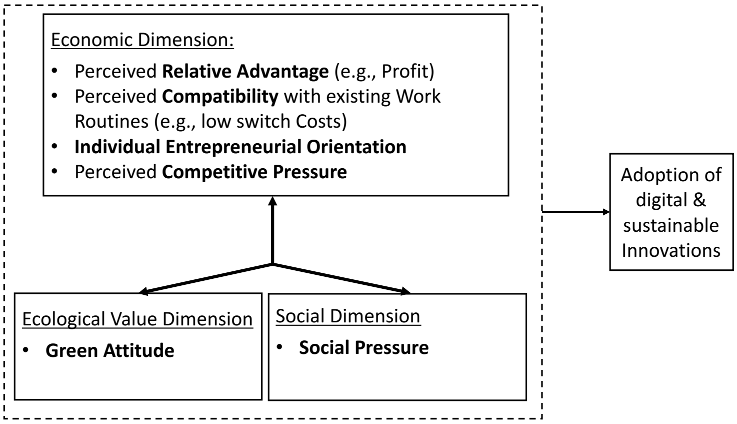
Research Question

Which configurations of economic, ecological, and social conditions elucidate the adoption of digital innovations with a positive green impact?

Theoretical Background

- Organizational adoption research
- Economic rationales
- Green value rationales
- Social rationales

Configurational Framework



Empirical Design

Quantitative survey with 52 responses of biogas plant owners in Germany in 2019

Analysis & Method

fuzzy set Qualitative Comparative Analysis

Results

Identification of four distinctive solutions for the adoption of virtual power plants: entrepreneurial market actor, green enthusiast, conformist, holistic player

Contribution

- Importance of complexity, conjunction, equifinality, and causal asymmetry
- Extension on adoption drivers and nuanced understanding of interactions
- Integration of the economic, ecological, and social influence within adoption

Figure 22 Structure and key findings of research paper 4.

to digital technologies using the term digital sustainability (George et al., 2021; Pan & Zhang, 2020; Yin & Yu, 2022). However, previous studies have studied these rationales mostly in different silos and thus overlook the combined influences and interactions in digital technologies, which are present in all three dimensions. As a result, it has often been ignored that technologies are increasingly linking economic efficiency and sustainability (Bähr & Fliaster, 2023). Thus, we ask the following research question: "Which configurations of economic, ecological, and social conditions elucidate the adoption of digital innovations with a positive green impact?"

We studied the previous literature regarding organizational adoption (Frambach & Schillewaert, 2002; Rogers, 2003) and integrated economic, green, and social impact factors within our theoretical and configurational framework (Ansari et al., 2010; Angst et al., 2010; Fliaster et al., 2022; Iyengar et al., 2011; Murillo Luna et al., 2008). In doing so, we shape the economic dimension with the conditions of relative advantage, compatibility, individual entrepreneurial orientation, and competitive pressure (Bolton & Lane, 2012; Iacovou et al., 1995; Karahanna et al., 2006; Rogers, 2003; Wang et al., 2010). Within the green dimension, we focused on the green attitude of the managers who are decisive for adoption (Murillo-Luna et al., 2008). Social pressure, i.e., the influence of family and friends of the deciding manager, completes the framework (Ansari et al., 2010; Eckhardt et al., 2009).

In our empirical context, we investigated the adoption decision of biogas plant operators in Germany, who can realize economic benefits by adopting the technology of virtual power plants while continuing to generate electricity in their biogas plants. Despite the economic and environmental advantages, this adoption process is complex, challenging, and fraught with uncertainties for the companies involved, making the decision far from trivial. Through a survey, we received 53 responses from biogas plant operators making an adoption decision. We identified four solutions using fuzzy-set QCA (Fiss, 2007; Fiss, 2011; Furnari et al., 2021; Ragin, 2008).

Solution 1, the – entrepreneurial market actor – is characterized by high membership scores for individual entrepreneurial orientation and significant competitive pressure. These companies recognize the strategic importance of adoption and aim to improve their competitive position while securing their existing status. Solution 2, the – green enthusiasts – are distinguished by a strong green attitude, where environmental values act as a catalyst.

Solution 3, the – conformist – sees adopters who perceive compatibility between their company and the innovation and experience strong social pressure. This enables them to meet social and emotional aspects while reducing risks. The final Solution 4, the – holistic player – combines compatibility, individual entrepreneurial orientation, competitive pressure, and social pressure, leading to an interplay of economic and social rationales. With these solutions, we contribute to the configurational perspective of adoption, provide a nuanced view of the interactions, and integrate economic, ecological, and social influences within adoption decision-making.

8.5. Publication 5: Stakeholder Influence on the Adoption of Digital Innovations – A Configurational Perspective on the Internet of Things

The publication 5 incorporates a stakeholder perspective to analyze the adoption of IoT innovations. Figure 23 depicts the structure and key findings. Using the stakeholder perspective, the three dimensions of stakeholder salience (Mitchell et al., 1997), network characteristics like dyadic relationships (Fliaster & Kolloch, 2017; Rowley, 1997), and organizational characteristics like stakeholder integration skills (Bundy et al., 2013) are decisive for the adoption. However, few previous studies have applied a configurational perspective in the context of adoption from a stakeholder view (Holm et al., 2021; Juntunen et al., 2019; Kumar et al., 2022). In addition, the connection between stakeholder and network characteristics and organizational characteristics is still in its infancy (Odziemkowska & Henisz, 2021). Finally, the digital context and especially network-related innovations, such as IoT, are studied little within innovation management research (Nambisan et al., 2017). This leads to our research question: “Which configurations of stakeholders’ characteristics, organizational characteristics, and networks contribute to adopting digital innovations?”

We reviewed the stakeholder literature on the adoption of innovations and defined our configurational framework with the dimensions of stakeholder characteristics (primary and secondary stakeholder salience) (Clarkson, 1995; Hall et al., 2014; Jiao et al., 2020; Shubham et al., 2018; Suchman, 1995), stakeholder relationship (coordination among stakeholders) (Fliaster & Kolloch, 2017; Rowley, 1997), and organizational characteristics (stakeholder integration skill, entrepreneurial orientation) (Lumpkin & Dess, 1996; Marshall et al., 2015; Plaza-Úbeda et al., 2010; Vaquero Martin et al., 2016). To answer our research question, we

**Stakeholder Influence on the Adoption of Digital Innovations –
A Configurational Perspective on the Internet of Things**

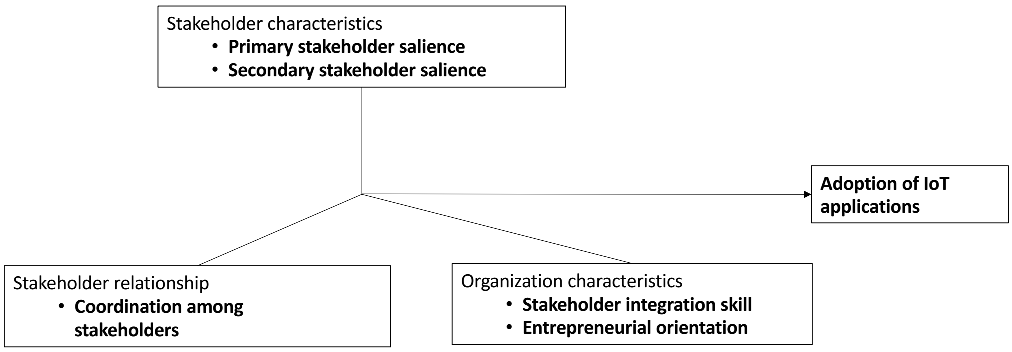
Research Question

Which configurations of stakeholders' characteristics, organizational characteristics, and networks contribute to adopting digital innovations?

Theoretical Background

- Stakeholder theory
- Organizational adoption
- Network characteristics

Configurational Framework



Empirical Design

Quantitative survey with 81 responses of managers includes CSOs from German organizations

Analysis & Method

fuzzy set Qualitative Comparative Analysis

Results

- Identification of four distinctive solutions for the adoption
- Solutions are characterized as coordinated network of strong business partners, stakeholders' supportive follower, entrepreneurial integrator, integrator of coordinated stakeholders' demand

Contribution

- Configurations can explain the organizations technology adoption
- Neither stakeholder characteristics, network relationships, nor organizational characteristics are a necessary condition
- Identification of different types of relations between the key factors (salience of primary stakeholders and coordination between stakeholder groups act as complements vs coordination between different stakeholder groups and stakeholder salience serve as substitutes)
- Entrepreneurial orientation is no necessary condition for a company to be an active adopter of (digital) innovations

Figure 23 Structure and key findings of research paper 5.

surveyed German organizations and received 81 answers from managers like CSOs. The innovations regarding IoT are particularly suitable for our study since most benefits are associated with partners and through connectivity.

We applied fsQCA to analyze the data and identified four distinctive solutions (Fiss, 2007; Fiss, 2011; Furnari et al., 2021; Ragin, 2008). Within the first solution, the – coordinated network of strong business partners – the salience of primary stakeholders, and the coordination among stakeholders facilitate the adoption. The second solution, – stakeholders' supportive followers – also relies on the salience of primary stakeholders but not on secondary stakeholders' salience. In addition, these adopters possess high levels of stakeholder integration skills. Solution three, the – entrepreneurial integrator – is characterized by the salience of the secondary stakeholders and the organizational characteristics of stakeholder integration skills and entrepreneurial orientation. The last solution, the – integrator of coordinated stakeholders' demand – is characterized by his stakeholder integration skill and the coordination of stakeholders among each other. In addition to the solutions, we looked deeper at exemplary cases within all four solutions. We discussed the findings regarding the configurational perspective and the interactions of the conditions, the importance of the different dimensions, and the adoption rationales. Thus, the adoption of digital technologies like IoT significantly hinges on the interaction, collaboration, and ecosystem involving stakeholders and their activities.

8.6. Publication 6: What Drives Individuals to Participate in Co-creation of Artificial Intelligence for Sustainability

In this publication, we explore the influencing factors that encourage actors such as customers and third parties to participate in AI co-creation projects with a green or social character. Figure 24 depicts the structure and key findings. Data is essential, particularly in the context of AI, as it is needed for training AI models, directly contributing to adopting AI technologies in sustainable contexts. Addressing grand challenges and a sustainable future requires efforts from various actors across multiple levels (United Nations, 2015; George et al., 2016). On the one hand, companies contribute through sustainable products and processes (Schaltegger et al., 2016), while on the other hand, individuals make significant contributions through behavioral changes (Köhler et al., 2019). Besides these individual activities, collaboration among stakeholders like companies and individuals can also contribute to solving these issues (Cillo et al., 2019).

Although previous studies on co-creation have highlighted the benefits of AI (Sjödin et al., 2020), there is still limited knowledge regarding co-creation and sustainable AI (Aquilani et al., 2020; Leone et al., 2021), especially regarding the antecedents and drivers for individual participation in AI co-creation projects. Using a configurational lens, this article poses the research question: "Which factors affect the participation of individuals in the co-creation efforts, and how do these relevant factors interact?"

Initially, we reviewed existing literature on co-creation in digital and sustainable contexts (Kim & Baker, 2020; Kumari et al., 2019; Lafuente et al., 2023; Ma et al., 2019; Mele et al., 2021; Merz et al., 2018; Ostrom et al., 2010), structured insights regarding AI as digital technology in companies (Haenlein & Kaplan, 2019; Krakowski et al., 2023; Raisch & Krakowski, 2021) and examined the role of AI in sustainability (George et al., 2021; van Wynsberghe, 2021).

Building on this, we developed a configurational framework. As outcomes, we considered two different project types: social and green co-creation projects, leading to two separate analyses. The considered conditions include personality traits (openness to ideas, susceptibility to social contagion), values (biospheric [in the green co-creation Project], altruistic [in the social co-creation Project]), motivators (autonomous motivation), and technology-related factors (importance of data protection, trust in AI).

We employed factorial survey experiments using vignettes and collected data from 196 individuals with 784 vignettes in 2022. To cover all possible outcomes with cases, we surveyed participants with experience in sustainable co-creation projects and non-participants in co-creation projects, ensuring the inclusion of green and social projects.

We identified five distinctive solutions for social AI co-creation projects using fsQCA (Fiss, 2007; Fiss, 2011; Furnari et al., 2021; Ragin, 2008) and four distinctive solutions for green AI co-creation projects. Individuals associated with Solution 1 are highly susceptible to social contagion, autonomous motivation, and trust in AI. Actors in Solution 2 are open to new ideas and trust AI but do not hold altruistic values and are not susceptible to social contagion.

What Drives Individuals to Participate in Co-creation of Artificial Intelligence for Sustainability

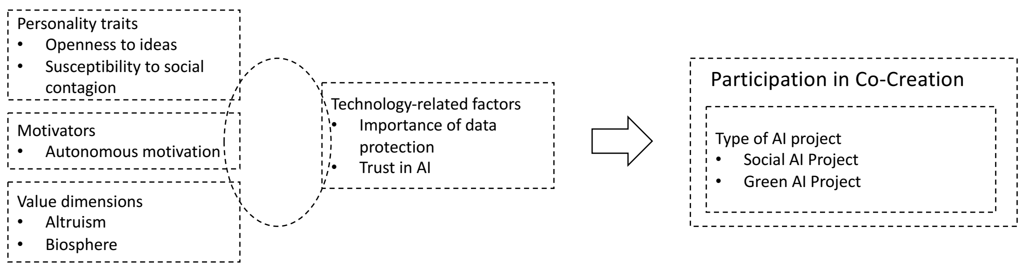
<u>Research Question</u>

Which factors affect the participation of individuals in social and green AI co-creation projects and how these relevant factors interact?

<u>Theoretical Background</u>

- Co-Creation
- Digital sustainability; AI for sustainability
- AI in organization

<u>Configurational Framework</u>



<u>Empirical Design</u>

- Factorial survey experiments, using vignettes to collect data from 196 individuals with 784 vignettes in 2022
- Participants with experience in sustainable co-creation projects and non-participants in co-creation projects

<u>Analysis & Method</u>

fuzzy set Qualitative Comparative Analysis

<u>Results</u>

- Identification of five distinctive solutions for social AI co-creation projects and four distinctive solutions for green AI co-creation projects
- Identification of two distinctive solutions for very high participation in social AI co-creation projects and two distinctive solutions for very high participation in green AI co-creation projects

<u>Contribution</u>

- Different rationales drive green and social co-creation projects
- Specific solutions for biospheric and altruistic value orientations
- Substitution of openness to ideas and susceptibility to social contagion (in specific solutions)
- Trust is important in green and social projects
- Autonomous motivation, high trust in AI, unimportant data protection, and a high social or, respectively, biospheric value orientation appears in both types of co-creation

Figure 24 Structure and key findings of research paper 6.

Individuals in Solution 3 are autonomously motivated altruists who trust AI and have no concerns about data protection. Those in Solution 4 also trust AI and have no data protection concerns, but unlike previous solutions, they are not open to new ideas. Instead, they have high susceptibility to social contagion. People in Solution 5 are open to new ideas and susceptible to social contagion but, surprisingly, are not altruistic and consider data protection important.

Examining the results for green co-creation projects, we find that individuals in Solution 1 are open to new ideas, follow green values, and place no particular emphasis on data protection. People in Solution 2 resemble the previous social Solution 3, having green values, high autonomous motivation, trust in AI, and no data protection concerns. Individuals in Solution 3 are not open to new ideas but are susceptible to social contagion, hold green values, and trust AI. Those in Solution 4 are susceptible to social contagion, possess green values, have autonomous motivation, and trust in AI. Our results contribute to the configurational understanding of co-creation in AI projects and emphasize the role of sustainable orientation.

8.7. Overall structure of the thesis

After providing an overview of the selected papers, Figure 25 outlines the structure of the whole dissertation. After this prologue, the papers contributing to the thesis are presented in the next section. In addition to the publication, the following chapters include information regarding the authors, the submissions, and the used datasets. The publications are presented in the style and format of the submitted outlets. Finally, the dissertation concludes with a synopsis subsuming and connecting the publications.

Synopsis - Prologue

Publications on the adoption of digital innovations

- **Publication 1: Application Potential and Impact of AI Service Innovations**
- **Publication 2: Organizational Adoption of Big Data Technologies: A Configurational Analysis of Affordances, Constraints, and Strategic Fit**
- **Publication 3: Integration of Artificial Intelligence in the Organizational Adoption – A Configurational Perspective**
- **Publication 4: Adopting Digital Technologies to Stay Green – A Configurational Analysis**
- **Publication 5: Stakeholder Influence on the Adoption of Digital Innovations – A Configurational Perspective on the Internet of Things**
- **Publication 6: What Drives Individuals to Participate in Co-creation of Artificial Intelligence for Sustainability**

Synopsis - Epilogue

Figure 25 Overall structure of the dissertation.

II. Publications

1. Publication 1: Einsatzpotenziale und Auswirkungen von KI – Dienstleistungsinnovationen

1.1. Notes on submitted Paper

This paper on "Application potential and impact of AI service innovations" was written by myself. After a double-blind peer review process and a revision process it was published in the book "Künstliche Intelligenz im Dienstleistungsmanagement" edited by Prof. Dr. Manfred Bruhn and Prof. Dr. Karsten Hadwich.

Publication details:

Laut, P. (2021). Einsatzpotenziale und Auswirkungen von KI-Dienstleistungsinnovationen. In Bruhn, M., & Hadwich, K. (Eds.). Künstliche Intelligenz im Dienstleistungsmanagement. (pp. 134-157). Springer Gabler, Wiesbaden. https://doi.org/10.1007/978-3-658-34324-8

Mit freundlicher Genehmigung von Springer Nature.

1.2. Academic Paper

Abstract

Dieser Beitrag adressiert die Integration von KI-Dienstleistungsinnovationen in Unternehmen. Mittels einer Typologie von Dienstleistungsinnovationen (inkrementell – radikal; Prozess – Service) werden Beispiele anhand der fünf Charakteristika Unternehmensstruktur, Wissensmanagement, Entscheidungsfindung, Leadership und Strategie analysiert. Auf dieser Grundlage werden Auswirkungen, Erfolgsfaktoren und Intensität der Handlungsfelder bei der Adoption von Künstlicher Intelligenz bei Dienstleistungsinnovationen analysiert.

Einführung

Im Kontext von Künstlicher Intelligenz (KI) finden nicht nur radikale Innovationen ihren Weg auf den Markt, sondern auch bisherige Produkte und Services unterziehen sich einem Wandel. Hierbei stoppt KI weder an den technologischen noch branchenspezifischen Grenzen und zwingt stattdessen Unternehmen zu ganzheitlichen Veränderungen (McAfee/Brynjolfsson 2017, S. 25ff.). Beispielsweise spielen KI-Dienstleistungsinnovationen entscheidende Rollen bei der Navigation mittels Waze (Agrawal et al. 2018, S. 89), der Auswahl von Plot und Schauspieler bei der Filmproduktion von Netflix (Raisch/ Krakowski 2020, S. 4) sowie der Entwicklung neuer Arzneimittel (Henstock 2019, S. 544). Abhängig von der Innovation selbst sowie des Einsatzgebiets sind unterschiedliche Erfolgsfaktoren für die Implementierung und Nutzung von KI-Innovationen entscheidend. Duchessi et al. (1993, S. 152) stellen bereits vor über einem viertel Jahrhundert eine Interaktion zwischen Management, Unternehmen und KI-Systemen fest. In der aktuellen Forschung wird diese Auswirkung konkretisiert und intensiv diskutiert. So wird der Einfluss von KI auf Unternehmen (Fountaine et al. 2019, S. 64ff.), Leadership (Jones 2018, S. 60), und das Zusammenspiel zur Entscheidungsfindung sowie Problemlösung (Shrestha et al. 2019, S. 66ff.) thematisiert. In diesem Zusammenhang wird vermehrt festgehalten, dass neben reinen Produktanwendungen insbesondere Dienstleistungsinnovationen durch KI realisierbar sind (Huang/Rust 2018, S. 155ff.).

Hierbei werden die KI-Innovationen sowohl Kunden angeboten als auch in unternehmensinternen Prozessen eingesetzt. Als Beispiel für das Kundenangebot dient IBM's Plattform Watson (Ignatius 2017, S.129), als Beispiel für interne Prozesse der Einsatz von KI zur

Personenerkennung bei Strafverfolgungsbehörden (Smith 2019, S. 3). Eine ganzheitliche Betrachtung der verschiedenen Einsatzpotenziale von KI-Dienstleistungsinnovationen findet bisher nicht statt. Resultierend fehlt eine Orientierung für Theorie und Praxis bei der Adoption und Implementierung von KI-Dienstleistungsinnovationen in Unternehmen.

An dieser Stelle setzt der folgende Beitrag an. In einem ersten Schritt werden auf Basis der bisherigen Literatur sowohl die Kriterien von KI im Unternehmenskontext erarbeitet als auch die Systematik der Eingruppierung von Dienstleistungsinnovationen entwickelt. Im zweiten Schritt werden aktuelle KI-Dienstleistungsinnovationen exemplarisch ausgewählt, anhand der entwickelten Systematik zugeordnet und die Auswirkungen auf Unternehmen und Management anhand der Aspekte Unternehmensstruktur, Wissensmanagement, Entscheidungsfindung, Leadership sowie Strategie erörtert (Duchessi et al. 1993, S. 155ff.). Im dritten Schritt werden, von den Beispielen ausgehend, die übergreifenden Charakteristika der einzelnen Elemente innerhalb der Eingruppierungsmatrix diskutiert. Abschließend werden die Erfolgsfaktoren und Einsatzpotenziale abstrahiert. Somit dient der Beitrag für Theoretiker und Praktiker gleichermaßen als Landkarte für die Entwicklung und Integration von KI-Dienstleistungsinnovationen in den Unternehmensalltag.

Grundlagen

Künstliche Intelligenz im Unternehmenskontext

KI ist ein schnell wachsendes Phänomen von hoher wirtschaftlicher und organisationaler Bedeutung (Fountaine et al. 2019, S. 64). Vier Gründe treiben die Adoption und Nutzung von KI im Unternehmenskontext voran: Zuerst entwickelten sich innerhalb der letzten zwei Jahrzehnte die zugrunde liegenden Methoden und Grundlagen signifikant weiter. Diese neuen Algorithmen sind meist frei zugänglich. Zweitens verfügen Unternehmen heute über die notwendigen Daten. Drittens sind die Kosten für die Anwendungen von KI stark gesunken (vgl. Moore’s Law). Als vierter Faktor ist die leichte Verfügbarkeit von Cloud Computing anzufügen, die nahezu jedem Unternehmen den Zugang zu benötigten IT-Ressourcen gewährt (von Krogh 2018, S. 404f.).

Im Rahmen dieses Beitrags wird unter KI die Erweiterung von Systemen um menschliche Fähigkeiten wie Fühlen, Verstehen, Handeln und Lernen verstanden (Daugherty/Wilson 2018, S. 3). Der Einsatz von KI ermöglicht es Unternehmen Services und Prozesse anpassungsfähiger zu gestalten. Hierbei geht es um die Interaktion zwischen

Menschen und Maschinen, in der KI eine integrative Rolle einnimmt. KI erreicht zwei verschiedene Potenziale – Automatisierung und Erweiterung. Zum einen können bisherige Aufgaben, die zuvor von Menschen ausgeführt wurden, automatisiert werden und somit zu mehr Freiraum für Mitarbeitende führen, zum anderen kann KI den Umfang an angebotenen Leistungen vergrößern. Hierbei kollaborieren Mensch und KI eng miteinander und lösen Herausforderungen im Zusammenspiel (Raisch/Krakowski 2020, S. 4ff.). Je nach Umfang und Einsatzbereich im Unternehmen sind unterschiedliche Erfolgsfaktoren relevant.

Die Charakteristika von Automatisierung und Erweiterung werden sowohl bei Services als auch bei den Prozessen der Serviceerstellung festgestellt. Bezogen auf die Automatisierung der Services wird die bisherige Leistung nicht mehr von Menschen, sondern durch KI erbracht. Dies ist beispielsweise im Fall von deepL, einem Angebot zur Übersetzung von Texten, zu finden (Coldewey/Lardinois 2017). Bei der Automatisierung von Prozessen, wie es bei Chatbots im E-Commerce der Fall ist, werden direkte oder indirekte Prozesse der Leistungserstellung von KI-Innovationen übernommen (Cui et al. 2017, S. 99). Bei der Erweiterung des Service wird dem Kunden durch die Zusammenarbeit von KI und Mensch zusätzlicher Nutzen gestiftet. So nutzt das Unternehmen Tempus KI, um die Patientenversorgung zu optimieren (Reichert et al. 2018, S. 9). BERG setzt KI ein, um im Zusammenspiel mit Pharmazeuten Prozesse in der Arzneimittelentwicklung zu verändern und neue Behandlungen von neurologischen Krankheiten zu ermöglichen (Berghealth 2020).

Diese Beispiele zeigen deutlich, dass KI über den reinen Einsatz in Services hinausgeht und zusätzlich die direkten und indirekten Prozesse der Leistungserstellung verändert. Folglich bleibt festzuhalten, dass sich neben den Charakteristika der Services, sowohl die Charakteristika unternehmensinterner Prozesse als auch die Anforderungen an das Management verändern. Hierbei hat die bisherige Forschung insbesondere die Bereiche Unternehmensstruktur, Leadership, Entscheidungsprozesse, Strategie und Wissensmanagement als relevant identifiziert (Duchessi et al. 1993, S. 155ff.; Ransbotham et al. 2019, S. 6ff.; Ready et al. 2020, S. 4ff.).

Zum einen beeinflusst die Unternehmensstruktur die erfolgreiche Implementierung von Innovationen im Unternehmen, zum anderen sind die bisherigen Strukturen auf umfassende Veränderungen anzupassen (Teece 1996, S. 200ff.). Durch die zunehmend dezentralisierte Organisation eigenverantwortlicher Teams sowie Unternehmens- und

Geschäftseinheiten wandeln sich auch Unternehmensstrukturen (Drucker 1988, S. 47ff.). Zusätzlich gewinnen insbesondere im Kontext von Innovationen Agilität, Kundenorientierung und Anpassungsfähigkeit an Bedeutung (Cooper 2014, S. 21ff.). Im Kontext von KI werden Unternehmensstrukturen benötigt, die eine Implementierung erleichtern. Zusätzlich können durch den Einsatz von KI bisherige Entwicklungen im Bereich der Dezentralisierung und Autonomie gefördert werden. Je nach Umfang und Intensität der KI-Innovationen sind unterschiedliche Bereiche der Unternehmensstruktur betroffen. Dementsprechend sind je nach Innovation unterschiedliche strukturelle Änderungen nötig.

Bei der Einführung von KI wird dem Leadership eine grundlegende Aufgabe zuteil (Ready et al. 2020, S. 7ff). Grundsätzlich werden unter Leadership formelle und informelle, kontextuell verwurzelte und zielbeeinflussende Prozesse verstanden, um Einigkeit über Ziele und deren Gelingen zu gewährleisten (Yukl/Gardner 2019, S. 23). Wichtig für die Effektivität von Leadership ist die Verbesserung der Leistung des Teams und der Organisation, um die gesteckten Ziele zu erreichen (Kaiser et al. 2008, S. 97). Für erfolgreiches Leadership werden vier Bereiche von Fähigkeiten betrachtet. So benötigen Führungskräfte technische, interpersonelle, konzeptuelle und politische Fähigkeiten, die je nach Aufgabe unterschiedlich ausgeprägt sind. Reck und Fliaster (2019, S. 2ff.) stellen fest, dass unterschiedliche Typen von Führungskräften mit verschiedenen Führungsstilen die Digitalisierung im Unternehmen stärken. In Bezug auf die Adoption und Nutzung von KI in Dienstleistungen stellen Führungskräfte zum einen den verantwortungsvollen Einsatz der KI sicher, zum anderen werden die Mitarbeitende beim Wandel begleitet und unterstützt (Davenport/Ronanki 2018, S. 112ff.). Hierbei werden die ethischen, sicherheitsbezogenen und juristischen Fragestellungen, welche mit dem Einsatz von KI ein- hergehen, betrachtet. Das Management muss im Kontext der KI garantieren, dass die Mitarbeitenden sich nicht durch die KI übergangen fühlen (Daugherty/Wilson 2018, S. 186ff.).

Betrachtet man den Wissensmanagementprozess sind die Bereiche Identifikation, Akquise, Entwicklung, Teilung, Nutzung und Erhaltung von Wissen zu unterscheiden. Erweitert werden diese Bereiche durch die Wissensbewertung und die Festlegung von Wissenszielen (Probst/Romhardt 1998, S. 133). Im Rahmen der Adoption von KI-Innovationen sind alle Bereiche des Wissensmanagements betroffen. Zum einen sind Festlegung von Wissenszielen und Wissensbewertung auf strategischer Ebene relevant, zum anderen sind auf operativer

Ebene die Bereiche von Wissensidentifikation bis zur Wissensspeicherung essenziell. Hierbei wird das Wissen in neuer Art und Weise gespeichert, verarbeitet und verfügbar gemacht. Weiterhin wird bisheriges Wissen, das zuvor oft nur in impliziter Form in den Köpfen der Mitarbeitenden und Unternehmensroutinen verankert ist, in expliziter Form den KI-Systemen zugänglich gemacht (Davenport/Kirby 2016, S. 59ff.). In der Folge kommen der Externalisierung sowie der Internalisierung des Wissens hohe Bedeutung zuteil (Becerra-Fernandez/Sabherwal 2001, S. 23ff.). Dieser Wandel von implizitem und explizitem Wissen ist sowohl bei der Entwicklung und Implementierung als auch im laufenden Betrieb der KI-Systeme wichtig. Vorhandenes Wissen muss in KI-Anwendungen übertragen werden und Mitarbeitende müssen im Umgang mit KI-Anwendungen geschult werden (Daugherty/Wilson 2018, S. 132). Durch diese Wissensvermittlung kann ein KI-System korrekt funktionieren und sinnvoll interpretiert werden.

Die kognitiven Fähigkeiten von Menschen sind begrenzt. Um die hieraus resultierenden Probleme zu umgehen, werden Informationsverarbeitung und Entscheidungsfindung im Unternehmenskontext auf mehreren Schultern in unterschiedlichen Funktionsbereichen verteilt (von Krogh 2018, S. 405). Dies führt zu einer horizontal und vertikal verteilten Informationsstruktur im Unternehmen (Aoki 1986, S. 971ff.). Durch den Einsatz von KI werden Entscheidungen, welche bisher von Mitarbeitenden getroffen wurden, entweder vollständig an die KI übergeben oder in kooperativer Form mit der KI getroffen. Entscheidungen, welche im Umfeld der KI getroffen werden, müssen nicht zwischen verschiedenen Unternehmensbereichen und -einheiten erarbeitet werden (von Krogh 2018, S. 405ff.). Somit können die für eine Entscheidung benötigten Daten direkt am Ort der benötigten Entscheidung ausgewertet werden. Dezentrale Entscheidungsfindung, konsistente Entscheidungen und eine höhere Zuverlässigkeit im Entscheidungsprozess sind die Folge. Somit resultiert eine Veränderung der Verantwortungen und Entscheidungshoheiten im Unternehmen und eine Machtverschiebung (Duchessi et al. 1993, S.152f.; von Krogh 2018, S. 405). Entscheidungen können vollständig von KI übernommen werden oder im Zusammenspiel zwischen KI und Mitarbeitenden getroffen werden.

Hieraus lässt sich folgern, dass die Veränderung in den Entscheidungsprozessen sowie die Veränderung des Wissensmanagements eine Neugestaltung der Machtverhältnisse innerhalb des Unternehmens bewirkt und bisherige Abhängigkeiten gelöst werden. Zum einen werden die bisherigen Machtbefugnisse von Mitarbeitenden beschnitten, zum anderen Mitarbeitenden neue Rechte zugeteilt (Duan et al. 2019, S. 67).

Gemäß Porter (2013, S. 73) verfügen Unternehmen mit der Kostenführerschaft, der Leistungsdifferenzierung und der integrierten Form über drei generische Alternativen ihre Wettbewerbsstrategie auszugestalten. Bei der Abstimmung der Strategie und KI gilt es, KI in die Strategie zu integrieren. Unternehmen können beim Einsatz von KI den Fokus sowohl auf die Kostensenkung setzen als auch durch zusätzliche Leistungen neue Umsätze generieren. KI-Innovationen fokussieren sich häufig auf die Erweiterung bestehen- der Angebote oder der Generierung vollständig neuer Leistungen (Ransbotham et al. 2019, S. 6ff.). In beiden Fällen kann die Leistungsdifferenzierung oder der Kostenführerschaft verfolgt werden. Dies wird durch die Einbettung der KI-Dienstleistungsinnovation in das bisherige Geschäftsmodell bestimmt (Ransbotham et al. 2017, S. 5). Bei der Priorisierung der Leistungsdifferenzierung werden durch den Einsatz von KI die Dienstleistungen von den Wettbewerbern stärker abgegrenzt, bei der Kostenführerschaft werden durch die Nutzung der KI-Einsparungen realisiert (Ransbotham et al. 2019, S. 6ff.). Neben diesen beiden generischen Wettbewerbsstrategien bietet die integrierte Form die Möglichkeit bewusst Schwerpunkte aus beiden Strategieoptionen zu setzten.

Im Kontext der Einführung der KI sind mehrere dieser Erfolgsfaktoren in Kombination entscheidend. Zahlreiche Beispiele verdeutlichen, dass die Kombinationen sich je nach Einsatzfeld und Intensität unterscheiden. Um eine Charakterisierung dieser verschiedenen Potenziale bei Dienstleistungsinnovationen zu realisieren, wird im nächsten Ab- schnitt eine Unterscheidungssystematik für Dienstleistungsinnovationen erarbeitet.

Eingruppierung von Dienstleistungsinnovationen

Dienstleistungsinnovationen stellen einen essenziellen Beitrag bei der Sicherstellung der Wettbewerbsfähigkeit eines Unternehmens dar. So schaffen Dienstleistungsinnovationen durch neue oder verbesserte Dienstleistungsangebote, -prozesse und -geschäftsmodelle einen Mehrwert für Kunden, Mitarbeitender, Geschäftsinhaber und Allianzpartner (Ostrom et al. 2010, S. 5ff.). Menor und Roth (2007, S. 826) definieren Dienstleistungsinnovationen als ein für Kunden neu verfügbares Angebot an Service, welche Veränderungen auf Anbieter- oder Nachfrageseite zur Folge haben.

Neben der Definition nutzt die bisherige Forschung die Charakterisierung von Dienstleistungsinnovationen und gruppiert Typen anhand unterschiedlicher Dimensionen. In ihrem Literaturreview identifizieren Snyder et al. (2016, S. 2404) folgende vier Bereiche:

- Grad der Veränderung (radikal versus inkrementell),
- Art der Veränderung (Service versus Prozess),
- Neuheit (Markt versus Organisation),
- Mittel der Bereitstellung (Technologie versus Organisation).

Insbesondere die gemeinsame Betrachtung des Grads der Veränderung sowie der Art der Veränderung bieten die Möglichkeit einer umfassenden Eingruppierung der durch KI ermöglichte Dienstleistungsinnovationen. Figure 26 stellt die Untergliederung der Dimensionen schematisch dar.

Beim Grad der Veränderung lassen sich radikale und inkrementelle Innovationen unterscheiden. Der Fokus liegt auf Veränderungen in den benutzen Technologien zur Leistungserstellung, den Prozessen, den Kundenwünsche, den Dienstleistungen selbst und den Beziehungen zu Kunden (Snyder et al. 2016, S. 2404). Grundsätzlich umfassen radikale Veränderungen hierbei vollständig neue Angebote. Bei inkrementellen Veränderungen sind Weiterentwicklungen und Verbesserungen bereits bestehender Dienstleistungen anzuführen (Gallouj/Weinstein 1997, 547ff.). Somit unterscheidet sich die Intensität und der Umfang der Neuerungen. Weiterhin ist anzumerken, dass die unternehmens- und branchenspezifischen Faktoren die Intensität beeinflussen (Snyder et al. 2016, S. 2404).

Neben dem Grad der Veränderung wird insbesondere die Art der Veränderung betrachtet. Amara et al. (2009, S. 410f.) unterscheiden die sechs Arten der Veränderung Produkt, Prozess, Lieferung, Strategie, Management und Marketing. Hierbei bezieht sich das Produkt auf die Einführung neuer oder modifizierter Leistungen und der Prozess auf eine veränderte Leistungserstellung. Die anderen vier Kategorien beziehen sich insbesondere auf nicht-technologische Innovationen. Daher werden im Kontext von KI-Dienstleistungsinnovationen lediglich die Arten Produkt und Prozess betrachtet. Dies deckt sich auch mit anderen Arbeiten wie beispielsweise Salunke et al. (2013, S. 1085), die Dienstleistungsinnovationen in interaktive und unterstützende Dienstleistungsinnovationen unterteilen. Interaktive Innovationen beziehen sich hierbei auf das Service-Konzept, welches dem Kunden extern angeboten wird. Unterstützende Innovationen umfassen dagegen den internen Leistungserstellungsprozess.

Hieraus ergibt sich für die weitere Analyse innerhalb der Arbeit eine 2x2 Matrix mit den Achsen Art der Veränderung und Grad der Veränderung (siehe Figure 26). Die Achsen werden in Prozess und Service sowie inkrementell und radikal unterschieden. Die Einteilung in die vier Felder ergibt sich durch unterschiedliche Anforderungen und Charakteristika, die bei der Einführung von neuen Dienstleistungen vom Management berücksichtigt werden.

Künstliche Intelligenz bei Dienstleistungsinnovationen

Die erfolgreiche Implementierung der KI-Dienstleistungsinnovationen hängt vom Umfang, der Intensität und dem Einsatzbereich der KI-Dienstleistungsinnovation ab und bietet unterschiedliche Einsatzpotenziale. Diese können in die in Figure 26 beschriebenen Kategorien eingruppiert werden. Je nach Kategorie werden für eine erfolgreiche Implementierung unterschiedliche Anforderungen an das Unternehmen gestellt.

Die Unterscheidung zwischen radikalen und inkrementellen Innovationen ermöglicht es den Handlungsumfang eines Unternehmens bei der Einführung eines neuen Service zu klassifizieren (Gustafsson et al. 2012, S. 312). Radikale Innovationen umfassen beispielsweise eine tiefgreifende und veränderte Einbeziehung des Kunden (z. B. Chatbots im E-Commerce). Inkrementelle Innovationen ermöglichen eine kleine Veränderung der Services im Vergleich zur vorhergehenden Version (z. B. Veränderung des Suchalgorithmus bei Google).

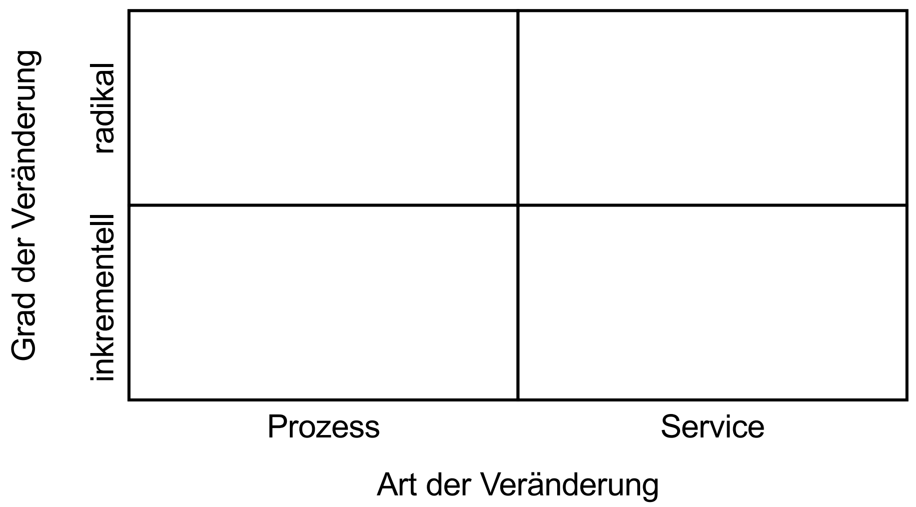


Figure 26 Eingruppierung von KI-Dienstleistungsinnovationen (Quelle: in Anlehnung an Snyder et al. 2016).

Die Unterscheidung zwischen Prozess und Service berücksichtigt hierbei den Einfluss der Innovation auf die Art der Veränderung. So können Dienstleistungsinnovationen die Art des Service verändern (z. B. Echtzeitnavigation bei Waze) oder auch die bisherigen Prozesse im Kontext des Service verändern (z. B. Abrechnungssysteme bei Krankenversicherungen). Diese Unterscheidungen dienen im nachfolgenden Abschnitt zur Klassifikation der Beispiele von KI-Dienstleistungsinnovationen.

Auswahl und Vorstellung der untersuchten Beispiele an KI-Dienstleistungsinnovationen

Nachdem ein Überblick über die Kategorien gegeben wurde, werden die Beispiele von KI-Dienstleistungsinnovationen vorgestellt und den vier Feldern der Matrix zugeordnet. Die Beispiele werden im Hinblick auf Relevanz, Aktualität, Diversität sowie Umfang ausgewählt und nachfolgend in Table 8 vorgestellt. Es werden Beispiele betrachtet, die für Unternehmen relevante Einsatzmöglichkeiten im Dienstleistungskontext verfügen, zwischen 2015 und 2020 in Anwendung gekommen sind und einen signifikanten Einfluss auf das Unternehmensgeschäft haben. Zur Analyse wurde auf Unternehmenswebsites, verfügbare Fallstudien und Zeitschriftenartikel zurückgegriffen.

Im Anschluss werden die Erfolgsfaktoren der KI-Dienstleistungsinnovationen anhand der in Abschnitt „Künstliche Intelligenz im Unternehmenskontext“ beschriebenen Bereiche beurteilt und gruppiert. Beispielsweise ist die Unterstützung bei der Filmproduktion von Netflix eine inkrementelle Veränderung der Prozesse, da die vorhandenen Prozesse im Kontext der Filmerstellung lediglich durch die KI unterstützt werden. Eine vollkommene Veränderung der Filmproduktion findet nicht statt. Die Patientenversorgung von Tempus stellt eine radikale Serviceinnovation dar, da eine neue Stufe an individualisierten Behandlungen für Patienten möglich ist. Diese Leistung kommt dem Patienten direkt zugute. Abschließend werden die Erfolgsfaktoren abstrahiert, um Schlüsse für die Gruppen abzuleiten.

Table 8 Übersicht der betrachteten KI-Dienstleistungsinnovationen.

KI-Dienstleistungsinnovation	Beschreibung	Grad der Veränderung	Art der Veränderung
Suchalgorithmen (Google)	Veränderung der Suchalgorithmen für verbesserte Ergebnisse	inkrementell	Prozess
Personenerkennung (Strafverfolgungsbehörden - Clearview)	Identifikation von Personen bei Behörden	inkrementell	Prozess
Beratung im Unternehmen (Leverton)	Unterstützung bei der Erstellung und Überprüfung von Verträgen	inkrementell	Prozess
Filmproduktion (Netflix)	Unterstützung bei der Auswahl von Plot- und Schauspieler	inkrementell	Prozess
Kundenansprache (Persado)	Entwurf von Marketingvorträgen für Unternehmen	inkrementell	Prozess
Speiseplananpassung (McDonalds)	Automatisierte Anpassung von Speiseplänen an externe Einflussfaktoren	inkrementell	Prozess
Filmempfehlung (Netflix)	Vorschläge basierend auf persönlichen Filmen und Serien-Historie	inkrementell	Service
Kreditkartenbetrug (Mastercard)	Vermeidung von Kreditkartenbetrug in Echtzeit	inkrementell	Service
Predictive Service (Siemens)	Integration von automatisierten Empfehlungen in Beratung und Steuerung	inkrementell	Service
Musikempfehlung (Spotify)	Vorschläge basierend auf persönlicher Streaming-Historie	inkrementell	Service

KI-Dienstleistungsinnovation	Beschreibung	Grad der Veränderung	Art der Veränderung
Kaufempfehlung (Amazon)	Vorschlag von potentiell interessanten Artikeln	inkrementell	Service
Texterstellung (AX Semantics)	Automatisiertes Schreiben von Zeitungstexten, Websites, Produktbeschreibungen	radikal	Prozess
Abrechnungssysteme (Krankenkassen)	Überprüfung der Anträge und Zahlungen durch KI-Unterstützung	radikal	Prozess
Dienstleistungen in der Arzneimittelenwicklung (Berg)	Unterstützung der Arzneimittelentwicklung durch Analyse chemischer Strukturen	radikal	Prozess
Kundenorientierung (Gongos)	Analyse von Kundendaten	radikal	Prozess
Investmentmanagement (Betterment)	Investitionsentscheidungen mit KI	radikal	Service
Patientenversorgung (Tempus)	Individualisierte Behandlung von Krebspatienten	radikal	Service
Analyse in medizinischer Bildgebung (Zebra Medical Vision)	Automatisierte Erkennung von Krankheiten durch CT, MRT usw.	radikal	Service
KI-Plattform (IBM)	Bereitstellung eines KI-Werkzeugkastens	radikal	Service
Navigation (Waze)	Navigation in Echtzeit im Straßenverkehr	radikal	Service
Chatbots im Online-Shopping (Zalando)	Beratung und Hilfe bei Bestellungen	radikal	Service
Unterricht (Mc Graw Hill)	Individualisierter Unterricht für Schüler	radikal	Service

Typen von KI-Dienstleistungsinnovationen

Auswirkungen der Künstlichen Intelligenz auf inkrementelle Prozesse bei KI-Dienstleistungsinnovationen

Bei Innovationen im prozessualen Kontext sind sowohl die direkten als auch die indirekten Prozesse betroffen. Zusätzlich können unternehmensinterne oder unternehmensübergreifende Prozesse durch KI-Innovationen angepasst werden und die bisherige Dienstleistung verändern. Es können sowohl bisherige Prozesse von KI-Systemen übernommen werden als auch bisherige Prozesse inkrementell weiterentwickelt werden.

Zur Realisierung der inkrementellen Prozessinnovationen lassen sich Unternehmen in zwei Typen einteilen. Der erste Unternehmenstyp entwickelt die KI-Systeme eigenständig und integriert die KI-Systeme in die bisherigen Prozesse. Solche meist technologieaffine Unternehmen verfügen bereits über Strukturen und Kompetenzen in der Entwicklung von KI-Anwendungen aus vorherigen Projekten (z. B. Google). Durch den Einsatz von vorhandenem Know-how und IT-Infrastrukturen sind die Kosten für den Aufbau, die Integration und die Anpassung von KI-Kompetenzen vergleichsweise gering. Weiterhin finden sich in dieser Gruppe insbesondere Unternehmen, die bisherige Prozesse schrittweise erweitern und über eine reine Automatisierung bestehender Prozesse hinaus gehen. Der zweite Unternehmenstyp besitzt diese beschriebenen KI-Kompetenzen nicht und bezieht externe Partner in die Entwicklung und Nutzung der KI-Systeme mit ein (z. B. Personenerkennung in der Strafverfolgung greift auf externe Partner wie Clearview zurück). Somit werden in diesem Kontext Routinetätigkeiten automatisiert und von der KI übernommen. Diese unterstützenden Prozesse der Leistungserstellung beziehen sich nicht auf die Kernaktivitäten und Kernkompetenzen des Unternehmens. Somit wird die Weitergabe von kritischem Wissen an externe Partner verhindert. Zusammenfassend kann festgehalten werden, dass keiner der beiden Unternehmenstypen seine bisherigen Unternehmensstrukturen neu ausrichtet oder erweitert. Stattdessen greifen Unternehmen auf vorhandene Strukturen zurück und nutzen diese zur Adoption der KI-Systeme. Dennoch profitieren beide Typen von flexiblen Strukturen.

Betrachtet man das Wissensmanagement, so werden diesem sowohl in der Entwicklung der KI-Innovationen als auch im routinemäßigen Betrieb der Leistungserstellung unterschiedliche Aufgaben zuteil. Während der Entwicklung der KI wird der Wissensfluss zwischen der etablierten IT-Abteilung bzw. dem externen Partner und der

Anwendungsabteilung sichergestellt. Es muss implizites und explizites Wissen zwischen beiden Bereichen ausgetauscht und verknüpft werden (z. B. arbeitet Persado intensiv mit seinen Kunden zusammen, um Marketingkampagnen anzufertigen). Hierbei integrieren die Mitarbeitenden der Serviceerstellung die KI-Anwendungen in die bestehenden Prozesse. Im routinemäßigen Betrieb erlernen die entsprechenden Mitarbeitenden das benötigte Wissen zur Nutzung der KI-Anwendung. Weiterhin wird das Wissen über Kundenanforderungen berücksichtigt und der Austausch mit anderen Abteilungen sichergestellt. Somit spielt neben der Wissensteilung die Wissensentwicklung eine wichtige Rolle.

Betrachtet man die Auswirkungen der Adoption von KI auf die Entscheidungsfindung im Unternehmen wird ersichtlich, dass abhängig von der jeweiligen Anwendung der Umfang der Veränderungen variiert. Die Entscheidungen können entweder vollständig oder teilweise von der KI übernommen werden. Prozesstyp, Umfang der KI und Komplexität der Entscheidungssituationen bestimmen die Veränderungen der Prozesse der Entscheidungsfindung. So können beispielweise Entscheidungen bei einfachen Rechtsfragen vollständig autonom getroffen werden (z. B. Leverton). Häufig werden bei inkrementellen Prozessinnovationen Entscheidungen im Zusammenspiel zwischen Menschen und KI getroffen. Mitarbeitende nutzen ihren reichen Erfahrungsschatz („implizites Wissen“), um mit neu entwickelten KI-Systemen Entscheidungen im Zusammenspiel zu treffen, die Entscheidungen der KI-Systeme zu überwachen, oder nach einer Vorauswahl der Entscheidungsoptionen durch die KI die Entscheidung selbst zu treffen (Plot und Schauspielerauswahl bei Netflix). Durch die gemeinsame Entscheidungsfindung kann flexibel auf wechselnde Anforderungen reagiert werden. Eine Vorauswahl hilft insbesondere bei der Entwicklung der KI-Systeme mit externen Partnern. Hier ermöglicht die Nutzung von externen Leistungen, dass Kernkompetenzen im Unternehmen verankert bleiben und Routineentscheidungen reduziert werden (z. B. Personenerkennung in der Strafverfolgung).

Dem Leadership ist eine moderate Rolle zuteil. Zwar müssen kaum neue Strukturen auf Unternehmensebene geschaffen werden, dennoch sind die Entscheidungsprozesse anzupassen. Zusätzlich sind Mitarbeitende bei den neuen Aufgabenspektren zu unterstützen und der Wissensaustausch zu fördern. Somit liegt der Fokus des Leaderships auf der Sicherstellung der Integration von KI in die etablierten Prozesse unter Berücksichtigung der Sorgen und Wünsche der Mitarbeitenden.

Betrachtet man die strategischen Ausrichtungen der KI-Innovationen geht es insbesondere um die Verfolgung einer Kostenführerschaft. Die Adoption dieser KI-Systeme zielt auf eine Effizienzsteigerung und eine Kostensenkung ab. Ein Verständnis über die Kostentreiber und potenzielle Kapazitätsfreistellungen von Mitarbeitenden sind Ausgangspunkt der Strategien. Wenige Unternehmen integrieren Vorteile bezüglich erhöhter Qualität durch Nutzung großer Datenmengen.

Auswirkungen der Künstlichen Intelligenz auf inkrementelle Services bei KI-Dienstleistungsinnovationen

Inkrementelle Service-Innovationen finden sich vor allem bei etablierten Serviceanbietern, die in einem wettbewerbsintensiven Umfeld aktiv sind. Häufig werden die neuen KI-Services als Ergänzung zu bestehenden Angeboten genutzt und dienen zur Differenzierung der Konkurrenz. Solche Unternehmen verfügen über eine hohe Technologie- und KI-Affinität, verfügen oft über eigene IT-Entwicklungsabteilungen und sind durch eine Vermeidung von Low-Cost Services zu charakterisieren.

Analog zu den inkrementellen Prozessen sind die Auswirkungen auf die Unternehmensstruktur gering. Durch die inkrementellen Veränderungen bleibt der Kern des Service gleich und wird lediglich durch Erweiterungen ergänzt (z. B. Musikempfehlungen bei Spotify). In der Folge bleiben die bisherigen Strukturen im Unternehmen unberührt und die Mitarbeitenden fokussieren sich auf ähnliche Kundengruppen.

Im Kontext des Wissensmanagements liegt der Fokus auf der Wissensverteilung zwischen der internen Entwicklungsabteilung und den für die Serviceerbringung relevanten Teams. Es geht in der Folge um die Verknüpfung von technologischem Wissen und dem Wissen über den Service. Hier zeigt sich, dass die Bereiche Kundenverständnis, Serviceerstellung, Marktsituation, Wettbewerb und Trends relevante Wissensfelder darstellen. Insbesondere bei technologieaffinen Unternehmen, die eine digitale Transformation bereits durchlaufen, stellt die Wissensintegration keine große Herausforderung dar.

Bezüglich der Entscheidungsfindung wird insbesondere die Interaktion mit dem Kunden von der KI übernommen. Häufig übernehmen Unternehmen in einem ersten Schritt die Interaktion des Kunden mit der Serviceabteilung durch die KI. Im zweiten Schritt werden resultierende Entscheidungen anhand zuvor definierter Kriterien durch die KI getroffen. In der Folge werden zuvor individuelle Kundenwünsche durch zusätzliche Services allen

Kundengruppen zugänglich gemacht (z. B. Verhinderung von Kreditkartenbetrug bei Mastercard kann nicht nur auf Nachfrage behoben werden, sondern wird präventiv vermieden). Zusätzlich übernimmt die KI-Entscheidungen der Kundenempfehlung. So nutzen zahlreiche inkrementelle Serviceinnovationen KI, um Kunden den nächsten Service zu empfehlen. Dies ist insbesondere im Kontext von digitalen Abonnements zu fin- den (z. B. Film- und Musikempfehlung bei Netflix und Spotify). Somit erhält der Kunde Empfehlungen über personalisierte Services.

Ähnlich zu der Unternehmensstruktur gibt es nur geringe Anforderungen im Bereich des Leaderships. Durch die häufig projektbezogene Implementierung der inkrementellen Services ergeben sich kaum Veränderungen im Kontext des Unternehmens die eine besondere Fokussierung des Leaderships benötigen. Hauptaufgabe des Leaderships ist die Integration der neuen Leistungen in den Servicekontext sowie die Klärung der sich veränderten Machtstrukturen, die durch die Anpassungen innerhalb der Entscheidungsfindung auftreten.

Die strategische Ausrichtung von Unternehmen bei inkrementellen Serviceinnovationen orientiert sich meist an Differenzierungsstrategien. Es wird versucht sich von den Wettbewerbern durch eine höhere Qualität der Services, Zusatzleistungen, Personalisierung und Individualisierung abzugrenzen. Weiterhin stellt KI eine Möglichkeit dar die Kundenbindung zum Unternehmen zu erhöhen und Follow-Up Services anzubieten. Dies ist wichtig, um die strategischen Ziele der Differenzierung zum Wettbewerb sicherzustellen.

Auswirkungen der Künstlichen Intelligenz auf radikale Prozesse bei KI-Dienstleistungsinnovationen

Radikale Prozessinnovationen bei KI-Dienstleistungen zeichnen sich durch eine hohe Komplexität und tiefgreifende Auswirkungen auf die Prozesse der Serviceerstellung aus. Die Services bleiben bei dieser Art von Innovation gleich. Stattdessen können sich einzelne Prozessschritte ändern, neue Prozesse hinzukommen oder die vollständige Prozessstruktur neu ausgestaltet werden. Häufig handelt es sich um etablierte Unternehmen außerhalb der Tech-Branche, die gemeinsam mit Partnern die Entwicklung und Implementierung vornehmen. Anders als bei den inkrementellen Innovationen, werden insbesondere die Kernaktivitäten und -prozesse des Unternehmens verändert und mit KI-Dienstleistungsinnovationen angereichert.

Aufgrund der tiefgreifenden Auswirkungen verfügen diese KI-Dienstleistungsinnovationen über einen großen Einfluss auf die Unternehmensstruktur. Innerhalb der Entwicklung erfolgt eine enge Zusammenarbeit mit externen Partnern und Start-ups. Zusätzlich werden häufig eigene neue Bereiche aufgebaut, die insbesondere bei der Serviceerstellung die bisherigen Teams unterstützen (z. B. Abrechnung bei Krankenkassen). Diese neuen Teams können aus dem bisherigen Bereich der Serviceerstellung entstehen oder neu aufgebaut werden. Wichtig ist in beiden Fällen die Integration in die bestehenden Strukturen und die Zuweisung der neuen Verantwortungen. Zum Teil existieren durch die KI-Innovationen die bisherigen und neuen Prozesse parallel nebeneinander und fokussieren sich auf unterschiedliche Kundengruppen. Die automatisierte Berichterstattung von Sportereignissen existiert beispielsweise neben dem klassischen Sportjournalismus und ermöglicht eine Fokussierung auf den Amateursport und die entsprechenden Kundengruppen.

Betrachtet man das Wissensmanagement, baut dieses auf den zuvor beschriebenen Erkenntnissen bei inkrementellen Prozessinnovationen auf. Neben dem Austausch und der Verknüpfung von Wissen der IT- und Service-Abteilungen kommt in diesem Kontext dem fachbezogenen Wissen eine essenzielle Rolle zu. Dieses wird für den funktionsfähigen Ablauf der Prozesse benötigt. Somit wird die Wissenskombination unterschiedlicher Wissensfelder verknüpft. Alle Wissensfelder werden sowohl im Innovationsprozess als auch bei der Serviceerstellung benötigt. Im Rahmen der Entwicklung und Implementierung muss implizites Wissen aus den einzelnen Feldern in explizites Wissen umgewandelt werden und den anderen Bereichen zur Verfügung gestellt werden. Erst durch die so mögliche Kombination können die Serviceprozesse realisiert werden. Somit kommen in Unternehmen den Aspekten der Übersetzung, Vermittlung und Verknüpfung des Wissens entscheidende Rollen zu.

Durch den großen Einfluss der KI-Innovationen kommt es zu einer notwendigen Verschiebung der Entscheidungen und Aufgabenverantwortungen. Je nach Ausgestaltung, Flexibilität und Komplexität der Prozesse kommt es zu einer Kontrolle der Entscheidung oder einer Vorauswahl durch die KI und die finale Entscheidung wird von einem Mitarbeitenden getroffen. Grundsätzlich wird in allen Fällen versucht sowohl automatisierbare Schritte als auch Routineentscheidungen von KI ausführen zu lassen und lediglich in komplexen Sachverhalten Experten in den Entscheidungsprozess einzubeziehen. Dies ist insbesondere bei neuartigen und eigenständigen Prozessen der Fall, die die Kernaktivitäten der Serviceerstellung betreffen (z. B. Arzneimittelentwicklung bei Berg).

In Folge der einschneidenden Einwirkungen auf Unternehmensstruktur, Wissensmanagement und Entscheidungsfindung bedarf es einer besonderen Betrachtung des Leaderships. Das Top Management wird in drei Bereichen tätig. Erstens werden im entsprechenden Unternehmensbereich eine passende Vision und adäquate Rahmenbedingung geschaffen. In diesem Zusammenhang kann es insbesondere bei etablierten und bisher nicht digitalen Unternehmen zu einem Wandel innerhalb der Unternehmenskultur kommen. Durch eine klare Kommunikation des Projektziels bei der KI-Einführung, dem Kulturwandel zum digitalen Unternehmen und der dabei notwendigen Bereitschaft mit digitalen Technologien zu interagieren findet die Implementierung erfolgreich statt. Zweitens stellt das Top Management notwendige Ressourcen bereit. Durch den tiefgreifenden Einfluss und die Entwicklung des Unternehmens werden bei der Einführung radikaler Prozesse mehr Ressourcen benötigt. Drittens werden die Mitarbeitende auf diesem Weg begleitet und beim Erlernen sowie der Ausführung der neuen Aufgabentätigkeiten unterstützt. Somit nimmt das Leadership eine Schlüsselposition ein.

Betrachtet man die strategische Ausrichtung der Unternehmen fällt auf, dass eine grundsätzliche Tendenz wie bei den inkrementellen Innovationen nicht sichtbar ist. Stattdessen sind die strategischen Schwerpunkte abhängig von den individuellen Anwendungsfällen. So fokussieren sich einige Unternehmen auf eine höhere Geschwindigkeit, andere auf die Verbesserung der Effizienz sowie der Qualität und dritte auf die Generierung von neuen, bisher nicht dagewesenen Leistungen für andere Kundengruppen. Insbesondere die Fokussierung auf neue Kundengruppen und eine damit einhergehende Neuinterpretation klassischer Services stellt einen Unterschied zu den inkrementellen Innovationen dar. Als Beispiel für eine solche Neuinterpretation dient beispielsweise die Berichterstattung im Amateursport durch den Journalismus.

Auswirkungen der Künstlichen Intelligenz auf radikale Services bei KI-Dienstleistungsinnovationen

Radikale Serviceinnovationen beinhalten die Erstellung von vollständig neuen Leistungen, die dem Unternehmen neue Geschäftsfelder erschließen und sich an den bisherigen Services orientieren. Es handelt sich hierbei um eine Anpassung der bisherigen

Services, einer Erweiterung der Services oder einer Neugestaltung der Services, die sich der jeweiligen Unternehmenssituation entsprechend in das bisherige Leistungsportfolio eingliedern (Cavalcante et al. 2011, S. 1330). Zum einen lassen sich Unternehmen identifizieren, welche bisher insbesondere in der Entwicklung von KI über Erfahrung verfügen und nun neue Services erschließen (z. B. IBM Watson). Zum anderen finden sich auch Firmen, die bisher keinen Kontakt zu KI-Innovationen hatten und diese Technologie als Möglichkeit ihre bisherigen Services zu erweitern identifiziert haben (z. B. Patientenversorgung bei Tempus).

Betrachtet man die Auswirkungen auf die Unternehmensstruktur, ähneln diese den Anpassungen der radikalen Prozessinnovationen. Zusätzlich kommt hier der Kundenintegration eine große Bedeutung zu. Für die erfolgreiche Implementierung und Nutzung sind die Kunden bei vielen der radikalen Services erfolgsentscheidend. So werden beispielsweise Nutzer direkt in die Interaktion mit der KI-Innovation integriert (z. B. Unterricht bei Mc Graw Hill) oder Informationen einzelner Nutzer für die Optimierung der Gesamtleistung eingesetzt (z. B. Navigation bei Waze). Folglich wird in den Unternehmensstrukturen die Möglichkeit zur Interaktion mit und die Integration von diesen Kun- den gegeben.

Das erfolgreiche Wissensmanagement ist bei dieser Art von Innovationen erfolgsentscheidend. Unternehmen integrieren die Wissensblöcke des Service, der KI, der Kunden sowie des allgemeinen Marktumfelds in die Implementierung und die Erbringung der Dienstleistungen. Das relevante Wissen wird identifiziert, unter den verschiedenen Akteuren geteilt, kombiniert, weiterentwickelt und schließlich in neuem Kontext angewendet. Arbeiten Unternehmen mit externen Partnern zusammen, wird deren Wissen ebenfalls integriert. In allen Schritten wird implizites Wissen in explizites Wissen gewandelt und durch die Nutzung und Anwendung in diesem Kreislauf wieder zu implizitem Wissen (vgl. Patientenversorgung bei Berg). Insbesondere die Koordination des Wissens zwischen Fachabteilungen und Kunden sowie die Einbindung des neu generierten Wissens in die bestehende Wissensstruktur ist essenziell. Hierbei ist ein tiefgreifendes Verständnis über das Servicespektrum wichtig (z. B. Navigation bei Waze).

Betrachtet man den Umfang bezüglich der Entscheidungsfindung fällt auf, dass es zwei Typen von Innovationen gibt. Zum einen dienen Innovationen der Problemlösungen (z. B. Unterricht bei Mc Graw Hill), zum anderen der Entscheidungsfindung (z. B. individuelle

Patientenbehandlung bei Tempus). Dies ist abhängig von der jeweiligen Ausgestaltung und Einordnung der Innovation. In beiden Fällen sind die jeweiligen Auswirkungen in den entsprechenden Bereichen hoch. Daher muss hier abhängig von der jeweiligen Innovation der Fokus auf die Folgen der Entscheidungsverschiebung und der Problemlösung erfolgen. Durch die umfassenden Auswirkungen der veränderten Entscheidungsfindungen gilt es insbesondere auf die Bereiche Flexibilität, Verantwortlichkeiten, Zuverlässigkeit und Bias-Vermeidung zu achten (z. B. bei Zebra Medical Vision und Tempus im Kontext der Patientenbehandlung).

Die Anforderungen an das Leadership entsprechen den drei Anforderungen an das Leadership der radikalen Prozessinnovationen. Somit steht eine klare Vision, die Bereitstellung der benötigten Ressourcen und die Weiterentwicklung der Mitarbeitende im Fokus.

Betrachtet man die Auswirkungen auf die Strategie des Unternehmens erkennt man, dass Unternehmen sowohl die klassischen Wettbewerbsstrategien verfolgen als auch die strategische Ausrichtung des Unternehmens anpassen. So fokussieren sich zahlreiche Unternehmen, insbesondere bei der Zusammenarbeit mit Partnern auf den Aufbau eines Ecosystems. Bei der individuellen Patientenversorgung erkennt man, dass es zur Entstehung eines solchen kommt. Hier arbeiten Anbieter für die KI-Services mit Ärzten unterschiedlicher medizinischer Disziplinen, Arzneimittelherstellern und Medizintechnikunternehmen zusammen. Somit bekommt neben der unternehmensweiten Ausrichtung die Zusammenarbeit zwischen den Partnern eine wettbewerbsrelevante Rolle.

Erfolgsfaktoren und Auswirkungen

Die Aggregation der Erkenntnisse der einzelnen Blöcke zeigt die unterschiedliche Bedeutung der Bereiche für die Implementierung. Figure 27 fasst die Anforderungen von KI-Serviceinnovationen an die Unternehmen zusammen. Anschließend stellt Table 9 den Umfang der Auswirkungen dar. Wird KI als inkrementelle Prozessinnovation eingesetzt, greifen technologiestarke Unternehmen auf interne Partner und deren Know-how zurück (z. B. Filmproduktion bei Netflix), andere Unternehmen setzen auf externe Partnerschaften (z. B. Personenerkennung bei Strafverfolgung). Veränderungen inner- halb der Unternehmensstruktur existieren kaum, da KI-Dienstleistungsinnovationen häufig in bestehende Strukturen eingegliedert werden. Somit steht die Wissensnutzung und -teilung im Vordergrund und wird häufig gefördert. Meist setzten diese inkrementellen Innovationen bei der Übernahme von internen Prozessentscheidungen an. Es gilt Mitarbeitende bezüglich der

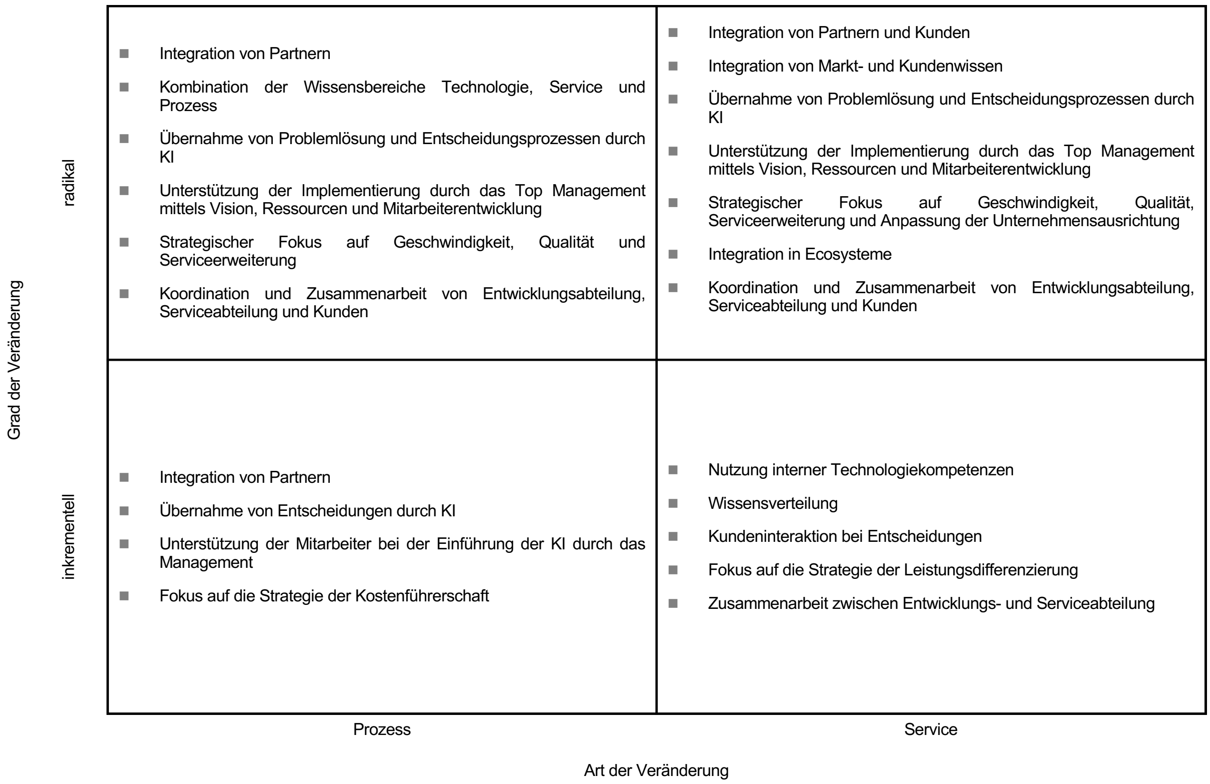


Figure 27 Zusammenfassung der Erfolgsfaktoren (eigene Darstellung).

Table 9 Handlungsfelder und deren Intensität bei der Adoption von KI-Serviceinnovationen (eigene Darstellung).

	Inkrementelle Prozess-innovation	Inkrementelle Service-innovation	Radikale Prozess-innovation	Radikale Service-innovation
Einfluss auf Unternehmensstruktur	gering	gering	moderat	moderat
Einfluss des Wissensmanagements	moderat	hoch	hoch	hoch
Auswirkung auf Entscheidungsfindung	moderat	moderat	hoch	moderat
Auswirkungen des Leaderships	moderat	gering	moderat	hoch
Auswirkungen der Strategie	moderat	hoch	hoch	hoch

KI zu schulen und die neuen Macht- und Verantwortungsverhältnisse, die sich aus der Entscheidungsübernahme durch die KI ergeben, klar festzuhalten. Durch die Fokussierung auf die internen Prozesse stehen die Aspekte der Kostensenkung und Effizienzsteigerung im Fokus. Eine Weiterentwicklung der Serviceangebote selbst findet nicht statt.

Bei inkrementellen Serviceinnovationen fokussieren sich Unternehmen auf die Zusammenarbeit mit internen Partnern (z. B. Kaufempfehlung bei Amazon). Diese verfügen über Know-how in den Bereichen Digitalisierung und KI. Veränderungen in der Unternehmensstruktur sind kaum nötig, da flexible Projektteams die Weitergabe des Wissens zwischen der Entwicklungsabteilung und den Servicebereichen ermöglichen. Somit ist der Aufwand des Leaderships überschaubar. Viele inkrementelle Services fokussieren sich auf die Entscheidungen an der Schnittstelle Unternehmen und Kunde. Dies wird durch die Fokussierung auf eine Strategie der Differenzierung von Wettbewerbern ergänzt. Insbesondere die Nutzung von eigenen Ressourcen und bereits vorhandenem Know-how im Bereich der KI hilft diesen Unternehmen bei der Realisierung der KI- Innovationen.

Unternehmen die Serviceinnovationen bei radikalen Prozessänderungen einsetzten zeichnen sich durch eine hohe Zusammenarbeit und Interaktion zwischen internen Akteuren und externen Partnern aus (z. B. Abrechnungssysteme bei Krankenkassen). Externe Partner werden in die eigenen Prozesse integriert, was eine Anpassung der Unternehmensstruktur zur Folge hat. Somit kann intern vorhandenes Wissen aus dem Bereich der Serviceerstellung mit externem Wissen über KI verknüpft werden. Diese Wissensverknüpfung ist der Ausgangspunkt für die Implementierung.

Radikale Prozessinnovationen zeichnen sich durch eine Verschiebung von Entscheidungs- und Aufgabenverantwortung aus. Dieser Wandel wird durch das Top Management sowohl auf operativer Ebene als auch auf strategischer Ebene unterstützt. Häufig versuchen Unternehmen durch die Implementierung die Qualität der Services zu verbessern oder vorhandene Services zu erweitern. Somit kann festgehalten werden, dass insbesondere die Kombination aus internem Servicewissen und externem KI-Know-how für die erfolgreiche Implementierung wichtig sind.

Für Unternehmen die radikale Serviceänderungen einsetzten, werden neben der Zusammenarbeit und Interaktion zwischen Unternehmensakteuren und externen Partnern die Integration der Kunden relevant (z. B. Navigation mittels Waze). Weiterhin ist für die erfolgreiche Implementierung die Integration des Wissens über Kunden- und Marktumfeld wichtig. Dies trifft insbesondere im Kontext der Entwicklung von Services, die in Kombination mit Partnern und anderen Akteuren erstellt werden, zu. Hierbei werden durch die KI sowohl Probleme gelöst als auch Entscheidungen durch die KI getroffen. Dementsprechend müssen Prozessstrukturen angepasst werden und Mitarbeitende bei den veränderten Verantwortungen begleitet werden. Somit bleibt festzustellen, dass die Komplexität bei radikalen Serviceinnovationen stark ausgeprägt ist und dass das Zusammenspiel der einzelnen Erfolgsfaktoren entscheidend ist.

Fazit

Im Rahmen dieser Arbeit werden Anforderungen und Erfolgsfaktoren anhand der Unterscheidungen radikal – inkrementell und Prozess – Service in vier Blöcken erarbeitet. Diese unterscheiden sich hinsichtlich der Anforderungen und Erfolgsfaktoren in der Ausgestaltung und Intensität. Durch die Fokussierung auf implementierte KI-Dienstleistungsinnovationen werden die einzelnen Blöcke charakterisiert und beschrieben. Hieraus ergibt sich ein Leitfaden für KI-Dienstleistungsinnovationen, der sowohl Handlungsfelder als auch Umfang und Intensität beinhaltet. Es wird deutlich, dass Einfluss und Ausgestaltung der Erfolgsfaktoren abhängig vom Einsatzbereich stark variieren.

Die aus Praxisbeispielen abgeleiteten Anforderungen und Erfolgsfaktoren dienen Unternehmen bei der Adoption und Implementierung von KI-Dienstleistungsinnovationen als Orientierung und Leitfaden. Zusätzlich wird eine strukturierte Übersicht über unternehmerische Aktivitäten im Kontext von KI-Innovationen gegeben.

Die hier dargelegten Erkenntnisse können in der zukünftigen Forschung aufgegriffen werden. Insbesondere die einzelnen Aktivitäten können im Rahmen von Fallstudien eingehend betrachtet werden. So bietet sich beispielsweise die strategische Ausrichtung des Unternehmens im Kontext der KI-Dienstleistungsinnovationen als Untersuchungsobjekt an. Weiterhin sind die Mechanismen innerhalb der Veränderungen bei der Entscheidungsfindung hervorzuheben. In den Beispielen wurde die Nutzung von KI als Entscheidungsinstanz sichtbar und stellt Unternehmen hierbei zum einen vor neue Herausforderungen, bietet zum anderen aber auch Chancen.

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2. Publication 2: Organizational Adoption of Big Data Technologies: A Configurational Analysis of Affordances, Constraints, and Strategic Fit

2.1. Notes on submitted Paper

The paper "Organizational Adoption of Big Data Technologies: A Configurational Analysis of Affordances, Constraints, and Strategic Fit" was co-authored by my dissertation supervisor Prof. Dr. Alexander Fliaster and myself. The paper was accepted for presentation at the 36th European Group for Organizational Studies (EGOS) Colloquium in Hamburg, Germany in 2020 after a double-blind peer-review process. In addition, a previous conceptual version of the paper was presented at the International QCA Paper Development Workshop 2018 in Zurich, Switzerland. The paper is submitted to a B- journal in business administration (VHB: B, VHB Publication Media Rating 2024).

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2.2. Academic Paper

Abstract

Past research used the theoretical TOE framework to address technological, organizational, and environmental antecedents of firms' adoption of digital technologies. However, these TOE dimensions have been mostly explored in an isolated manner as scholars strived to identify net effects of individual adoption predictors. Contrary to this approach of correlational theorizing, we advocate the configurational logic of conjunctural causation arguing that TOE dimensions affect technology adoption by interacting with one another. We enrich the TOE framework by building on two theories that aid in shedding light on these interactions – the technology affordances and constraints theory (TACT) and the strategic fit theory. We collect an original data set of 63 German industrial companies that adopt big data analytics (BDA) and analyze these data by use of the fsQCA methodology. Our analysis shows that it is the conjunction between TOE dimensions that explains organizational BDA adoption, and that these explanatory factors build three equifinal configurations, which lead to adoption. We discuss the contributions of our research findings to the literature and suggest avenues for further studies as well as implications for managerial practice.

Keywords: technology adoption, strategic fit, digital innovation, big data analytics, fsQCA

Introduction

In today's dynamic business environment, digital technologies gain crucial importance for organizational success (Cefis et al., 2023; Nambisan et al., 2017). Digital technologies are general-purpose technologies, which encompass devices such as sensors, software such as big data analytics (BDA) and artificial intelligence, as well as infrastructure such as transmission systems that allow the interactions between the individual technologies (Autio et al., 2018; Zammuto et al., 2007). In the last decades, innovative digital technologies have transformed several products, services, and value creation processes and pushed the development of new business models in various industries (Björkdahl, 2020; Dremel et al., 2020; Wiener et al., 2020).

Given their wide-ranging business outcomes, the research question of which factors drive organizational adoption of innovative technologies is of crucial importance (Kaur Kapoor et al., 2014; Oliveira et al., 2019; Zhu et al., 2006). In general, adoption refers to “a decision to make full use of an innovation as the best course of action available” (Rogers, 2003: 177). Within this research area, at least two large streams can be identified. On the one hand, several studies draw on the seminal Diffusion of Innovation Theory (DOI) (Rogers, 1962, 2003) and the Technology Acceptance Model (TAM) (Davis, 1989; Venkatesh & Davis, 2000) and focus especially on the impact of various attributes of technology on organizational adoption decision (e.g., Gangwar et al., 2014). On the other hand, scholars recognize that the adoption is a complex phenomenon that is influenced by multiple factors that extend beyond the technological attributes. Hence, more holistic theoretical concepts, foremost the Technology-Organization-Environment (TOE) framework (Tornatzky & Fleischer, 1990; DePietro et al., 1990) have been suggested. Within the TOE framework, adoption of an innovative technology is seen in its context, as being affected not only by technological features but also by contingency variables, i.e. organizational and external determinants (see for an overview van Oorschot et al., 2018).

While the generic TOE framework has proven to be helpful in providing a multidimensional and hence, more comprehensive perspective on digital technology adoption at the organizational level (Gangwar et al., 2014), previous research is characterized by several shortcomings. These shortcomings are related to both the individual components of the TOE framework as well as the interplay among them (e.g., Sun et al., 2024). In this study, to enhance understanding of digital technology adoption, we theoretically and empirically address especially the following three issues.

First, regarding the technology component, previous adoption studies within the TOE stream have been mainly focused on technology attributes that were consistent with the classic DOI theory (Rogers, 1962, 2003), such as relative advantage and complexity (e.g., Wang et al., 2010; Gangwar et al., 2014). However, current research on new digital technologies theorizes that those technologies are characterized by a number of unique features, in particular, the flexible affordances (Yoo et al., 2012; Nambisan et al., 2017). Originally introduced by Gibson (1979) in the area of ecological psychology (e.g., Jones, 2003), the affordance concept emphasizes that the applicability and value of technologies essentially depend on particular users and their context (Nambisan et al., 2019). In other words, the concept of affordances represents “relationality of technology in practice” (Faraj & Azad, 2012:

249) as it postulates that for adopters with different characteristics and purposes technology affordance would refer to different action potentials (Majchrzak & Markus, 2013).

This notion of affordances leads to a substantial shift in the focus of analysis: It is not "what features digital tools or artifacts possess, but how actors' goals and capabilities can be related to the inherent potential offered by the features" (Nambisan et al., 2017, p. 230). Thus, from the theoretical perspective, we argue that adoption of digital technologies is particularly affected by affordances they provide for particular adopters. Subsequently, we advocate that relational theories, especially the TACT (Technology Affordances and Constraints Theory) that address flexible affordances and focus on the fit between technology and adopter (Majchrzak & Markus, 2013), can contribute to a better understanding of adoption of novel digital technologies in business organizations, In doing so, we build on the argument that considering the use of digital technology as sets of affordances and constraints for particular actors "helps explain how and why the 'same' technology can be repurposed by different actors or has different … outcomes in different contexts" (Nambisan et al., 2017: 227).

Second, we extend this notion of relationality of adopted technology applying it to both intra- and extra-organizational (i.e., environmental) dimensions of the TOE framework. In doing so, we theorize that adoption studies can essentially profit from the consideration of the theory of strategic fit. While previous works addressed manifold facets related to the organizational usage of digital technologies (e.g., Gangwar et al., 2014), the strategic role technology plays within the adoption context is still underexplored. This shortcoming is striking as strategic fit is "a key concept in strategy" (Bettis & Blettner, 2020: 9) and "a cornerstone of strategy and organization research" (Carmeli et al, 2010: 347). This concept has been used by both organization theorists and strategic management scholars as a key predictor of firm's economic performance, indicating that performance is high when organizational response variables match external business environment variables (Volberda et al., 2012), especially the competitive environment. Moreover, according to the strategic fit approach, for a strategy to be successful, it must be consistent not only with the firm's external environment, but also with its internal features, e.g., organizational structure, systems, and technological resources and capabilities (Grant, 2018). Scholars have long theorized that strategy can interact with technology in different ways (Itami & Numagami, 1992). Despite its importance, however, the interplay between strategy and adoption of technology, in particular the digital one, is underexplored yet, and existing adoption research has been already criticized for lacking the strategic perspective (van Oorschot et al, 2018). Consequently, we argue that the company's strategy should be considered in the analysis of technology adoption, as it guides the selection of technologies to be adopted and how these technologies are used to support the business objectives (e.g., Itami & Numagami 1992).

Third, we advocate that for a better understanding of digital technology adoption, not only the individual TOE framework components under-investigated in previous studies, e.g., competitive strategy and flexible affordances, but also the interplay between those components must be addressed. In our study, this argument refers to both – the approach to theorizing and the methodology of empirical research. In the past, two research streams we draw on in present paper – adoption and strategy research – have been essentially dominated by the 'net effects thinking' (Ragin, 2008) and 'correlational theorizing' (Delbridge & Fiss, 2013) neglecting multiple causations and frequently assuming linear relationships between dependent and independent variables. For adoption research it means that mainly the isolated impacts of diverse variables within the three TOE pillars have been studied (see for an overview regarding digital technology adoption, for instance, Gangwar et al., 2014). However, current works revealed that the impacts of those elements differ substantially across previous empirical studies and the available findings are inconsistent and controversial (Sun et al., 2024). For instance, technological (e.g., complexity), organizational (e.g., firm size), and environmental conditions (e.g., competitive pressure) have been found to show both significant and insignificant influences in different works (Gangwar et al., 2014; Huang et al., 2008; Kuan & Chau, 2001; Ramdani et al., 2009; Zhu et al., 2006). Due to these inconsistencies scholars currently began to criticize technology adoption research for "an oversimplified interpretation of TOE by neglecting the interdependencies among the three elements" (Sun et al., 2024: 6; italics in original text). We argue that theoretical arguments mentioned above, e.g., the relational concept of affordance that establishes an explicit link between technology features and the user's strategy and context will help resolve this shortcoming. This contribution is important as the number of studies that interpret TOE as a configuration of interdependent adoption factors is very limited yet (Sun et al., 2024).

In a similar vein, scholars currently criticize that strategic management is dominated by linear statistical models (Bettis & Blettner, 2020). However, for concepts such as strategic fit that are “inherently complex, and thus not a sum of linear additive effects” (Bettis & Blettner, 2020: 9), approaches other than linear correlational relationships promise to deliver deeper insights and explanations (Delbridge & Fiss, 2013). Past works have already proposed fruitful alternatives to linear models for research on strategic fit. For instance, Venkataraman (1989) suggested the concept of “fit as gestalts” which “is defined in terms of the degree of internal coherence among a set of theoretical attributes” (Venkataraman, 1989: 432). Venkataraman (1989: 432) advocated that such sets, or archetypes, “could provide useful insights into a powerful concept of equifinality or the feasible sets of internally consistent and equally effective configurations”.

Drawing on these ideas, we argue that approaches others than the correlational theorizing and standard regression methods need to be used to adequately consider both relational tenets – the technology relationality and strategic fit. More specifically, we advocate that the neo-configurational approach of fuzzy-set Qualitative Comparative Analysis (fsQCA), which transcends traditional linear models and is built on the notions of conjunction and equifinality (Ragin, 2008; Furnari et al., 2021; Misangyi et al., 2017), is particularly suitable to capture the complex and configurational nature of relationships among conditions of organizational digital technology adoption.

Based on these arguments, our research question can be specified as follows: How do the configurations of key dimensions of strategic fit and the digital technology affordances and constraints contribute to the adoption of digital innovations in organizations? To address this question, the remainder of this paper is structured as follows. We first briefly outline the generic TOE construct und discuss two pillars of our research framework – the TACT and the strategic fit theory. We then integrate these concepts with set-theoretic arguments that underly the fsQCA methodology and build the configurational research framework of organizational digital technology adoption. Third, we deploy this framework empirically to explore the adoption of one of the most powerful digital technologies – the big data analytics (BDA). In doing so, we describe data collection and fsQCA methodology, and discuss the empirical findings. Finally, we delineate theoretical and practical implications of our study, depict its limitations and suggest directions for further research on digital technology adoption.

In sum, our configurational theoretical framework and empirical study augment previous literature in three ways. First, we enrich the TOE framework by deploying two theories that have been underused in previous technology adoption research – the TACT and the strategic fit theory. In doing so, we enhance technology adoption literature by theoretically identifying important factors that impact adoption at the organizational level. Second, we extend adoption research by empirically testing this theoretical framework. Our findings reveal that these theoretically grounded factors operate not in an isolated manner but interact in accordance with the logic of conjunctural causality and build three equifinal configurations that lead to technology adoption. By examining these configurations, our study also contributes to the underdeveloped neo-configurational perspective on organizational technology adoption, as it sheds light on its causal complexity. Finally, by collecting empirical data on the adoption of BDA that represents one of the most powerful modern digital technologies, current study also enriches understanding of digitalization in business organizations.

Theoretical Background

Technology Adoption through the Lens of the TOE Framework

The TOE framework (DePietro et al., 1990) has proven itself as one of the most prominent concepts to systematize antecedents of firms' adoption of technology (Sun et al., 2024; Wisdom et al., 2014). Concerning the technological dimension, especially the attributes of innovation suggested in the DOI theory by Rogers (2003), e.g., relative advantage, compatibility, and observability have attracted substantial scholarly interest (Oliveira & Martins, 2011; Hameed et al., 2012; Kaur Kapoor et al., 2014). The organizational dimension refers to firm’s resources and characteristics. While DePietro et al. (1990) first emphasized the size and slack of the company, more recent studies also examined the impact of top management support, the attitude of managers towards innovation, and technology competence, among others (Damanpour & Schneider, 2006; Wang et al., 2010; Hameed et al., 2012). Concerning the environmental dimension, DePietro et al. (1990) described the impact of competitive pressure and innovation support infrastructure. Further studies revealed, for instance, that adoption is also shaped by such external factors as competition and governmental regulations (Zhu et al., 2006).

In sum, as TOE framework covers three key categories of adoption factors, it goes beyond the more simplistic consideration of merely technological attributes. What's more, Zhu and Kraemer (2005) pointed out that TOE can be adapted in many ways because of its generic nature. In particular, scholars assumed that for different technological innovations, different factors within the TOE framework might be relevant as antecedents of adoption (Zhu et al., 2006). As previous works used different individual factors within the three core TOE dimensions (Oliveira et al., 2019), in the most current study, Sun et al. (2024) drove attention to two critical aspects associated with this variety of TOE interpretations: First, as "research into TOE has sought to derive contextualized factors to reflect each of the three elements … the impacts of the three TOE elements differ substantially across studies" (Sun et al., 2024: 5-6). Summarizing past research, Gangwar et al. (2014) also demonstrated several inconsistent and controversial empirical findings related to the impact of individual TOE variables on the adoption of various digital technologies.

The second (and interrelated) issue associated with the use of the TOE framework lies in "neglecting the interdependencies" among its three dimensions (Sun et al., 2024: 6) as past empirical works predominantly conducted correlational analysis over-emphasizing the independent net-effects of individual TOE variables. Hence, three conclusions can be made for further development of the theoretical framework of our study: (1) TOE provides a useful general pattern to systematize possible adoption antecedents; (2) to be useful, these antecedents need to reflect the particularities of digital technologies; and (3) the possible interdependencies among the TOE dimensions have to be explicitly addressed.

Technology Adoption through the Lens of TACT and FIT Theory

TACT framework: Technology affordances and constraints

From the theoretical perspective, we argue that adoption of digital technologies, such as BDA, is particularly affected by flexible affordances they provide. The notion of affordances has been first suggested by Gibson (1979) in the context of ecological psychology research to explore the behavior of actors (e.g., animals or people) that make use of material objects, and has been adapted since in social sciences, for instance, sociology (Jones, 2003; Hutchby, 2001). In the last decade, the concept of affordances has been increasingly used both theoretically and empirically to address the relationship between information systems and their users (e.g., Faraj & Azad, 2012; Dremel et al., 2020; Leonardi, 2013). While the concept of affordance has become “the predominant way to theorize about the action possibilities provided by the material features of information technology” (Lehrer et al., 2018: 430), in the information systems research it has been mainly used at the individual level, and scholars currently call for further development of this concept also at organizational level, that is, in support of specific organizational goals (Dremel et al., 2020).

More specifically, this notion has been elaborated by technology affordances and constraints theory (TACT). Within this theory, the concept of technology affordance refers to “what an … organization with a particular purpose can do with a technology or information system”, while “technology constraint refers to ways in which an … organization can be held back from accomplishing a particular goal when using a technology or system” (Majchrzak & Markus, 2013: 832). We argue that these key tenets of TACT are conducive to a better understanding of technology adoption by business organizations which operate in a particular competitive context, deploying specific competitive strategies and being embedded into collaborative arrangements within ecosystems. In applying TACT, we refer to the calls made, for instance, by Majchrzak & Markus (2013: 832) who advocate that “TACT can be used to study … the patterns of similarity and difference in technology uses and consequences across … organizations”. Moreover, scholars argued that for TACT to create testable hypotheses about organizational behavior, “the concepts of affordance and constraint should be concretely examined for particular categories of technologies and use settings” (Majchrzak & Markus, 2013: 834). Following this line of reasoning, we apply the TACT lens to explore the organizational adoption of novel digital technologies, particularly the big data analytics.

Technology affordances and Internal strategic fit

The importance of fit is seen in the literature as “one of strategy’s most longstanding notions” (Porter & Siggelkow, 2008: 34; footnote omitted). Strategic fit is particularly crucial to a firm's ability to change and adapt to unforeseen contingencies, such as new technological developments (Ansari et al., 2010). Previous works explored different dimensions of strategic fit (Bettis & Blettner, 2020; Porter & Siggelkow, 2008) and revealed that, by and large, firms seek ways to develop both internal and external strategic fit (Ansari et al., 2010).

Applying this notion to adoption of a novel digital technology within a company, we start with the internal fit between the technology and the company’s strategy. In general terms, we define fit between adopted technology and the adopting organization as the degree to which the characteristics of this technology are consistent with the strategic objectives and activities of the adopting organization (e.g., Ansari et al., 2010). Previous works theorized that technology and strategy might interact in at least two mutually reinforcing ways. On the one hand, companies utilize the technology as a tool, a competitive weapon to create advantages over competitors; by doing so, companies strive to maintain the internal fit as a match between strategy the firm pursues and the technology it uses (Itami & Numagami, 1992). On the other hand, scholars argue that when the firm has a commitment to a particular technology, this technology drives cognition of a particular strategy because it activates and channels idea generation process for strategy formation (Itami & Numagami, 1992).

Within this context, strategy refers to an integrated concept of how the company wants to achieve its objectives (Hambrick & Fredrickson, 2005: 53). More specifically, competitive strategy describes "the way a firm decides to position itself in the markets in which it competes vis-à-vis the value propositions of its rivals" (Zollo et al., 2018, p. 1754). The concept of generic competitive strategies has been introduced by Porter (1980, 1985); it postulates that superior value a firm is able to create for its customers results "from offering lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price" (Porter, 1985: 3). Accordingly, competitive strategy can be defined as a choice whether to compete on the logic of differentiation or cost leadership (Zollo et al., 2018), while both approaches to achieving competitive advantages can be taken by the firm in a broad or a focused variant that addresses a narrow market segment (Porter, 1985; Murray, 1988).

An important facet of Porter's seminal conceptualization of competitive strategy is thus that strategy is about "making trade-offs in competing" and thus, its essence is "choosing what not to do" (Porter, 1996: 79). Accordingly, Porter suggested that to be successful, companies must have a strong continuity of strategy, rather than jumping from cost leadership to differentiation or vice versa, facing the risk to "stuck in the middle" (Porter, 1980, 2002). As these two approaches to business strategy are "fundamentally different", firms that compete on low cost are distinguishable from firms that compete through differentiation in several terms, e.g., market positioning, resources and capabilities, and other organizational characteristics (Grant 2018: 184).

In recent years, however, scholars increasingly questioned this "either-or" argument (e.g., Dagnino, 2012). In particular, researchers argue that it is especially the use of digital technologies that provides new opportunities for both the efficiency gains as well as customer intimacy and innovation (e.g., Volberda et al., 2021), potentially enabling companies to pursue integrated, or hybrid strategies and achieve lower cost and product differentiation concurrently. What is much less illuminated yet, however, are the mechanisms how digital technologies affect firm's strategy (Menz et al., 2021). Current research on organizational innovations with digital technologies theorizes that those innovations are characterized by several important new features, in particular convergence and generativity (Yoo et al., 2012, Lyytinen et al, 2016), which essentially determine their affordances (Majchrzak & Markus, 2012). In particular, thanks to generativity digital technologies become malleable and dynamic, while convergence comprises merging of previously separate user experiences, linking digital and non-digital artifacts and previously independent industries and application domains (Yoo et al., 2012).

Hence, we argue that due to their flexible affordances digital technologies might help firms pursue not only pure but also hybrid strategies, contributing both to process efficiency and development of new products and services for customers. By doing so digital technologies create a resource spillover that occurs when a particular resource is leveraged to support two (or more) different strategies (Zollo et al., 2018).

Technology affordances and External strategic fit

Besides the internal fit between pursued competitive strategy and adopted technology, we also consider the external fit between technology and the firm's competitive environment as well as within its business ecosystem. The first facet represents the classic argument of strategic fit theory as it refers to a key question corporate strategists are to ask: “How should the firm cope with technological innovation introduced by the competitors or technological trends in the industry?” (Itami & Numagami, 1992). Scholars argue that “(w)hile internal fit is of importance, by itself it is of little value unless the organizational system as a whole is aligned with its external competitive environment” (Carmeli et al., 2010, p. 340). Hence, we assume that competitive pressure perceived by the firm likely affects its technology adoption decisions (Alaskar et al., 2021; Kretschmer et al., 2012; Tyler et al., 2020).

Secondly, in emphasizing the fit with the ecosystem partners, we argue that this fit dimension is of particular importance for novel digital technologies as recent studies found that these technologies especially embrace networks and ecosystems (Nambisan et al., 2019).

Some researchers even argue that future competitive battles will be waged not between individual companies but between ecosystems (Iansiti & Levien, 2004). Therefore, scholars describe the firm's decision, whether to create and capture value independently or in cooperation within an ecosystem as one of core tensions at the heart of digital transformation (Furr et al., 2022).

In this study on digital technology adoption, we follow previous works and use the term "business ecosystem" to describe groups of firms that use common standards (Teece, 2018) of digital technologies to "combine their individual offerings into a coherent, customer-facing solution" (Adner, 2006: 99). As multiple actors within an ecosystem collectively create value, providing goods and services, ecosystems are characterized by a larger set of interdependencies among the actors (Furr et al., 2022), and hence, those actors must deploy shared standards and interfaces (Teece, 2018) to put collaborative arrangements into action (Adner, 2006). Thus, we assume that a crucial consequence of the shift toward ecosystems is that the digital technology adoption might not go back to an independent decision made by the given firm in an isolated manner, but it is ecosystems that affect the choice of technology, allocation of resources, and the relevant strategies that a firm adopt (Furr et al., 2022). This is particularly true for novel technologies such as big data analytics, as not all organizations possess capabilities needed to exploit them (Wiener et al., 2020). Previous empirical studies also indicate that pressure from business partners, e.g., dominant suppliers and major buyers, might have a positive effect on the adoption of technological innovations (e.g., Wang et al., 2010; Thiesse et al., 2011). From more general perspective, current literature reviews reveal that lack of common standards is a substantial external factor that hinders the deployment of big data business models as it can cause interoperability issues and data exchange/integration problems (Wiener et al., 2020).

In sum, regarding the environmental (external) dimension of strategic fit, we argue that new flexible technology affordances necessitate an explicit consideration of other actors in the adopter's ecosystem. On the one hand, we assume that pressure from competitors might foster companies to adopt new technologies to leverage appropriate competitive strategies. On the other hand, to provide valuable affordances, the adopter's deployment of new technologies needs to be aligned with the activities of other key actors in the adopter's ecosystem – the suppliers, end-users, and complementors (Dellermann et al., 2017). Thus, we include competitive pressure and compatibility with ecosystem partners in our research framework.

Technology constraints: Technical fit and operational compatibility

From the theoretical perspective, affordances and constraints can be seen from both functional and relational perspectives (Hutchby, 2001; Faraj & Azad, 2012). While functional aspect means that certain objects (e.g., digital technologies such as BDA) "have affordances which enable the particular activity while others do not", the relational aspect reflects that "the affordances of an object may be different for one species than for another" (Hutchby, 2001: 444). To apply this view to the adoption of innovative digital technologies in business organizations we draw on the works by Tornatzky & Klein (1982) and Karahanna et al. (2006) who argued that the adoption of an innovation is likely to be affected by its "operational compatibility", that is, the fit with what adopters do. This "practical" compatibility (Tomatzky & Klein, 1982: 33) reflects the magnitude of change potential adopters are likely to experience when using a new technology (Karahanna et al., 2006: 783).

In a similar vein, Ansari et al. (2010: 75) discuss in theoretical terms the concept of "technical fit", that is, the degree to which the characteristics of a practice (e.g., a new technology) are compatible with technologies that are already in use by potential adopters. They argue that technical fit is affected by both the supply-side factors, such as characteristics of this new technology, and the demand-side factors, for instance, the experience of the firm's employees. Noteworthy, these scholars build upon the seminal work by Rogers (1962, 2003) who theorized that the "basic notion of the compatibility attribute is that new idea is perceived in relationship to existing practices that are familiar" to the potential adopter (Rogers, 2003: 254). Current reviews of empirical literature provide additional evidence indicating that internal, mostly operational, and organizational issues, such as, for instance, constraints of existing structures, processes, and roles create essential challenges for the deployment of novel big data business models (Wiener et al., 2020).

Drawing on these ideas, we argue that perceived strategic affordances and perceived compatibility serve as two complementary impact factors for new technology adoption: The affordances (e.g., cost-cutting effects that contribute to cost leadership strategy) make new technology attractive for the firm, while compatibility makes the adoption easier by reducing the uncertainty and requesting less effort to deploy this new technology (e.g., Rogers, 2003;

Karahanna et al., 2006). This argument is consistent with the basic relational notion of affordance that postulates “that an object in the environment will offer different possibilities of action depending upon the actor’s abilities”, as these abilities might substantially differ among the actors (Faraj & Azad, 2012: 251). In a similar vein, Dremel et al. (2020) and Zammuto et al. (2007) argued that at the organizational level, the actualization of affordances is influenced by several social and technical factors, such as employee expertise, organizational processes and procedures, controls etc. To particularly address the intersection of IT systems and organization systems, Zammuto et al. (2007) coined the term “affordances for organizing” that expresses that the impact of technology “on organizational functioning and performance cannot be separated from expertise, jobs, processes, or structures“ (Zammuto et al., 2007: 753). Based on these arguments, we include the operational compatibility into our configurational model as a constraint.

Big data analytics as a key digital technology

In this study we focus on the adoption of BDA that builds an important part of artificial intelligence (e.g., Bag et al., 2021; Sun & Huo, 2021) and represents one of the key technologies which enable the digital age (Menz et al., 2021). In general, big data can be defined as “the collection and interpretation of massive data sets, made possible by vast computing power that monitors a variety of digital streams … and analyses them using ‘smart’ algorithms” (Davenport, 2014: 45). In recent years, a common framework to describe the dimensions of big data has emerged in the literature, usually coined as ‘The 3V’ (Gandomi & Haider, 2015; Johnson et al., 2017¸ Lee, 2017).

From the firm’s perspective, within this framework, big data volume refers to the magnitude of data available to an organization, which depends, among others, on factors such as the types of data and the industry (Johnson et al., 2017; Gandomi & Haider, 2015). The formats and types of data refer to the dimension of variety (Johnson et al., 2017) as structured data available, for instance, in spreadsheets or relational databases, constitutes only 5% of all existing data (Gandomi & Haider, 2015: 138). Thanks to novel data management and analytics technologies, companies are increasingly enabled to process and create value from the huge subset of unstructured data, such as text, images, audio, and video. These heterogeneous data can be collected from both internal (e.g., sensor data) and external (e.g., social media) sources (Gandomi & Haider, 2015). Finally, big data velocity refers to the speed at which data are processed and analyzed (Johnson et al., 2017). For instance, big data that physical objects now generate thanks to advances in sensors and wireless communications, can be used by companies to enhance a product or service or create new business value, e.g., improve the design, operation, maintenance, and repair of assets (Parmar et al., 2014). Hence, “from an affordance-theoretic perspective, BDA technologies and tools provide the means to process, store, and collect a vast volume of data characterized by variety, variability, and velocity” (Dremel et al., 2020:2). In addition to these ‘3V’s’, other dimensions of big data have also been mentioned in the literature, such as, for instance, veracity, variability, and complexity, to address features such as data unreliability, variation in the flow rates etc. (Gandomi & Haider, 2015; Wiener et al., 2020).

There are several reasons why BDA is particularly suitable for our study. First, BDA is of strategic importance for business organizations as its use might strengthen strategic position of the firm contributing to competitive advantages (Iansiti & Lakhani, 2014; Wiener et al., 2020). The BDA value for business organizations is realized “through better insights from different, diverse, and new data sources (e.g., social media, wearables, and radio-frequency identification (RFID)) and computational approaches which uncover patterns, correlations, or other previously unknown information pertaining to this data” (Dremel et al., 2020: 4). These useful information and new insights can contribute to better strategic decisions (Chen et al., 2015; Davenport, 2014).

Second, to serve as a trigger of competitive advantages, BDA can be deployed by companies in different ways. For instance, Wixom & Ross (2017) argue that firms can use BDA to improve internal business processes and to enrich their products, services, and customer experiences (“wrapping activities”). A recent systemic literature review also revealed that big data can positively affect both the operational performance, cost reduction and productivity as well as new product development and innovation (Acciarini et al., 2023; for concrete examples see, for instance, Johnson et al., 2017; Lee, 2017; Mazzei & Noble, 2017). Thus, we argue that in strategic terms, BDA can potentially contribute to both generic strategies, cost leadership and differentiation.

The third reason why we deploy BDA in our empirical study is that it not only delivers benefits but also might cause additional costs and problematic issues for adopting organizations, thus, creating trade-offs that adopters need to consider. Literature reviews

(Acciarini et al., 2023) reveal, however, that only few studies have explored these negative effects of BDA, such as costs necessary to acquire, store and process data. What's more, current studies indicate that different 3V dimensions of big data mentioned above might have different impact on firm's performance, showing, for instance, that the 'bigness' of big data alone does not ensure value creation for a firm (e.g., Cappa et al. 2021). Hence, we theorize that as BDA create both benefits and disadvantages, they are associated with several new affordances and constraints and can be used to leverage different competitive strategies in different external environments; thus, they are particularly appropriate for the empirical part of our work.

Finally, while the importance of BDA for business organizations has been emphasized in current academic and practical publications, only a small number of studies addressed the individual antecedents of BDA adoption (e.g., Dremel et al., 2020; Lehrer et al., 2018). Some more sophisticated models modified the original TOE framework, considering, for instance, mediation effects. For instance, the study by Chen et al. (2015) found that technological factors directly influence organizational BDA usage, while organizational and environmental factors indirectly influence organizational BDA usage through top management support. However, to our knowledge, almost none of previous works has theoretically developed and empirically tested a configurational set-theoretic framework to address BDA adoption (for a current exception see Sun et al., 2024).

Development of the Configurational Framework: Integration of the TOE and Configurational Perspective

Reviews of empirical research on information technology adoption (Oliveira & Martins, 2011; Hameed et al., 2012) reveal that the bulk of past adoption studies deployed correlational methods such as regression analysis, multiple correspondence analysis, and confirmatory factor analysis. These research methodologies aimed at isolating the net effects of explanatory variables, such as, for example, the firm's size, on adoption, mainly "in terms of linear relationships that take the correlational form of 'the more of X, the more of Y'" (Delbridge and Fiss, 2013: 328). While they have delivered some valuable insights, correlational approaches, however, are limited in their ability to address two core aspects of causal complexity, i.e., constellations "where multiple explanatory factors combine in complex and at times contradictory ways, and where there is equifinality, that is, multiple alternative paths to an outcome" (Furnari et al., 2021: 3).

These limitations in copying with equifinality and complex, e.g., conjunctural causation have currently come under criticism in adoption research (Sun, 2024). By previous arguments, we suggested two relational concepts for the identification of relevant impact factors of digital technology adoption – technology affordances/constraints as well as the strategic fit. The relational nature of the concepts means that these individual factors affect adoption not in an isolated manner, but in combination, which is in concordance with the logic of conjunctural causality. For instance, TACT draws attention to the interdependencies between technology affordances and firm's characteristics such as competitive strategy, while the notion of strategic fit accentuates the competitive and ecosystem suitability of this technology. Noteworthy, research on strategic fit has also called for multivariate, configurational perspective as alternative to correlational causation. For instance, Venkataraman suggested the concept of "fit as gestalts" advocating that such gestalts, or archetypes "could provide useful insights into a powerful concept of equifinality or the feasible sets of internally consistent and equally effective configurations" (Venkataraman, 1989: 432).

Consistently with prior works that stressed the need for explicit bridges between theoretical meanings and the use of specific analytical schemes and operational tests (Venkataraman 1989), we argue that to adequately consider these relational theoretical tenets and explore the possible combinations among the individual impact factors, the "neo-configurational approach" (Misangyi et al., 2017; Ragin, 2008; Fiss, 2007, 2011) is particularly appropriate. This approach is fundamentally compatible with the generic TOE framework: Both notions take a holistic view, postulating that it is complex patterns rather than individual independent factors that lead to a specific outcome (i.e., adoption of digital innovation). In the context of our study, three fundamental principles of configurational approach are especially relevant. The neo-configurational perspective is based on the assumption of conjunctural causality advocating that "it is the presence or absence of particular other factors that gives a variable meaning or not" (Fiss, 2007: 1182). The neo-configurational perspective also builds upon the principle of equifinality assuming that multiple alternative paths can lead to the given outcome (Furnari et al., 2021). Related to this is the notion of causal asymmetry that postulates that a condition (i.e., impact factor) may be present in one configuration but absent in another, indicating that solutions for the outcome and its negation are not necessarily symmetrical (Greckhamer et al., 2018; Ragin, 2008). In our case, these principles imply that viable solutions (i.e., configurations of impact factors) could be based on different competitive strategies and draw on different aspects of affordances and constraints.

In sum, enriching the TOE by the configurational logic allows the shift from linear theorizing based on net effects of isolated technological, organizational, and environmental antecedents to the exploration of causal complexity that is associated with organizational adoption of digital technology. Figure 28 depicts our configurational framework that includes the relational TOE components theoretically grounded above.

Empirical Study

Methodology

fuzzy set Qualitative Comparative Analysis

To conduct a configurational analysis of the BDA adoption, we utilize the methodology of fsQCA (Ragin, 2008). Recently, QCA has gained increased prominence in empirical management research and has been applied in various areas, including strategy (Greckhamer & Gur, 2021), decision making (Bartkus et al., 2022), innovation management (Meuer, 2014), stakeholder management (Crilly, 2011), interfirm networks (Reck & Fliaster, 2022), and research on digitalization (Sun et al., 2024).

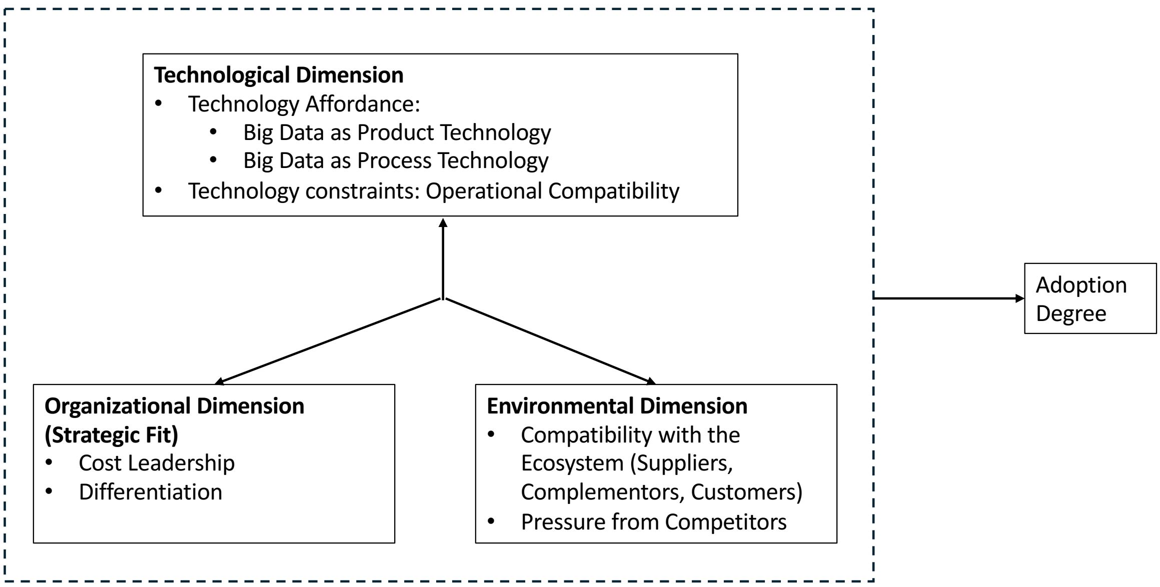

Figure 28 Research framework.

The fsQCA approach relies on a set-theoretic logic to uncover the key facets of causal complexity mentioned above, e.g., conjunction and equifinality. By doing so, it builds on four pillars: Conceptualization of cases as configurations of sets, calibration of cases' memberships in these sets, exploration of causality in terms of necessary and sufficient relations between sets, and counterfactual analysis of unobserved configurations (Greckhamer & Gur, 2021; Misangyi et al., 2017). In conducting our empirical work, we adhere to the best practices of fsQCA methodology outlined by Greckhamer et al. (2018) as well as the recommendations for capturing causal complexity proposed by Furnari et al. (2021). In particular, during the calibration step, we employ fuzzy sets to facilitate a detailed examination of the cases and differentiate between types and degrees of variables. Moreover, the truth table analysis we conduct includes alternative combinations of both present and absent conditions that determine the outcome (i.e., adoption). To ensure the validity of our results, we perform robustness checks. Furthermore, we meticulously report our procedures, including all relevant thresholds, and present the findings in accordance with the guidelines recommended by Fiss (2007).

Data collection, measurement scales, and reliability analysis

Following previous empirical works, we collected the data using questionnaires. The use of surveys for data collection is widespread in both the adoption studies of the TOE framework and in the field of QCA (e.g., Kennedy & Fiss, 2009; Meuer et al., 2015). We randomly identified companies from the manufacturing sector in the German commercial register and searched for CXOs such as CDOs and CTOs via LinkedIn. We contacted 1320 firms; out of them, 168 respondents clicked on the online questionnaire. Ultimately, 63 top managers fully completed the survey, providing valid responses. This results in a 37.5% response rate. The response rate from initially contacted firms is 4.7%. This is comparable to other adoption studies that followed a similar procedure (Barlatier et al., 2022). Moreover, this sample size corresponds with the particular strengths of QCA as this methodology was initially developed specifically for relatively small-N settings (10–50 cases) and has subsequently proven useful for analyzing situations with more than 50 cases (Greckhamer et al., 2013; Greckhamer et al., 2018).

We collected the data on all causal conditions via multiple items rated on a seven-point Likert scale ranging from 1 = "completely disagree" to 7 = "completely agree". The formulation of the measurement items mainly followed previous works; we used established scales, relied on standard definitions, conducted a pre-test, and validated the answers. The survey has been conducted between August and October 2019. Table 10 depicts the items, factor loadings, descriptive statistics of the items, AVE, CR, and Cronbach's alpha.

Regarding the BDA adoption, we relied on previously tested items (e.g., Brown & Russel, 2007; Chwelos et al., 2001; Thiesse et al., 2011). For affordances, we developed a set of questions derived from previous theoretical and empirical works (Majchrzak & Markus, 2012; Lyytinen et al., 2016; Yoo et al., 2012; Cennamo & Santaló, 2019) and subsequently discussed them with seven experts from academia and practice. Organizational compatibility was derived from Karahanna (2006). The two competitive strategies, cost leadership and differentiation, are based on Kennedy and Fiss (2009) and Hambrick (1983). Ecosystem compatibility that considers links to customers, suppliers, and complementors is based on Teo et al. (2003). Competitive pressure measurement relies on Helmig et al. (2016) and Graham (2020).

Table 11 shows the correlation matrix. The discriminant validity was assessed by the heterotrait-monotrait ratio of correlations criterion by Henseler et al. (2015). We followed their procedure and received the highest value of .591. In addition, we checked for non-response bias and found no abnormalities (Armstrong & Overton, 1977). As mentioned above, we strived to ask organizational members who are best informed about the adoption and the characteristics of digital innovations (Cruz, 2022). Since we collected self-reported data, however, there might be a concern regarding the common method bias (Podsakoff et al. 2012). Hence, we applied several procedures recommended in the literature to address this possible issue. First, we implemented ex-ante recommendations to reduce common method bias (CMB), such as carefully selecting question order and assured anonymity. In addition, we used the Harman single-factor test, including all items. The results of our analysis show the items load on multiple distinctive factors, with the first factor explaining 20.13% of the variance. Taken together, these findings indicate that CMB was not a serious problem in this study (MacKenzie & Podsakoff, 2012).

Table 10 Items and loadings.

	Item	Loading
Adoption		
Spearman-Brown = 0.78	If you expect your company to use big data analytics in the future, how soon do you think this will happen (implementations - no pilot tests)?	-
	When did the company start using Big Data Analytics (implementation - no pilot tests)	-
Affordance with products		
Cronbachs-Alpha = 0.93 CR = 0.95 AVE = 0.75	Big Data Analytics can link product and service data from various sources (e.g. sensors, cameras, machines) and provide decision recommendations.	0,937
	Big data analytics enable products or components and services that come from different industries to work together.	0,815
	Big Data Analytics delivers economic added value when used in products and services.	0,898
	Big data analytics can be used for various products and services from our company.	0,853
	Big data analytics can be quickly adapted to changing requirements and framework conditions for products and services.	0,839
	Big Data Analytics promotes the further development and optimization of existing products and services.	0,851
	Big data analytics create completely new products and services.	0,896
Affordance with processes		
Cronbachs-Alpha = 0.88 CR = 0.91 AVE = 0.64	Big Data Analytics can link process data from different sources (e.g. sensors, cameras, machines) and provide decision recommendations.	0,815
	Big data analytics can be used to connect processes that come from different industries together.	0,734
	Big Data Analytics delivers economic added value when used in processes.	0,866
	Big Data Analytics can be quickly adapted to changing requirements and framework conditions in processes.	0,757
	Big Data Analytics promotes the further development and optimization of existing processes.	0,855
	Big data analytics create completely new processes.	0,758
Operational compatibility		
Compatibility with excisting practices Spearman-Brown 0.94 CR = 0.75 AVE = 0.60	In order to use big data analytics, our company does not have to change anything that it is currently doing.	0,796
	The use of big data analytics does not require any significant changes in our company's existing work processes.	0,749
Compatibility with experience (neg. coded) Cronbachs-Alpha = 0.89 CR = 0.93 AVE = 0.77	The use of Big Data Analytics is a new experience for our company.	0,880
	Using Big Data Analytics is nothing like what our company has done before.	0,894
	The use of big data analytics differs from other experiences that our company has had.	0,791
	The use of Big Data Analytics is a new business experience for our company.	0,935
Cost leadership		
Cronbachs-Alpha = 0.91 CR = 0.94 AVE = 0.79	It is very important for our company to keep labor costs as low as possible.	0,781
	It is very important for our company to keep the material consumption as low as possible.	0,944
	It is very important for our company to keep energy consumption as low as possible.	0,917
	It is very important for our company to keep storage costs as low as possible.	0,914
Differentiation		
Spearman-Brown = 0.82	It is very important for our company to introduce new products and services frequently.	0,819
CR = 0.81	It is very important for our company to improve our products and services with additional functions.	0,834
Compatibility within the ecosystem		
Supplier Cronbachs-Alpha = 0.96 CR = 0.95 AVE = 0.83	The sucess of our company depends on the resources of our main suppliers who have introduced big data analytics.	0,883
	Our company cannot easily break away from major suppliers who have introduced big data analytics.	0,938
	Our company must maintain good relationships with the main suppliers who have introduced big data analytics.	0,907
	Our primary suppliers who have introduced Big Data Analytics are primary suppliers in a concentrated industry.	0,920
Customer Cronbachs-Alpha = 0.94 CR = 0.93 AVE = 0.77	The sucess of our company depends on the purchases of our main customers who have introduced big data analytics.	0,957
	If our main customers who introduced Big Data Analytics wanted to switch to another provider, they would not incur high switching costs as a result of this change.	0,870
	Our company needs to maintain good relationships with key customers who have introduced big data analytics.	0,919
	Our main customers who have adopted Big Data Analytics are the largest customers in the industry.	0,744
Complementors Cronbachs-Alpha 0.96 CR = 0.97 AVE = 0.90	The success of our company depends on the resources of our complementators who have introduced big data analytics.	0,930
	Our company cannot easily free itself from complementers who have introduced big data analytics.	0,961
	Our company needs to maintain good relationships with the complementers who have introduced big data analytics.	0,964
	Our complementators, who have introduced Big Data Analytics, are main providers in the respective concentrated industries.	0,943
Pressure from Competitors		
Cronbachs-Alpha 0.95 CR = 0.98 AVE = 0.95	Our company's main competitors who introduced Big Data Analytics benefited greatly.	0,978
	industry.	0,973
	Our company's main competitors who have introduced Big Data Analytics, are viewed positively by the suppliers.	0,982
	Our company's main competitors who have introduced Big Data Analytics, are viewed positively by customers.	0,980

Notes: CR = Composite Reliability; AVE = Average Variance Extracted

Table 11 Correlation matrix.

	1	2	3	4	5	6	7
Adoption							
Product affordances	,270*						
Process affordances	,240*	,680**					
Compatibility fit	,366**	-,089	,073				
Cost leadership	-,081	-,117	,194	-,168			
Differentiation strategy	,282*	,159	,073	-,067	-,213		
Fit with the ecosystem	,333**	,163	,140	,138	-,235*	,236*	
Competitive pressure	,324**	,049	,091	,051	,155	,093	,174

Data analysis and Results

In order to extract configurations that lead to the adoption of BDA, we used R (3.5.3) and the packages QCA (3.6) and SetMethods (2.5). In total, the procedure contains main steps of calibration, necessary and sufficiency analysis, and counterfactual analysis as well as validation and robustness checks (Misangyi et al. 2017; Greckhamer & Gur, 2021).

Calibration: We followed calibration guidelines for survey measurement and calibrated the values from the questionaries in set membership scores between 0 and 1 using three thresholds – full membership (1), full non-membership (0), and the crossover point (0.5) (Fiss, 2011; Ragin, 2008). These anchors are determined using the Likert Scale definition as well as mean, standard deviation, minimum, and maximum values. Finally, we validate them through available statistics. For example, we contextualized the adoption rates of BDA by leveraging freely available statistics on digitalization (e.g. Statista, 2024). This additional information ensures that our classification is sensible in relation to our sample and the BDA adoption and usage in organizations in general. For example, the calibration of competitive strategy can be illustrated as follows: We utilize a 7-point Likert scale. On this scale, a score of 1 indicates 'not pursued at all,' 2 signifies 'not pursued,' 3 represents 'partially not pursued,' 4 serves as the neutral midpoint, 5 corresponds to 'partially pursued,' 6 means 'pursued,' and 7 denotes 'fully pursued'. Additionally, we considered the average score (5.46), the standard deviation (1.72), and the observation that respondents utilize the entire range of the scale, from 1 to 7. Based on these parameters, we determined a crossover point of 5.5, a value for non-membership (“fully out”) at 2.0, and a value for full membership (“fully in”) at 6.7. Table 12 depicts the calibration anchors.

Necessity and sufficiency analysis: With regard to causality, QCA explores two types of relations – necessity and sufficiency (Fiss, 2007, 2011). In the context of our study, for instance, if all firms that adopt BDA would follow the cost leadership strategy, this would indicate that this type of strategy must be present for adoption to take place, and thus, cost leadership strategy will be a necessary condition. On the other hand, if all firms that pursue cost leadership strategy would adopt BDA, this would indicate that cost leadership is a sufficient condition for adoption. To evaluate causal necessity and sufficiency, fsQCA deploys the measures of consistency and coverage (Fiss, 2011). While consistency shows “how closely a perfect subset relation is approximated” between outcome and case attributes (Ragin, 2008: 44), coverage measures the proportion of cases that are captured by a configuration of attributes and thus indicates the “empirical relevance or importance” of the configuration (Ragin, 2008: 44). We checked for necessary conditions and found that neither the conditions nor their negations met the consistency threshold of 0.9 for necessary conditions (Ragin, 2008).

Table 12 Calibration anchors.

	Fully out	**Cross over point**	**Fully in**
Product affordances	1.9	5.59	6.8
Process affordances	1.9	5.64	6.8
Compatibility fit	1.8	3.49	6.8
Cost leadership	2.51	5.2	6.9
Differentiation strategy	2.01	5.51	6.7
Fit with the ecosystem	1.8	4.61	6.6
Competitive pressure	2.01	4.8	6.7

Next, we searched for sufficient solutions. In doing so, we created the truth table with all 2number of conditions (27) rows (Ragin, 2008). Then we conducted the truth table refinement and set the frequency threshold to 2, which means that combinations that were empirically observed at least two times were included in the analysis. With respect to consistency, we used a raw consistency threshold of .9 and a PRI (proportional reduction in inconsistency) score of .8, and followed the procedure as described, for instance, by Fiss (2011*).*

Counterfactual analysis of causal conditions: In the next step of the fsQCA methodology, the counterfactual analysis has been conducted that categorizes causal conditions into core and peripheral causes. By doing so, the analysis procedure distinguishes parsimonious and intermediate solutions based on “easy” and “difficult” counterfactuals (Ragin, 2008; Fiss, 2011). First, we calculated the parsimonious solution, then the intermediate solution, and finally, linked the two solutions. Core conditions, which appear in both parsimonious and intermediate solutions, provide strong empirical support for the outcome and are central to our analysis. Peripheral conditions, which appear only in the intermediate solution, show less empirical significance. These conditions augment the core conditions and are relatively interchangeable. As such, various neutral permutations may arise, with identical core conditions accompanied by different sets of peripheral conditions, highlighting the principle of equifinality. The presence of a core condition implies that a high membership score in this condition is crucial for the outcome. The absence suggests that a low membership score in the condition is significant within this solution (Fiss, 2011).

Validation and robustness checks: We conducted several robustness checks on our results in accordance with prior studies (e.g., Fiss, 2011; Greckhamer & Gur, 2021; Ordanini et al., 2014). We first modified our calibration parameters, rerunning the analysis with changed thresholds for full non-membership and full membership at the 10th and 90th percentiles, and the 20th and 80th percentiles, respectively. Next, we adjusted the frequency threshold to 1 in the truth table refinement and repeated the analysis. Lastly, we varied the threshold for the proportional reduction in inconsistency. Throughout all these steps, we observed only minor variations in the number of solutions and neutral permutations; however, the overall patterns in the results remained consistent.

Solution charts

Table 13 shows the five solutions (causal recipes) that are sufficient for a high adoption level of BDA, as well as the respective coverage and consistency values. Three basic types of solutions can be distinguished, each based on different core and peripheral conditions. The first solution has no neutral permutation (solution1) and is characterized by the absence of product affordances and high compatibility with the ecosystem. Solution two has two neutral permutations (solution 2a, 2b) and is determined by the core conditions of product affordance, operational compatibility, and no cost leadership. Solution three also has two neutral permutations (solution 3a, 3b) and is based on a differentiation strategy and high compatibility with the ecosystem. The values for consistency are between .914 and .982 and thus they demonstrate a high significance of the individual solutions. The values for unique coverage are higher than .000 and underline the empirical relevance of the different solutions. Furthermore, the overall solution coverage is .469, and the overall solution consistency is .943. These results are comparable to other studies that deploy the fsQCA methodology (Meuer, 2014).

Table 13 Configuration for innovation adoption.

	Solution				
	1	**2a**	**2b**	**3a**	**3b**
Technology					
Affordance - Product	⨂	⬤	⬤	●	●
Affordance - Process	●		●	●	
Operational compatibility	●	⬤	⬤		⊗
Organizational (Strategic Fit)					
Strategy - Cost leader	●	⨂	⨂	⊗	●
Strategy - Differentiation	⊗	●	●	⬤	⬤
Environment					
Compatibility with the ecosystem	⬤	●	⊗	⬤	⬤
Competitive pressure	●	●	⊗	●	●
Consistency	0.982	0.982	0.965	0.959	0.914
Raw Coverage	0.123	0.217	0.147	0.298	0.241
Unique Coverage	0.040	0.005	0.026	0.057	0.079
Overall Solution Consistency			0.943		
Overall Solution Coverage			0.469		

Notes: large black dots indicate present core conditions, small black dots present peripheral conditions; large crossed circels indicate absent core conditions, small crossed circels indicate absent peripheral conditions

Additionally, we verified the results for non-adoption of BDA and observed that only the combination of all absent conditions is identified as a solution, with no alternative solutions involving the considered conditions being found. Thus, with the above-mentioned calibration anchors, there exists only one solution. This finding aligns with existing research on non-adoption and resistance to innovation, which suggests that adoption and non-adoption are likely to be influenced by different factors (Bao, 2009). This finding indicates that other factors need to be studied in the configurational framework for the non-adoption than the adoption.

In the following, we look at the interactions of the individual conditions in the various solutions and highlight the relevant patterns, considering adoption theory, TACT theory, and strategic fit. By doing this, we follow Furnari et al. (2021) and give meaningful names to the individual solutions.

Solution 1: Cost leaders: The first archetype pursues the pure cost leadership strategy in a consequent manner. Perceiving high competitive pressure, a firm of this type consistently uses BDA affordances (i.e., technology-based action potential) for optimization and refinement of internal processes, striving to strengthen its strategic position by coordinating and accommodating with other actors within the ecosystem. Technology adoption likely occurs in a reactive mode, as those process innovators make efforts to reduce transaction costs and increase their attractiveness as efficient business partners.

Solution 2 & Solution 3a: Product innovators and differentiators: From the strategic perspective, these solutions have two essential features in common: They follow pure differentiation strategy and make an extensive use of new BDA affordances for product innovations. In addition to the similarity regarding the competitive strategy and use of product affordances, solutions 2a and 2b have also another key aspect in common: Both types of companies pay substantial attention to the internal fit, i.e., operational compatibility of BDA.

Moreover, the archetype 2b supports this internal compatibility by novel process affordances of BDA. In doing so, these companies do not suffer under high competitive pressure and move ahead of their established ecosystems. On the contrary, solutions 2a and 3a represent organizations that feel under siege within their competitive environment and strive to cope with competitive challenges in alliance with their ecosystem partners, operating as a part of the whole by maintaining compatibility with other ecosystem actors.

Solution 3b: Hybrid strategy pursuers: Facing a strong competitive pressure, the third archetype focuses on a hybrid competitive strategy integrating differentiation and cost leadership approaches. In doing so, these adopters strive to unleash new affordances for new products. The implementation of product innovations based on novel BDA affordances, however, causes need to change internal processes and the firm's way of operating und thus, destroys operational compatibility. In other words, these adopters need to deal with a tradeoff between external and internal dimensions of compatibility: "Flying together" with business partners within the ecosystem, they have to look for better ways to maintain internal operational compatibility to reestablish the cost leadership component of their hybrid strategy.

Discussion and conclusions

Our empirical study provides intriguing insights into three key aspects of technology adoption – its individual conditions, different equifinal configurations, and the interplay (conjunctional effects) of conditions within these configurations. First, our study delivers empirical evidence for the usefulness of the theory of technology affordances and constraints for adoption research. Previous works have already advocated the use of TACT for a better understanding of digital technology adoption (e.g., Nambisan et al. 2019). However, scholars noted that due to its relative newness the number of empirical TACT studies is limited and most of them built on individual case analysis (Majchrzak & Markus, 2013). Collecting original empirical data on 63 industrial companies, we were able to receive an important finding: All three solutions reveal the substantial role both the strategic affordances and various dimensions of technology constraints play for adoption. In our dataset, there is no adoption solution without at least one category of affordances and no solution without at least one category of technology constraints.

Furthermore, our results provide empirical evidence for another key theoretical tenet of TACT: We found that the same digital technology, i.e., BDA, can contribute to both product and process changes, and thus, the adopting firms pursue different competitive strategies based on different uses of the same technological artefacts. Moreover, we augmented previous TACT literature by revealing strategic effects of adopted digital technologies. Exploring technology affordances, past works mainly focused on the individual, or group level of analysis, while several researchers currently call further studies to investigate affordance actualization at the organizational level (e.g., Dremel et al., 2020), especially addressing "IT-strategy affordances" (Zamuto et al. 2007: 760). We answered these calls shedding new light on strategic affordances and constraints, that is, the relation between (digital) technology and its deployment for various strategic objectives (e.g., cost leadership and differentiation) by business organizations.

Within this context, our findings also contribute to the strategic management theory as they throw new light on the notion of fit and its dimensions. Previous studies advocated that both internal and external alignment are necessary for organizations to meaningfully pursue competitive strategies. Our findings show that within distinct configurations companies pay particular attention to different fit dimensions – the strategic, operational one, and the ecosystem-related fit. In addition, we found that the three fit dimensions affect the adoption of digital innovations in different configurations under different contingencies, such as competitive pressure. For instance, while operational fit is present in solutions 1 and 2, it is absent in solution 3b and can or cannot be present in the solution 2a. From the perspective of neo-configurational theorizing, this empirical insight reveals causal asymmetry as one of the key dimensions of causal complexity, which means "that the presence as well as the absence of any attribute may produce the same outcome, depending on its combination with other attributes" (Misangyi et al., 2017, p. 261). By this means, our results further enrich the adoption theory showing that it is rather complex configurations than net effects of isolated factors that drive the adoption of digital technologies in organizations.

In addition to conjunctural causality and causal asymmetry, our empirical findings provide intriguing insights into the other key facet of causal complexity that is related to the principle of equifinality. As mentioned above, equifinality means that multiple alternative paths can lead to an outcome (Furnari et al., 2021). To systematize and integrate key conditions of digital technology adoption, we deployed the TOE framework that has been widely accepted in the theoretical and empirical literature as a "dominant … lens for comprehending organizational technology adoption" (Sun et al., 2024: 2). The bulk of previous works, however, used the TOE dimensions in an isolated manner ignoring possible interdependencies and interactions among them. This made possible only a limited use of the explanatory potential of this generic framework. Following the notions of conjunctural causality and equifinality, we augmented the TOE framework by explicitly considering conditions that are of relational nature and thus, interact with one another within different configurations.

It's worth to note that prior work on strategic fit and diffusion already theorized on interactions between the key features of the diffusing practice (e.g., technology) and those of the adopter (Ansari et al., 2010). We enrich this perspective by considering not only the interplay between characteristics of diffusing technology (i.e., flexible affordances) and the adopting organization (i.e., internal fit with corporate competitive strategy) but also the environment (i.e., external fit with ecosystem partners' needs). In particular, we theorized that technology affordance as a relational construct links technology artifacts to the purposes of organizational actors (Faraj & Azad, 2012; Majchrzak & Markus, 2013) and hence, to strategies that are built to achieve these objectives. In doing so, we found that not isolated antecedents, but three different equifinal configurations are effective in fostering technology adoption.

Finally, our study also augments the burgeoning stream of research on digital technologies. The number of empirical studies that use the affordance-theoretical perspective to address how companies create value from BDA is limited yet (Dremel et al., 2020; Lehrer, 2018). We built on arguments raised, for instance, by Dremel et al. assuming that the value of BDA "is highly dependent on the sociotechnical context and rooted in the strategic goals of an organization" (Dremel et al., 2020: 1), and answered current calls for more empirical studies on this topic (Dremel et al., 2020; Lehrer et al., 2018). For instance, our results demonstrate that the same digital technology can contribute to both product and process changes, and thus the adopting firms develop different competitive strategies based on distinct use of the same technological artefacts.

In addition to theoretical contributions our research also has managerial implications. First, our results let companies consider the adoption of novel digital technologies such as BDA from a broader perspective than they used to do regarding more traditional, e.g., analog technologies. While past technology management literature clearly discerns product and process (e.g., manufacturing) technology, interpreting them "as related yet distinct … phenomena" (Swan & Alfred, 2003), our study shows that the affordances of BDA cover both product and processes. Hence, we recommend that considering the adoption of BDA, companies should think carefully about flexible affordances which these technologies generally allow, and how these affordances fit other adoption factors, such as competitive strategy. As technology can not only support current strategy, but also drives cognition of future strategy (Itami & Numagami, 1992), this interaction works in both directions: The decision to realize a particular BDA affordance can also drive the choice for a particular competitive strategy. The same conclusion is true regarding the constraints of BDA: We suggest that while adopting BDA technologies companies should systematically consider their critical constraints, such as operational, strategic, and external compatibility.

Second, our configurational analysis reveals several equifinal adoption solutions with conjunctural and asymmetrical effects (Greckhamer et al., 2018). This finding means that there is no single "correct" path to the adoption of BDA, but rather, the interactions of various conditions are essential (Sun et al., 2024). Therefore, it is crucial for companies to consider this interplay in their decision-making and implementation activities. Focusing solely on a single factor is insufficient; successful deployment of BDA requires directed effort and coordination of multiple factors. Thus, we suggest that organizations engage with the interplay of technological, organizational, and environmental factors. This approach focuses on the specific circumstances of the organization and the potential leverage points within these conditions, allowing for holistic solutions to the adoption of BDA to be developed.

Despite these theoretical and practical contributions, the present study is not without limitations, which, in turn, present opportunities for future research. First, in developing the theoretical framework, we took a strategic perspective integrating it with the notion of TACT. Past research indicates that other factors, such as individual characteristics of top managers, might also influence adoption (e.g., Damanpour & Schneider, 2006). Future research could consider these factors, deploying other theoretical perspectives, such as, for instance, the upper-echelon theory that explicitly addresses the role and impact of organizational leaders (Hambrick & Mason, 1984). Second, our study explores industrial companies in Germany. Thus, we recommend that its findings should be validated in other industries and regions. Third, we collected data using questionnaires completed by top managers such as chief strategy officers. In doing so, we followed previous works that advocate collection of data from the best-informed persons (Cruz, 2022). We argue that for our research question the chief strategy and digital officers are such best-informed persons. As we relied on a single data source, however, this approach might lead to CMB (Podsakoff et al., 2012). Therefore, we took several measures to address this issue. In particular, we followed best practices for procedures prior to the data collection and avoided potential causes for CMB as described by Podsakoff et al. (2024), such as long scales, repetitiveness, and clarity. Furthermore, we followed the methodological recommendations regarding the item order, scales, social desirability, and anonymity. In addition, we ensured that our respondents are educated and involved in the BDA topics within the organization (MacKenzie & Podsakoff, 2012; Podsakoff et al., 2024). Moreover, we considered that it is mainly personal questions, that refer to personality and behavior, that are particularly susceptible to CMB (Podsakoff et al., 2012; 2024). Such questions are not included in our questionnaire, and thus, the associated risks are likely not relevant to our study. Furthermore, we checked the data using the Harman Single factor test and also found no problems. Due to these measures, we believe that CMB is unlikely a problem in our empirical data.

In sum, our study provided three main contributions: It enriches the generic theoretical TOE framework by embedding several 'relational' conditions, i.e., digital technology affordances and constraints as well as multiple fit dimensions. In doing so, it shows that adoption of digital technology is affected by different equifinal configurations of these interacting conditions. In doing so, our findings also contribute to a better understanding of powerful modern BDA technologies. We hope that these insights provide useful leads for further exploration of the important topic of digital technology adoption in organizations.

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3. Publication 3: Integration of Artificial Intelligence in the Organizational Adoption – A Configurational Perspective

3.1. Notes on submitted Paper

This paper on “Integration of Artificial Intelligence in the Organizational Adoption – A Configurational Perspective” was co-authored by myself, Philipp Dumbach and Björn Eskofier. The paper was submitted to the International Conference on Information Systems (ICIS) 2021. After a double-blind peer-review process and one round of revise and resubmit, it was accepted for presentation at the ICIS 2021. The paper is published in the proceedings of the conference (VHB: A, VHB Publication Media Rating 2024 Information Systems conference proceedings).

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3.2. Academic Paper

Abstract

The adoption of artificial intelligence (AI) within organizations is experiencing growing interest. Since AI has distinctive characteristics (automation – augmentation), it is unclear how both characteristics influence the adoption. Besides, current research calls for a configurational perspective within the adoption theory. Building on these research gaps, we use the technology-organization-environment framework (TOE) and combine the AI characteristics ‘automation – augmentation’ and ‘product or service – process’ with the organizational and environmental characteristics: differentiation strategy, resources, entrepreneurial orientation, and network support. We collected a sample of 104 questionnaires from top-level and middle-level managers as well as IT experts. Using fuzzy set Qualitative Comparative Analysis (fsQCA), we reveal four different solutions, namely internal integrator, supportive provider, powerful innovator, and rising enthusiast, that explain the adoption of AI. Moreover, we show that organizations adopting AI have an explicit focus on AI characteristics. Furthermore, we underline the importance of configurational thinking within the adoption.

Keywords: Artificial Intelligence, Organizational Adoption, Automation, Augmentation, Adoption, Configuration, fsQCA

Introduction

The importance of artificial intelligence (AI) is increasing in organizational domains and is finding its way into numerous process specific as well as product specific applications (Davenport and Ronanki 2018). Since the 2010s, this development has been driven by innovations within the underlying AI methods, new data sources, increased computational power, and cloud-based services (von Krogh 2018). Thus, organizations start to consider the adoption and integration of AI and foster the usage in products or services and in processes (Chui and Malhotra 2018). Nevertheless, organizational adoption of AI is still in its infancy, with only one-fifth of manufacturing companies and less than half of service operation companies using AI (Balakrishan et al. 2020; Perrault et al. 2019). Focusing on these early adopters of AI, recent studies have shown the importance of the strategic orientation as well as the characteristics ‘resources’ and ‘network support’ for the adoption of AI (Ransbotham et al. 2019).

With the increasing practical importance of AI, the scientific examination of AI is gaining momentum, too. The current management literature focuses on AI in several aspects like decision-making, application branches, data usage, and occurring challenges (Dwivedi et al. 2019). On the one hand, current research uses a generic perspective and looks at the holistic impact on management. On the other hand, scientists are investigating the impact of AI on decision-making (Duan et al. 2019), automation potentials (Raisch and Krakowski 2020), and implications for business areas like operations management (Grover et al. 2020) or production and predictive maintenance (Keller et al. 2019). With regard to the AI adoption in the enterprise, current studies are examining application scenarios as well as technical and ethical requirements (Alsheibani et al. 2018). However, there is still a gap regarding the impact of AI on existing organizational theories (Bailey et al. 2019). Little research addresses the AI-specific characteristics and its impact on the adoption in organizations. Raisch and Krakowski (2020) emphasize the interaction between automation and augmentation within AI adoption. Nevertheless, empirical studies have not sufficiently investigated this conceptualized relationship.

From a methodological perspective, most adoption research considers the ‘net effect thinking’ (Ragin 2008), assuming singular causation and linear relationships (Fiss 2007). Isolated effects of diverse adoption antecedents, such as perceived advantages and complexity, are mostly discussed (Rogers 2010). Lyytinen and Damsgaard (2011) suggested the investigation of a configurational analysis of inter-organizational adoption. We argue that especially in the adoption process which is still done by humans and therefore complex (Frambach and Schillewaert 2002) the net effects of individual causal conditions depend on the presence or absence of other individual causal conditions (Fiss et al. 2013). There is both theoretical and empirical evidence for the configurational perspective. Depietro et al. (1990) emphasize that different factors are crucial for the adoption and implementation depending on the specific context. They show that the different factors are interconnected and jointly influence adoption. In addition to this theoretical aspect, several studies find that the same factors can have a significant or insignificant influence on adoption. Gangwar et al. (2014), who conducted a literature review on IT adoption and demonstrated that different variables such as relative advantage, complexity, top management support, and technology competence are both significant and insignificant in different studies, prove this indication of causal complexity. Therefore, we agree with Furnari et al. (2020) and contend that configurational theorizing is suitable for the adoption of innovations, where complex interdependencies of several factors, derived from the theory, can be revealed by using qualitative-comparative analysis (QCA).

Using an adoption perspective and building on the current research of AI, we use the suggested perspective of Depietro et al. (1990), namely, the three dimensions of the technology-organization-environment framework (TOE), and enrich them with the existing AI-specific characteristics of augmentation and automation. Hereby, our study answers the research question: how do technology-specific, organizational, and environmental factors interplay, and in which configurations do they lead to the organizational adoption of AI? To answer the research question, we focus on industry companies in Europe that are digitizing their business. These companies are appropriate because they provide us with a cross-section of the adoption of AI in the corporate context.

We first review the current literature on AI in the organizational context and situate the findings within the information systems (IS) literature. The next section describes the deviated theoretical configurational model. The following chapter deals with the survey methodology and illustrates the theoretical foundation of fuzzy set qualitative-comparative analysis (fsQCA) and the measurement scales. Afterwards, the descriptive statistics, the analysis, and the results are presented and followed by the discussion. The study finishes with our theoretical and managerial contribution, the limitations and the outlook.

Artificial Intelligence and Organizational Adoption Theory

Russell and Norvig (1995) describe AI as a technological area, which aims for the creation of intelligent agents and their understanding. Literature illustrates various AI definitions from machines having minds over computers doing human activities (Bellman 1978; Haugeland 1989; Luger and Stubblefield 1993; Russell and Norvig 1995). Among the enormous variety of descriptions, we follow the definition of Russell and Norvig (1995), who described AI as the automation of human tasks, actions and reactions in the form of problem solving, decision making and learning. Table 14illustrates the different core themes within AI adoption in organizations for further structuring the most relevant literature.

Table 14 Literature review – Organizational adoption of AI.

Theme	Details	Citations
Benefits & challenges of AI adoption	Decision-making, decision support Artificial knowledge creation Opportunities, challenges	Duan et al. (2019) Harfouche et al. (2017) Unhelkar and Arntzen (2020), Dwivedi et al. (2019), Sestino and Mauro (2021),
Application scenarios	Predictive maintenance AI-based digital transformation, business model transformation Operations management, SCM	Keller et al. (2019) Akter et al. (2020), Wamba-Taguimdje et al. (2020), Burström et al. (2021) Grover et al. (2020), Min (2010)
Requirements & technological readiness	AI readiness of firms Weaknesses of AI approaches	Alsheibani et al. (2018) Greene (1987)
Factors influencing AI adoption	Employee perspective Strategic management Automation - augmentation Product - process Business case, benefits, TMS, data, AI talent & compatibility Entrepreneurial orientation	Ambati et al. (2020) Alsheibani et al. (2020a) Raisch and Krakowski (2020) Paschen et al. (2020) Alsheibani et al. (2020b), Bag et al. (2021) Dubey et al. (2020)
Ethics, legal & security	Ethical framework, explainable AI, accountability	Asatiani et al. (2021), Dwivedi et al. (2019)

These themes underline the focus areas of current research. Advantages and challenges within the adoption process play an important role. The investigation of potential application areas and scenarios is observable. We summarize multiple factors and their influence on AI adoption. However, the consideration of AI-specific characteristics within current organizational adoption research was less considered, so we broaden the view to the established findings regarding organizational adoption research from an IS perspective.

Especially in the IS field, scholars follow the TOE framework (Depietro et al. (1990). Nevertheless, most researchers incorporate different conditions within these three dimensions with regard to the innovation itself and the theories of interest. Oliveira and Martins (2011) conduct an intensive literature review, highlight the relevance of the different dimensions within the TOE-framework, and compare the findings with Rogers' (2010) attributes of innovation. Zhu et al. (2006) combine the technological, organizational, and environmental context. They differentiate the technological context from Depietro et al. (1990) and focus on technology readiness and technology integration. Zhu et al. (2006) look additionally at organizational characteristics instead of the characteristics of innovation as in the TOE-framework. With regard to the organizational dimension, most scholars take descriptive characteristics (e.g. size, slack, and scope) into account. The environmental dimension often considers competitive pressure, regulatory environment, or network (Depietro et al. 1990; Iacovou et al. 1995).

Besides the importance of technological, organizational and environmental characteristics, Depietro et al. (1990) emphasize the interaction and connectedness between the three dimensions. Most studies establishing the connection between antecedents and adoption of a technology apply “variance-based or process-based theories in nature of their analysis” (Sun et al. 2020, p. 111). Recent research follows those suggestions and reveals “that factors from the technology, organization and environment contexts jointly influence organizational adoption” (Sun et al. 2020, p. 117). This emphasizes the claim for a configurational perspective where “variables found to be causally related in one configuration may be unrelated or even inversely related in others” (Meyer et al. 1993, p.1178). These interactions between different dimensions shed a new light in the current research on IS adoption and AI adoption in particular. Following configuration theory, we investigate the interaction of characteristics leading to the outcome (Rihoux and Ragin 2009). While regression-based methods look at the influence of antecedents on adoption, the consideration of the interactions between factors is necessary.

Configurational model for the adoption of AI

In order to identify different configurations that influence the adoption of AI, we follow (Furnari et al. 2020) by looking at the three dimensions of technology, organization, and environment as frames that affect the adoption. Within each of those dimensions, we selected conditions that individually or in interplay influence adoption in an organization (see Figure 29). Therefore, our research model is based on configurational considerations. Nevertheless, configurational models do represent causality, even if not in the form of preformulated hypotheses (Furnari et al. 2020). In configurational models, causality is described as causal recipes, which are “formal statements explaining how the causally relevant elements combine into configurations in ways to produce a target outcome” (Park et al. 2020: p. 1497). Our model comprises four technological factors (perceived advantages of augmentation, perceived advantages of automation, perceived applications in products and services, perceived applications in processes), three organizational factors (competitive strategy, resources, entrepreneurial orientation), and one environmental factor (network support).

According to Raisch and Krakowski (2020) we argue that organizations perceive AI in the context of automation and of augmentation. In addition, AI can be used in processes or in form of products and services (Ransbotham et al. 2019). Focusing on the organizational aspects, we follow a configurational approach and aim to incorporate conditions that are distinct from each other and have no theoretical overlap. Those conditions are the competitive strategy especially differentiation strategy (Congden and Schroeder 1996), resource availability (Depietro et al. 1990), and entrepreneurial orientation (EO) (Avlonitis and Salavou 2007). Previous research showed the importance of the organizations’ environment, we also consider network support (Iacovou et al. 1995; Valente 2010).

When designing our configurational model, we followed three basic best practice recommendations. First, we choose the variables in alignment with existing theory. Second, we ensured adequate exhaustiveness, and third, reduced the overlap between different variables in the model. According to the empirical limits, we considered the number of attributes in the fsQCA methodology, too (Greckhamer et al. 2013). In the subsequent sections, we illuminate the theoretical bases for the variables taken into account.

Adoption of AI

We selected the organizational adoption of AI as an outcome variable and used the definition from our theoretical section to characterize AI. Clearly separating the adoption from the intention to adopt, we define the adoption as the implementation within the organization (Hausman and Stock 2003; Kennedy and Fiss 2009). Thus, we focus on realized AI adoption instead of current plans.

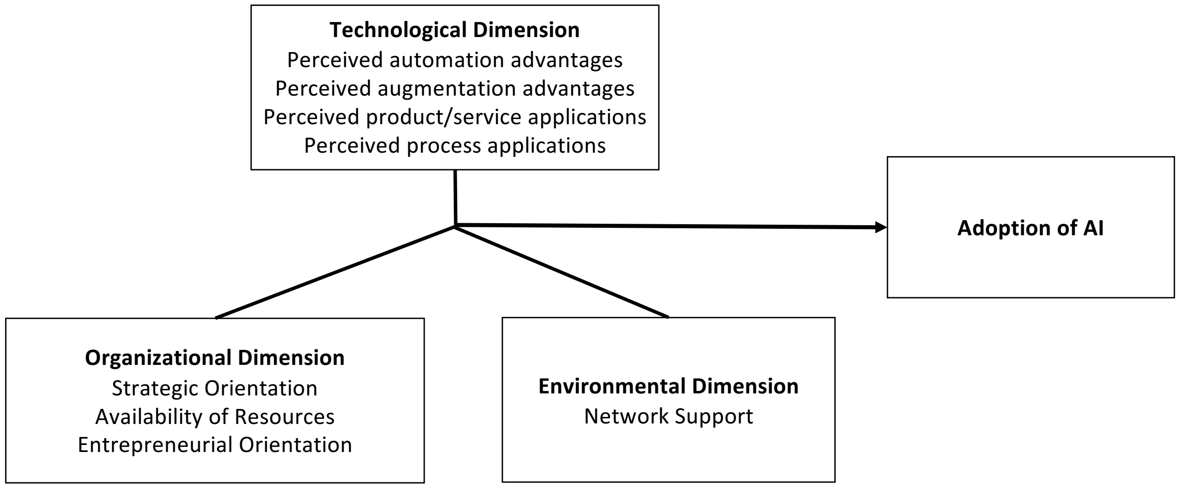

Figure 29 Configurational research framework.

Technological Dimension

Perceived automation – augmentation advantages: With regard to the technological dimension, Depietro et al. (1990) advocate for the consideration of innovation specific characteristics. Raisch and Krakowski (2020) subsume the current literature on AI and identify two characteristics that distinguish AI from other technologies: automation and augmentation. Both refer to potential benefits that can have a positive impact on the company, which favors their decision to adopt the technology (Rogers 2010). They argue that it is no either-or decision to automate or augment current businesses. They apply a comprehensive paradox theory perspective and elaborate that the interaction of both applications is interdependent over time and space. While automation is considered as the replacement of humans by AI systems, augmentation highlights the interaction and the collaborative work between humans and AI systems (Raisch and Krakowski 2020). While the presented literature argues for a comprehensive picture and usage of AI, most practical oriented research such as Ransbotham et al. (2019) highlight the importance of augmentation. Furthermore, current use cases and publicly presented AI-systems focus on one of the mentioned applications (Grover et al. 2020; Keller et al. 2019). We follow Raisch and Krakowski (2020) and emphasize the connection between the perceived advantages of augmentation and automation as the interplay of two variables.

Perceived potentials in products or services and processes: Organizations apply AI within both products and services as well as organizational processes (Dwivedi et al. 2019). Concerning Tornatzky and Klein (1982), we follow their understanding regarding the compatibility practices. Technologies are adopted if they are compatible with the possible applications in the company. It is important for what and in which context technology is implemented. In the context of AI, innovations can fit regarding processes or products and services. Most adoption research focuses on either product or processes, we argue that depending on the organizational and environmental situation of a firm, the application within product or service and process is determined (Ransbotham et al. 2019). Perceived product and process potentials perfectly integrate with automation and augmentation characteristics of AI. There may be cases where augmentation, product applications, and differentiation strategies complement each other and influence AI adoption.

Organizational Dimension

Focusing on the organizational dimension, we use the described principle and integrate three pillars of management theories. According to Makadok et al. (2018) current research should not follow new and groundbreaking theories and instead aim for an integration of existing theories, to explain the topic of interest in a better way. We incorporate the organization’s strategic focus, the availability of resources, and the innovative capacity of organizations. These fundamental theories have been investigated in prior research and demonstrated causal relevance for the adoption (Marshall et al. 2015). We argue that the interaction of these three pillars enables adoption.

Organizational adoption always depends on the actual circumstances (Wang et al. 2010). Therefore, the adoption is influenced by the characteristics such as strategies and mindsets of the organization. Especially the adoption of technological innovations is relative to the fit of the technology and the organization. We follow Fiss (2011) and argue that the interaction of different characteristics enables the adoption as different configurations lead to different possible outcomes. Miles et al. (1978) underline the configurational perspective within the organizational context, too. Building on Grant (1991) we highlight the strategy-driven focus with resources and capabilities. Furthermore, we enrich these two perspectives with the entrepreneurial orientation of the organization as this condition describes the openness and innovativeness of an organization to integrate and use innovations (Hughes and Morgan 2007).

Differentiation Strategy: Focusing on the competitive strategy, current research builds on the seminal work of Porter (1980), who first elaborated two strategic opportunities - cost leadership and differentiation - and then extended those by focused differentiation and cost leadership strategies (Porter 1985). The current theory integrates the competitive strategy with other strategies and investigates the influence on activities and performance (Zollo et al. 2018). Although both competitive strategies need specific actions and decisions within the organization in unique ways, neither cost leadership strategy can neglect customer requests nor will a differentiation strategy work without a focus on the project costs (Porter 1985; Zollo et al. 2018). However, concentrating on the adoption of AI, scholars highlight the potential regarding extending current activities or offerings and do not only focus on cost-cutting (Ransbotham et al. 2019; Ransbotham et al. 2020). Differentiation strategy underlines those demands as it is based on adapting and enriching existing or creating new products and processes with new technologies (Porter, 1985). This is in line with findings of the adoption literature as differentiation predicts the adoption better than cost leadership (Congden and Schroeder 1996).

Resources: Using a broad understanding of organizational resources, we integrate financial resources, human capital specific resources, and absorptive capacity. Since Depietro et al. (1990) resources are known as drivers of adoption decisions. They considered employees as well as financial resources. Furthermore, they integrated capabilities such as boundary spanning and communication with external sources. Those are integral aspects of absorptive capacity, as we follow Cohen and Levinthal (1989, 1990) who define it as the ability to recognize, assimilate, and commercialize new external information. Financial resources are important as they enable the organization to obtain the potential and flexibility to adopt AI (Iacovou et al. 1995). As AI is a complex, case-specific technology that needs to be developed and modified for specific tasks, skilled and further trained employees are required (Sousa and Rocha 2019). AI is a fast-developing technology and a huge research field in itself, therefore resources are crucial for AI adoption in organizations.

Entrepreneurial Orientation: Recent studies have shown that EO influences the adoption of innovations (Marshall et al. 2015; Pérez-Luño et al. 2011). The moderating influence of EO is particularly evident in complex adoptions (Marshall et al. 2015). Characteristics such as innovativeness and risk taking are conducive to these courageous decisions. We build on Lumpkin and Dess (1996) and argue that an existing EO is an essential condition for startups as well as existing organizations as it enables these firms to create new business opportunities and expand an existing business. As EO consists of “processes, practices, and decision-making-activities that lead to new entry” (Lumpkin and Dess 1996, p. 136), these activities are essential for recognizing the potential, adopting, and using AI. We refer to the widely accepted five dimensions of EO - risk-taking, innovativeness, proactiveness, competitive aggressiveness, and autonomy (Hughes and Morgan 2007; Lumpkin and Dess 1996).

Environmental Dimension

Network Support: Besides the characteristics of the innovation and the internal organizational conditions, the organizational environment also influences the adoption. Recent studies have shown the importance of the ecosystem (Mäkinen et al. 2014), the stakeholders (Sarkis et al. 2010) and the network on the adoption (Valente 2010). We agree with Valente (2010) as well as Rodan and Galunic (2004) and underline that a strong and close network with different partners influences the adoption of innovations. This is especially important for innovations that are knowledge intensive such as AI. Networks assist in acquiring the knowledge needed for implementation in sharing experiences and providing insights (Rogers 2010). Networks have a causal link to adoption, for example, by compensating internally for missing knowledge (or other resources). We focus on the characteristics of the network relationships like cooperation, missing resources like knowledge, and motivation to relationship development as those determine the quality of the network ties (Ibarra 1993; Rodan and Galunic 2004). Within this study, we include actors of the value chain (customer, supplier, and complementor) as well as research institutions (e.g. universities, clinics) and public institutions like ministries and associations.

Methodology

Introduction to fsQCA

Analyzing the interaction between conditions rather than identifying net effects we apply the fuzzy set Qualitative Comparative Analysis (Fiss 2011; Furnari et al. 2020; Ragin 1987, 2000). Most studies on adoption theory have used traditional methods such as regression analysis (Oliveira and Martins 2011). However, researchers consider adoption decisions and its implementation as complex phenomena by nature due to the fact that humans and their perceptions are involved (Frambach and Schillewaert 2002; Sun et al. 2020). Furnari et al.

(2020) highlight the benefit of configurational thinking if phenomena of interests, called outcomes, are influenced by conditions that interact in complex or contradictory ways.

FsQCA sees cases "as combinations of theoretical attributes of interest rather than as disaggregation of their attributes being treated in isolation from each other as it is done in conventional regression approaches" (Misangyi et al. 2017: p. 260). This leads to three specific characteristics that separate fsQCA from traditional qualitative and quantitative methods, causal asymmetry, equifinality, and conjunction (Misangyi et al. 2017), and build on "the analysis of set relations" (Ragin 2008: p. 13). Conditions as well as outcomes of interest are conceptualized as sets and subsets and no single, independent variables.

Conjectural causality is described as "causal recipes" (Ragin 2008: p. 109) and shows that different combinations of the conditions lead to the outcome. The focus is shifted from identifying the intensity of attributes with independent effects to the combination and interaction of conditions (Misangyi et al. 2017). Equifinality describes the fact that more than one solution might lead to the same outcome. Similar to Porter (1985), who describes two different successful competitive strategies, fsQCA allows the identification of more than one solution for the same outcome (Fiss 2007). Causal asymmetry is contradictory to the fundamental symmetry principle of linear regression and underlines the idea that either the presence or the absence of one condition will lead to the outcome, depending on the interplay with others (Ragin 2008).

FsQCA is suitable for the analysis of factors influencing the adoption, since the three fsQCA-specific characteristics causal complexity, equifinality, and causal asymmetry are found. Causal complexity is illustrated by Depietro et al (1990), who emphasize that conditions interact and lead in combination to adoption. In addition, they underline equifinality because adoption can appear in different contexts. These contexts result from the conditions in the three dimensions of technology, organization, and environment (see Figure 1). Evidence of causal asymmetry occurs in the partially significant and partially insignificant influence of conditions such as relative advantage (Gangwar et al. 2014).

Furnari et al. (2020) call for a heuristic approach while conducting fsQCA and recommend the three steps: scoping, linking, and naming. Scoping focuses on the identification of characteristics that might explain possible configurations. As described, we use the TOE framework with its three dimensions as an anchor and enrich it with aggregated and relevant themes. This consideration was the fundament for the integration of the three aspects of resources and the combination of the five dimensions of EO. In the linking step, we built on these ideas and looked at the three distinctive characteristics of fsQCA (causal asymmetry, equifinality, and conjunction). On the one hand, we considered the interaction of different characteristics within one dimension such as the focus on differentiation strategy, EO, or the relevance for automation and augmentation within the AI characteristics (see Figure 1). On the other hand, we integrated the connection across the three dimensions. The interplay between the focus on product and service or process in combination with the differentiation strategy is often-discussed within AI research (Ransbotham et al. 2019). In addition, the interplay of EO, resources, and network support describes the power supply and motivation sources needed for the adoption. We apply the naming within the next sections while we create names for the solutions and capture the central ideas above distinct solutions differentiating between core and peripheral conditions.

Data Collection and Measurement Scales

The empirical data was gained in a quantitative survey with top-level and middle-level executives as well as IT experts from European organizations. We follow previous studies that also used questionnaires in the context of organizational adoption (Sun et al. 2020; Won and Park 2020). We used LinkedIn to carefully select managers that are chief responsible for digitizing their company. We scanned the profiles with regard to their position within the organization (e.g. c-level, director, head of IT) and their job description (e.g. AI, digitization) (Sun et al. 2020). In total, we identified 650 managers to whom we mailed the invitation to our survey. We asked the participating managers whether they were responsible for digitization in the company and if they were the “most-informed person in the firm to answer the questionnaire” (Zhu et al. 2006, p. 1565). If this was not the case, we asked them to forward the questionnaire to the relevant manager. We received 104 completed questionnaires (response rate: 16%) between May and September 2020. Table 15 illustrates the industry background, the participants’ responsibilities and the number of employees within the organizations, which were on average 48 years in the business.

Table 15 Industry survey – Participant description.

Industry	23% IT; 18% Healthcare & Medical Technology; 14% Automobile & Parts; 9% Industrial Engineering; 8% Electronics; 4% Financials; 24% Other
Employees	18%: <10; 21%: 10-99; 5%: 100-999; 23%: 1,000-9,999; 33% >10,000
Management Level & Job	46% Top-Level (e.g. CEO, CTO, Founder); 37% Middle-Level (e.g. VP, Department Manager); 17% IT Experts (e.g. Senior Data Scientist)

The outcome, as well as most conditions, were measured with multi-item scales with a five-point Likert scale ranging from 1 = "completely disagree" to 5 = "completely agree". The item development followed previous work as well as established and validated items. In addition, we conducted a pre-test and validated the questionnaire with seven AI industry experts and six researchers. Concerning the adoption of AI, we employed two items based on Gerstner et al. (2013) and Lenox and King (2004). The first item captures the engagement of the firm in AI initiatives and projects, the second item captures the degree to which AI is part of the firms' product and service offerings. The corresponding questions were "We implemented initiatives and innovation projects with AI for our product, processes and business models." and "Products and services that use AI or are produced with the help of AI account for a share of our sales". We followed the definition of Raisch and Krakowski (2020) and measured automation and augmentation with two single items each. For the perceived application of AI in products and services as well as in processes, we used three items each, based on the characteristics of digital innovations (Lyytinen et al. 2016; Yoo et al. 2012). When looking at the differentiation strategy, we followed the two items suggested by Fiss (2011). Concerning the resources, we linked tangible (financial, employees) and intangible (absorptive capacity). The budget for AI was set in relation to the revenue. Focusing on the employees, we adapted three items by Oliveira and Martins (2011) and Ransbotham et al. (2017). We measured absorptive capacity by the four items suggested by Ritala and Hurmelinna-Laukkanen (2013). We used the fifteen items from Hughes and Morgan (2007) to measure EO. Network support involved customers, suppliers, complementors, universities, and public institutions. We followed Rodan and Galunic (2004) and used three items for each of the five types. Table 16 depicts the descriptive statistics.

Table 16 Means, standard deviations, and correlations.

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1. Augmentation	2.361	1.279									
2. Automation	2.519	1.377	.837**								
3. Product/Service	3.469	1.174	.482**	.428**							
4. Process	3.34	1.095	.556**	.528**	,804**						
5. Differentiation	3.968	.965	.167	.18	,471**	.429**					
6. Rel. AI Budget	.278	.415	.119	.181	0,151	.104	.244*				
7. Human Resources	2.91	1.191	.483**	.441**	,494**	.399**	.338**	.308**			
8. Absorptive Capacity	3.683	.9	.375**	.287**	,442**	.363**	.242*	.210*	.361**		
9. Entrepreneurial Orientation	3.738	.717	.397**	.336**	,566**	.455**	.415**	.352**	.513**	.592**	
10. Network Support	3.491	.755	.1	.033	.15	.19*	.252**	.129	.2*	.38**	.298**
*Notes: * p < .05 ** p < .01*											

For reliability analysis, we calculated Cronbach's alpha and evaluated the internal consistency of the different subscales with three or more items. For conditions that used only two items, we calculated the Spearman-Brown-Coefficients. The internal consistency is acceptable (lowest: .687, highest: .897) (Eisinga et al. 2013). Additionally, composite reliability (lowest: .827, highest: 0.946) and average extracted variance (lowest: .626, highest: .854) were calculated. All reliability coefficients were above the thresholds (Bagozzi and Yi 1988). We assessed discriminant validity using the heterotrait-monotrait ratio of correlations criterion. The highest value was 0.78 and thus below the threshold suggested by Henseler et al. (2015). We tested for non-response bias and checked the early and latter half of the sample. This did not provide any abnormalities (Armstrong and Overton 1977). Multicollinearity might exist in fsQCA, but fsQCA is not affected (Gligor and Bozkurt 2020; Schneider and Wagemann 2010). Instead, more dimensional phenomena appear in clusters and "exert their causal impact on the outcome only in conjunction" (Wagemann and Schneider 2007: p. 11). This is particularly important for automation – augmentation, and product - process as we described in the chapter "Configurational model for the adoption of AI".

Since we collected self-reported data from a single respondent within an organization, there is the possibility of common method bias (CMB) (Podsakoff et al. 2012). In order to reduce CMB, our study design followed ex-ante recommendations (e.g., questions had no particular order). Furthermore, we used the Haman's single factor test including all items. The results show that the items loaded on multiple distinct factors with the first factor accounting for 24.35% of the variance. This suggests CMB as non-problematic (MacKenzie and Podsakoff 2012).

Data Analysis and Results

FsQCA Execution

To extract the solutions that lead to a high and organization-wide adoption of AI, we conducted the fsQCA with the software R-Studio (1.2.1335) and R (3.5.3). We used the packages QCA (3.6) and SetMethods (2.5) (Duşa 2018). We identified configurations with high- and low-adopting rates (Ragin 2008). Therefore, variables are traded as indicators of set memberships and not absolute numbers. Linking the case membership scores of the different conditions with the membership scores of the outcome, we can assess if configurations are necessary or sufficient for the intended outcome (Fiss 2011; Ragin 2008). We perform three steps – calibration, necessity and sufficiency analysis, truth table analysis – and check the results with robustness checks.

Calibration: All construct measures are calibrated into fuzzy set membership scores between 0 and 1 (Ragin 2008). Therefore, three anchors are defined for each condition. The crossover point defines the borderline between being a non-member and a member of a condition (=0.5), the exclusiveness score defines the full non-membership score (=0) and the inclusiveness score refers to the full membership score (=1) (Fiss 2011). We followed the calibration guidelines for multi-item scales (Ragin 2008). Our calibration process consists of two steps and is based on best practice recommendations (Greckhamer et al. 2018; Schneider and Wagemann 2010). In the first step, we orient on the minimum, midpoint, and maximum of the 5-point Likert scale as full non-membership, cross-over point, and full membership. Second, we include mean, standard deviation, and variance in the calibration, as these differed to some extent. This is particularly evident in the minimum value of EO, which corresponds to 1.8 (Thornton et al. 2019). Therefore, we assigned the anchor for the non-membership condition a value of 1.8 to EO and a value of 1.4 to all other constructs. As an anchor for the crossover point, we assign a value of 3.01 to adoption of AI, 2.49 to automation and augmentation, and 3.49 to all other constructs. The anchor for full-membership is 4.6 for all constructs. For the ratio of AI budget to revenue, the anchor for the non-membership score is zero (no dedicated AI budget), the anchor for the crossover point is 0.005, and the anchor for full membership score is 1 (AI budget is at least as huge as the current revenue).

Necessity and sufficiency analysis: We checked for both, a necessity as well as single sufficiency. All results were validated with x-y-plots.

Truth Table Analysis: We structured the cases in the truth table and considered all 2k combinations (k=number of causal conditions) (Ragin, 2008). Using the thresholds for inclusion, consistency, and coverage, the truth table was refined (incl.cut = 0.8; pri.cut=0.7; n.cut = 1) (Fiss 2011; Greckhamer et al. 2018; Schneider and Wagemann 2010). First, we calculated and studied the parsimonious solution, second, the intermediate solution, and third, linked both together (Fiss 2011).

Core conditions appear in parsimonious and intermediate solutions and indicate stronger empirical evidence for the outcome than peripheral conditions. The major interest for interpretation is defined by the core conditions. Peripheral conditions only appear in the intermediate solution and indicate less empirical relevance. These peripheral conditions complement the core conditions and are rather exchangeable. Therefore, there can appear different neutral permutations, where the same core conditions are accompanied by different permutations of peripheral conditions. This emphasizes the principle of equifinality. A present core condition suggests that a high membership score of this specific condition is essential for the outcome. An absent core condition indicates that a low membership score of the condition is important within this solution (Fiss 2011).

Validation and robustness checks: We checked our results with regard to robustness and validity. We changed the calibration and tested the results with the crossover point of the outcome as well as the conditions being either below or above three. We changed the crossover point for the ratio of AI budget to revenue from 0.005 to 0.02 and to 0.0025. Furthermore, we changed the calibration according to the 10%/90% percentile and the 20%/80% percentile. No major changes were recognized, and the results stayed robust. In addition, we examined the cases of the four individual solutions and checked that companies of different sizes and industries as well as responses of differing management levels are present in all solutions. We did not find any anomalies here.

Results

Identifying necessary conditions: The results, presented in Table 17, indicate that neither the presence nor the absence of any condition is necessary for the outcome. However, some conditions are almost necessary. We checked the x-y-plots but there were always cases that contradict necessity. Deploying fsQCA a necessary condition requires a consistency score larger than 0.9 (Ragin 2008).

Identifying sufficient solutions: We analyzed the truth table for the described causal recipes that are sufficient for AI adoption. Table 18 illustrates the six solutions that lead to a high membership score for AI adoption. In total, four major solutions are identified. Solution 1 has three neutral permutations (solutions 1a, 1b, 1c). Solution 2, 3, and 4 have no neutral permutations. The permutations of solutions 1a, 1b, and 1c only differ in peripheral elements. The core elements remain identical. Solution 4 unites the core conditions of solution 1 and 3. The consistency values of the solutions are between .924 and .969. Therefore, the empirical findings strongly agree in predicting the outcome. The overall solution consistency is .904. The raw coverage values that evaluate the size of the overlap between solution sets and outcome set are between .189 and .486. The unique coverage that controls for the overlap between different solutions ranges between .008 and .059. As all values are above .000 all the six solutions possess mathematical and empirical relevance (Rubinson et al. 2019). Solution 1b has the highest number of coverage, which implies that this configuration occurs most frequently in our sample. The overall solution coverage is .602 showing a high explanatory power in terms of representing the majority of empirical observations' membership in the outcome. These numbers are comparable with current QCA studies (Meuer 2014; Meuer et al. 2015).

Table 17 Test for single necessary conditions.

	Necessity			**Necessity**	
ADOPTION	**Consistency**	**Coverage**	**ADOPTION**	**Consistency**	**Coverage**
AUTOMATION	.672	.766	automation	.549	.430
AUGMENTATION	.712	.731	augmentation	.478	.402
PRODUCT/SERVICE	.878	.667	product/service	.356	.408
PROCESS	.825	.685	process	.455	.466
DIFFERENTIATION	.893	.555	differentiation	.313	.520
RESOURCES	.873	.704	resources	.442	.469
ENTREPRENEURIAL ORIENTATION	.894	.621	entrepreneurial orientation	.393	.519
NETWORK SUPPORT	.765	.601	network support	.523	.574
Note: capital letters indicate the present of a condition; lowercase letters indicate the absence of a condition.					

Table 18 Solution chart for adopting AI.

	Internal Integrator			Supportive Provider	Powerful Innovator	Rising Enthusiast
	(1a)	(1b)	(1c)	(2)	(3)	(4)
Technological Dimension						
Automation	●	●	●	●		●
Augmentation	•	•	•		●	•
Product or Service		•	•	●	●	●
Process	●	●	●	⊗	•	●
Organizational Dimension						
Differentiation Strategy	•	•		•	•	⊗
Resources	●	●	●	●	●	●
Entrepreneurial Orientation	•	•	⊗	•	●	
Environmental Dimension						
Network Support	•		⊗	●	●	●
Consistency	.928	.930	.934	.969	.924	.946
Raw Coverage	.428	.486	.213	.233	.459	.189
Unique Coverage	.017	.059	.008	.031	.048	.010
Overall Solution Consistency				**.904**		
Overall Solution Coverage				**.602**		

Notes: large black dots indicate present core conditions; small black dots present peripheral conditions; large crossed circles indicate absent core conditions; small crossed circles indicate absent peripheral conditions.

Discussion

Our empirical analysis revealed worthwhile patterns that need to be discussed in the light of adoption theory, organizational context, and AI characteristics. As suggested by Furnari et al. (2020) we assigned representative names to highlight the empirical distinct characteristics of the main solutions.

Solution 1: Internal Integrator: We find three variants of the first type that lead to AI adoption. The core conditions (automation, process, and resources) are each extended by the perception of the potential of AI in augmentation. Furthermore, one of the following three combinations complements them: high differentiation, strong entrepreneurship and high network support (1a); high differentiation, strong entrepreneurship and the perception of the potential of AI within products and services (1b); high perception of the potential of AI within products and services, low EO and lack of network support (1c). These configurations indicate that those companies focus especially on cost saving potentials realized through AI. Since these firms rely primarily on their resources and see the AI potential in process automation, we characterize them as internal integrator of AI. However, these organizations make use of augmentation benefits. Current literature discusses the potential of AI for the process e.g. in predictive maintenance (Keller et al. 2019). AI does not only automate existing processes, instead the processes are enriched by new functionalities (Raisch and Krakowski 2020). With the help of predictive maintenance, new maintenance cycles can be determined efficiently and effectively. Organizations either supplement their own resources with the help of partners (1a) or rely on their internal capabilities (1b, 1c).

Solution 2: Supportive Provider: These organizations combine a high perception of automation and product or service potentials, lots of resources, and high network support. Peripheral conditions include low perception of process potentials, a focus on differentiation strategy, and high EO. This indicates that they combine innovation spirit with resources in a focused rationale. These firms perceive the AI advantages for their organization within product and service offerings and not in processes. Therefore, companies focus on individual AI applications within the adoption. Organizations offer new products to customers that rely on AI's automation potentials. Since they offer AI applications for other companies, these firms are named supportive providers. They possess a clear strategic focus and EO to realize those projects. Several members are relatively young firms like IT startups that focus on one specific product or service for its customers. Despite the fact, they are young; they invest most of their resources on AI and work closely with partners within their strong network. Universities and public institutions offering bootcamps and special funding are an integral part, enabling the firms to adopt AI.

Solution 3: Powerful Innovator: This type of firm combines the core conditions perceived potential for augmentation, products and services, high resources, EO, and network support. The peripheral conditions perceived potential for processes and differentiation strategy extend this solution. We see that these organizations rely on their strong network partners, high resource strength, and innovation spirit to develop new product and service offerings. These organizations use AI to create radical innovations. Ransbotham et al. (2019) call for those applications as they offer new values.

One well-known example fitting in this group is IBM Watson, which uses AI in applications to support the transformation of healthcare organizations (IBM Watson Health 2021). Here, customers receive offerings about new products or services with previously unavailable value dimensions. For the realization, the companies use not only their resources but also external partners such as complementors, universities, and cooperation with customers. If we look at other companies in this group, such as Alphabet Inc., they realize the potential of the same technologies in internal processes in addition to the use of AI in products and services. Alphabet Inc. applies AI both to run its data centers optimally (Evans and Gao 2016) and within numerous offerings like real time media translation (Google Cloud 2021).

Solution 4: Rising Enthusiast: These firms build on the core conditions of solution 1 and 2 (automation, product, process, resources, network support) and are complemented by the peripheral conditions low differentiation strategy and strong perception of potential within augmentation. We find several companies beginning their AI journey. They are often well-established players within industries that at first glance seem far removed from IT corporations. Instead, we find companies e.g. from the ceramics-manufacturing sector. Nevertheless, these organizations recognize numerous potential application opportunities and increasingly implement technologies linked to the field of AI. Therefore, firms establish internal AI departments and collaborate with external partners. Through bootcamps or cooperation with IT companies this collaboration form can be fostered. Being in trial phases, they still explore use cases within their core business without focusing on specific AI potentials. Thus, they are fascinated by the promised offerings of AI but still appear as seekers. Therefore, we characterize this group of adopters as rising enthusiasts.

Conclusion, Limitations and Outlook

Theoretical Implication

With current literature discussing the potentials and applications of AI within organizations, the rationales leading to the adoption of AI are still unclear. We contribute to answering this open question, by building on precious adoption theory and developing a framework building on technological, organizational, and environmental characteristics as configurations. In addition, we integrate existing theoretical AI characteristics in an empirical context.

Our theoretical contribution is divided into two points. First, we are contributing to current literature with a (neo-)configurational perspective on technology adoption that explicitly maps causal complexity, equifinality, as well as causal asymmetry and develops into a theory based on a typology of causal recipes (Furnari et al. 2020; Park et al. 2020). By using fsQCA, our work represents one of the first approaches to take a configurational perspective in the adoption of digital technologies. Sun et al. (2020) also apply fsQCA in the context of adoption. However, they focus on intention and unrealized adoption. We focus on actual adoption and implementation. Thus, from a theoretical perspective, we show that adoption is not only dependent on individual factors. Instead, the interaction of factors (conditions) is also important. We can show that different solutions exist as to how adoption can take place. The same factor can be required to be both present and absent for adoption to occur.

Second, we expand the current understanding of AI adoption. The literature review demonstrates, hardly any studies exist on AI adoption. In particular, factors that influence the adoption of AI are very rare. Furthermore, we consider AI-specific factors and incorporate AI-specific characteristics automation and augmentation (Raisch and Krakowski 2020). We find empirical evidence for the importance of this concept. We start with the three dimensions of technology, organization, as well as environment and enrich them with context-specific conditions. In doing so, we draw on current findings from management research and demonstrate their importance within the adoption.

Managerial Implication

Our study also helps organizations with their adoption of AI. First, it can be used as a blueprint or map for organizations considering the AI implementation. They can evaluate their position and see their potential for AI adoption. These findings will help firms within the adoption decision and implementation, as they know what conditions are required. In addition, firms can use our results to identify blind spots and strengthen important characteristics. Second, our findings might help organizations that already use AI to evaluate their potentials for further applications.

In conclusion, we answer our research question by analyzing 104 cases using fsQCA. We develop a configurational framework and include technological, organizational, and environmental conditions that are relevant in the context of adoption theory. Here, we supplement previous adoption characteristics with the AI-specific factors automation as well as augmentation and transfer the hitherto mostly conceptual considerations into an empirical context. In our analysis, we find four distinctive solutions, namely internal integrator, supportive provider, powerful innovator, rising enthusiast, and discuss them under consideration of configurational and adoption theory aspects. We show that the interaction between different conditions is important in the context of organizational adoption of AI.

Limitations and Directions for Future Research

Our study has several limitations, which offer potential for future research. First, our study is based on a broad definition of AI. We do not distinguish between different AI technologies, such as computer vision, machine learning or deep learning (Dwivedi et al. 2019). Future studies could investigate the use of specific AI technologies and focus on the respective application areas. Second, our study focuses on European organizations; it is unclear if those findings will appear similar within different cultural backgrounds. Third, our methodology relies on a cross-sectional study and uses self-reported data. Despite being sure CMB is not a problem, we suggest that future work could incorporate longitudinal data as well as different data sources. Our study showed a configurational approach for the adoption of AI. We hope these results will encourage the investigation of interplaying characteristics within the adoption theory.

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4. Publication 4: Adopting digital technologies to stay green – A configurational analysis

4.1. Notes on submitted Paper

This paper on "Adopting digital technologies to stay green – A configurational analysis" was co-authored by myself and my dissertation supervisor Prof. Dr. Alexander Fliaster. The paper was accepted for presentation at the 80th Annual Meeting of the Academy of Management in Vancouver, Canada in 2020 after a double-blind peer-review process. The paper is under review in a B- journal in business administration (VHB: B, VHB Publication Media Rating 2024).

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4.2. Academic Paper

Abstract

Prior research extensively addressed the adoption of digital and green innovations. However, these research streams mostly developed separately, ignoring the complex interaction between economic, ecological, and social influences: Different adopters can use the same technological functionalities because of different rationales. Moreover, previous adoption studies have been dominated by correlational thinking and methods like structural equation modeling, highlighting the isolated effects of diverse adoption antecedents. Transitioning from a predominant focus on correlations among isolated adoption antecedents, we pivot towards a view that integrates three rationales—economic, ecological, and social—that shape the adoption of green digital technologies. In this paper, we integrate these mechanisms within a comprehensive theoretical framework and examine their impacts using data from 53 'green innovators,' individuals who own biogas plants in the German energy sector, navigating the transition towards sustainability and digitalization. We analyze the data using fsQCA. Our findings reveal four archetypes of adopters that essentially differ concerning the configuration of adoption antecedents: Entrepreneurial market actor, green enthusiast, conformist, and holistic player. Our study contributes to the literature by providing a more comprehensive understanding of technology adoption factors as well as their combinations and developing theoretical bridges between digital innovation research and studies green entrepreneurship.

Keywords: adoption, digital technology, green innovation, QCA, sustainability, innovation management

Introduction

This paper deals with the complex interaction of economic, social, and green mechanisms within the adoption of digital and green innovations. In recent years, new offerings, organizational operations, and management practices are driven by digital technologies (Dąbrowska et al., 2022; Yoo et al., 2012). Consequently, adopting digital technologies occupies a central position in academic inquiry and practical application. Recent organizational adoption studies on digital innovations focused particularly on the impact of economic, network-related, and value-related factors (Ansari et al, 2010; George et al., 2021; Iyengar et al., 2011).

First, the economic drivers have been extensively elaborated within the organizational adoption research (Dąbrowska et al., 2022; Nambisan et al., 2017; Oliveira et al., 2014). As elucidated by Ansari et al. (2010, p. 69), this economic rationale has been described as "arguably the most dominant perspective in the diffusion of innovation literature". This perspective posits innovation adopters as "rational actors that scan their environment and make efficient choices" (Ibid.).

Second, previous studies have highlighted that adopting innovations can be encouraged by contagion over network ties (Angst et al., 2010; Iyengar et al., 2011). Social contagion emerges through interactions with various groups, encompassing peers and observations of other actors within the broader business environment (Strang and Soule, 1998). For instance, Iyengar et al. (2015) highlighted the influence of peers and partners, whereas Rogers (2003) delineated the pivotal role played by early adopters and opinion leaders.

Third, several digital technologies enable innovations that have a positive impact on the natural environment (Deng and Ji, 2015). Scholars have coined the term "digital sustainability" (Pan and Zhang, 2020), prompting a comprehensive exploration of how digital technologies can contribute to sustainability objectives. Recent works have begun to address the impact and opportunities offered using digital technologies to advance sustainability goals (George et al., 2021).

Within these three adoption research streams, most studies on digital innovations have focused on only one single rationale. On one hand, digital technologies promise to bolster efficiency and foster economic growth potential (Wang et al., 2010; Yeh and Chen, 2018). On the other hand, ecological thinking steers the development and adoption of green innovations (Thomas and Lamm, 2012). Nonetheless, this bifurcation fails to recognize that a growing array of promising technologies seamlessly combine potentials prowess with environmental friendliness (Bähr and Fliaster, 2023). This convergence of green and digital elements bears profound significance, particularly considering the synergies it engenders, which are instrumental in addressing pressing global challenges, such as climate change.

We argue that separating different adoption rationales into isolated silos neglects that they might spring into action simultaneously and be interrelated. This omission of multi-factor combinations reflects that prior research on innovation adoption has predominantly adhered to a "net effects thinking" paradigm (Ragin, 2008). Previous studies have predominantly focused on examining the impacts of individual antecedents rather than delving into their potential configurations (Chatterjee et al., 2020; Wang et al., 2010; Won and Park, 2020; Yeh and Chen, 2018; Zhu et al., 2006), However, adoption decisions are made for multifarious reasons, operating within a complex and uncertain environment (Frambach and Schillewaert, 2002). Thus, we assume that the effects of individual causal conditions on adoption can hinge on the presence or absence of other conditions (Fiss et al., 2013). Consequently, our research question asks: *Which configurations of economic, ecological, and social conditions elucidate the adoption of digital innovations with a positive green impact.*

We employ a fuzzy set Qualitative Comparative Analysis (fsQCA) in the context of biogas plant owners in Germany and analyze the interaction of relative advantage, compatibility, individual entrepreneurial orientation, and competitive pressure as well as green attitude and social pressure. Our paper follows previous work on adoption research (e.g., Rogers, 2003), insights in digital innovations (e.g., Yoo et al., 2012), and sustainable thinking (e.g., George et al., 2021). The analysis resulted in four different interacting mechanisms leading to the adoption. Those mechanisms rely on an economic rationale (individual entrepreneurial orientation, competitive pressure), a green rationale (green attitude, not competitive pressure), a conformism rationale (compatibility, social pressure), and a holistic rationale (compatibility, individual entrepreneurial orientation, competitive pressure, social pressure). Our findings contribute to the debate on adoption of digital and green innovation by providing insights into the interacting mechanism of economic, green, and social conditions.

Theoretical Foundation

Introduction in the organizational adoption theory

According to Rogers (2003), adoption can be defined as “a decision to make full use of an innovation as the best course of action available” (p. 177). Organizational adoption is a well-explored research field (Won and Park, 2020; Tortorella et al., 2020) that encompasses various established theories, especially the Diffusion of Innovation Theory (Rogers, 2003), the Institutional Theory (Dacin et al., 2002; Scott, 2001; Sherer et al., 2016), and the Technology-Organization-Environment (TOE) framework (DePietro et al., 1990). The Diffusion of Innovation Theory (Rogers, 2003; Tornatzky and Klein, 1982) emphasizes critical technology-related factors like relative advantage, compatibility, and complexity as predictors of adoption decisions. In contrast, institutional theory is concerned with the influence of institutional or external environments on the actions of companies and is thus suitable for explaining adoption decisions (Oliver, 1997). External pressure from competitors, partners, politics, and the social environment has been found to promote the adoption (Chatterjee et al., 2020). Finally, to systematize the multitude of internal and external factors influencing adoption decisions, the TOE framework provides a valuable conceptual tool (DePietro et al., 1990). This framework accommodates diverse characteristics depending on the specific innovation and its contextual circumstances (Oliveira et al., 2014).

Research within the information systems domain has examined the adoption of digital innovations primarily from an economic perspective. In their literature review, Kohli and Melville (2019) also revealed the high significance of economic rationales of technology adoption. Studies have considered the specific attributes of distinct digital technologies, such as RFID (Wang et al., 2010) or artificial intelligence (Dwivedi et al., 2019). More recently, utilizing fuzzy set Qualitative Comparative Analysis (fsQCA), Eggers et al. (2022) elucidated the network dynamics that influence the adoption of digital innovations, particularly within the domain of small enterprises like startups. In contrast, research on the adoption of green innovations focused on internal and external key facets (Schiederig et al., 2012). First, it explored the impact of supply-side pressures, demand-side pressures (Triguero et al., 2013), and the pressures exerted by various stakeholders (Murillo-Luna et al., 2008). Second, studies focused on the motives driving green adoption and the impact on organizational performance (Ghisetti and Rennings, 2014). Notably, past research indicated that a strong alignment with ecological values can prompt the adoption of green innovations, even when its economic advantages are not immediately apparent (Bossle et al., 2016; Driessen and Hillebrand, 2002).

Integration of economic, green, and social impact factors – theoretical framework

We argue that it is the interactions of economic, green, and social impact factors, that have previously mostly studied in separate research streams, lead to the adoption. Thus, it is evident that considering concepts such as equifinality, multifinality, and asymmetry is paramount in comprehending the intricate web of causal relationships inherent in the adoption of innovations (Misangyi et al., 2017). Our theoretical framework serves as the scaffolding for guiding both empirical data collection and the subsequent development of adoption theory (Park et al., 2017). It must comprise the most relevant causal conditions for the outcome, be exhaustive in terms of covering the dominant facets of the research topic at hand, and parsimonious enough to allow for meaningful interpretation (Schneider and Wagemann, 2010). Figure 30 illustrates our framework that synthesizes recent insights from the mentioned adoption research streams. First, we draw on Rogers (2003) and include two technology-related economic factors (relative advantage and compatibility). Second, we introduce the organizational facet of individual entrepreneurial orientation and the impact of competitive pressure. Moreover, we augment these economic considerations with the green orientation and the impact of adopters' social environment.

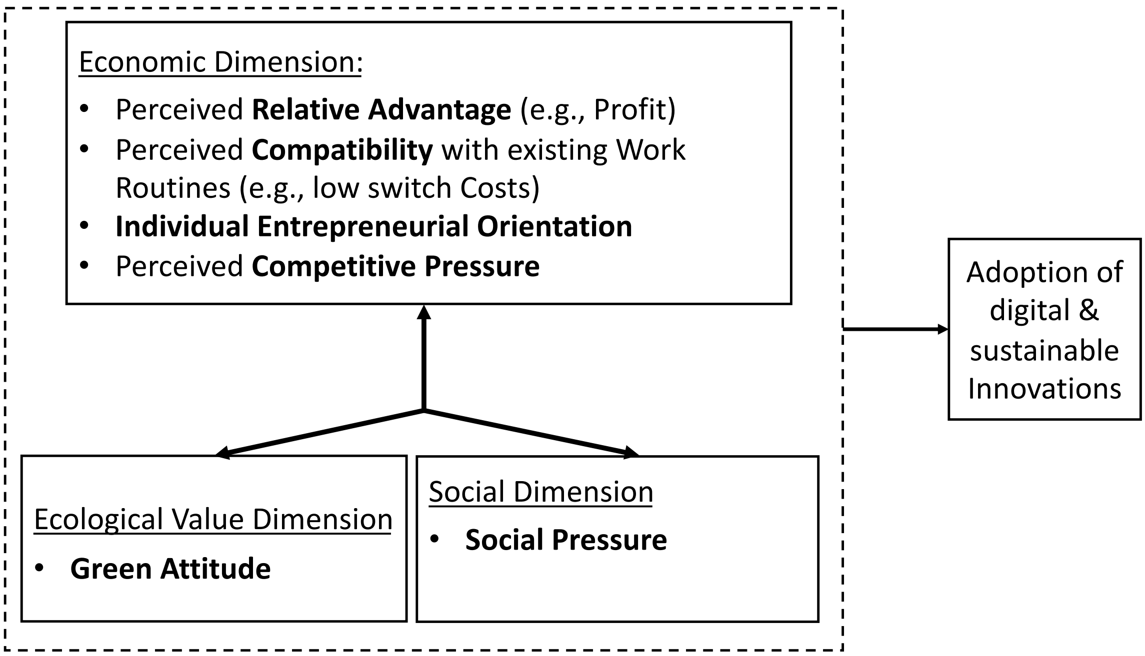

Figure 30 Research framework.

Adoption

Adoption has been conceptualized as either intention or behavior (Arts et al., 2011; Jamieson and Bass, 1989; Plouffe et al., 2001). Adoption intention describes the desire of a potential adopter to implement the innovation soon (Rogers, 2003). On the contrary, the adoption behavior encompasses implementing the innovation and its usage (Frambach and Schillewaert, 2002). As the digital technology that we address in the empirical part is innovative and was recently developed, we focus on the adoption intention and define it as the plan to adopt it within the next months.

Economic dimension

Relative Advantage: Regarding the economic facet, scholars addressed the attributes of innovation (Rogers, 2003; Oliveira et al., 2014), barriers (Thong, 1999), and costs (Tornatzky and Klein, 1982; Kuan and Chau, 2001). Most studies highlighted the innovation's relative economic advantage as the most crucial attribute (Arts et al., 2011; Reinhard et al., 2019). Rogers (1962, 2003) originally suggested this factor, and several empirical studies explored the relative advantage (Mansfield, 1993; Robinson, 1990; Zhu et al., 2006). Following Moore and Benbasat (1991, p. 195), we also consider the impact of this factor defining relative advantage as "the degree to which an innovation is perceived as being better than its precursor." Better relates to product and process-related aspects regarding quality, efficiency, effectiveness, finance, and profit.

Compatibility: We argue that compatibility with existing working routines plays a vital role in adopting digital technologies. Prior research revealed the positive influence of compatibility as switching costs are low, only few uncertainties exist, and the need for adapting existing machines and processes is also low (Frambach and Schillwaert, 2002). Most previous studies drew on the seminal definition suggested by Rogers (2003, p. 240), who interpreted compatibility as "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters." However, literature criticized this interpretation for several conceptual and methodological reasons (Karahanna et al., 2006; Ramiller, 1994). Focusing on the economic facets, we draw on Karahanna et al. (2006), who disaggregated compatibility into four distinct dimensions and argued that compatibility with existing work practices is likely to (positively) affect the adoption of digital technologies. Empirically proven, this compatibility dimension significantly influences adopters' perceived ease of use because it does not require significant changes in the user's work, resulting in less effort to adopt the technology (Karahanna et al., 2006).

Individual Entrepreneurial Orientation: Regarding organizational facets, the focus was primarily on either individual characteristic like age, tenure, and education of managers (Damanpour and Schneider, 2006) or organizational characteristics such as firm size (Damanpour, 1992; Kelley and Helper, 1999). More recent studies addressed the impact of characteristics like absorptive capacity, innovation climate, and readiness for change (Gomez and Vargas, 2009; Holt and Daspit, 2015; Nystrom et al., 2002). Since pervasive digital technologies possess a high potential for radical and disruptive innovations and thus generate new entrepreneurial opportunities (Nambisan et al., 2017; Yoo et al., 2012), we argue that the entrepreneurial orientation of the adopter is likely to play an essential role in determining the adoption decision. The importance of institutional entrepreneurship in adopting and spreading new technologies supports this argument (Munir and Phillips, 2005). Previous studies mainly follow Lumpkin and Dess (1996) and interpret entrepreneurial orientation as a characteristic of organizations. However, as our empirical study targets small, family-owned organizations, such as farms, we focus on individual entrepreneurial orientation, drawing on Bolton and Lane (2012) and considering the dimensions of innovativeness, risk-taking, and proactiveness.

Competitive pressure: For small entrepreneurial organizations, the external pressure from competitors will likely affect the adoption of new digital technologies (Iacovou et al., 1995; Wang et al., 2010). Moreover, scholars showed that pressure might also come from changing regulations (Calof and Smith, 2010). Previous studies also found that the considerable role of laws and regulations characterizes the transition to a sustainable energy sector. This change might trigger the generation and adoption of digital innovations and contribute to a firm's business development and revenue growth (Kolloch and Golker, 2016). Therefore, we use a broader definition and argue that pressure from competitors, regulators, and other external forces is likely to foster the adoption of digital green technologies.

Ecologic Value Dimension

Green Attitude: Past research indicates that the values and attitudes of managers influence the interpretation of environmental issues (Murillo-Luna et al., 2008). For instance, Andersson et al. (2005) used the individual level's value-believe-norm theory and referred to these sustainable values in the organization's actions. In concordance with this line of reasoning, we argue that the adopter's values regarding green and sustainability transition will likely affect the decision to select and adopt digital green technologies. This notion aligns with findings from Schmermbeck (2019), who observed that green values manifest at the individual level in the context of green and digital innovations. Other studies also showed the importance of eco-technological awareness (Koo and Chung, 2014) and individual green attitudes (Wang et al. 2015) for the adoption of green and digital innovations. In a recent meta-analysis, Neves et al. (2022) found that the attitude towards environmental protection and green purchase attitude predict the adoption of sustainable technologies. In sum, we assume that green attitude will drive potential adopters toward adopting digital technologies with a green dimension.

Social Dimension

Social Pressure: Finally, the adopters' decisions might be affected by their social environment, especially the pressure toward social conformity (Ansari et al., 2010). Both the information system research and green research have shed light on various aspects of social pressure on adoption (Karahanna et al., 1999; Kulviwat et al., 2009; Ozaki, 2011). Studies indicate that adopters and non-adopters perceive and react to social influence by various interest groups differently (Eckhardt et al., 2009). In other words, it is not only social pressure itself that is important but also who exerts this influence. Social pressure from family and friends is essential in small and family-run companies (Chrisman et al., 2012; Kelly et al., 2000; Spence and Lozano, 2000). Chrisman et al. (2012) showed that family firms may be willing to follow family-centered goals that are non-economic in adopting innovations. Previous research on the impact of the social environment is based on behavioral theory (Cyert and March, 1993), stakeholder theory (Mitchell et al., 1997), and social contagion (Iyengar et al., 2011). All three theories provide consistent and complementary results on the impact of non-economic goals in the family business (Westhead and Howorth, 2007; Zellweger and Nason, 2008). In the context of adoption theory, social contagion refers to the assumption that social actors (like friends) can influence adoption due to network ties. This means that the introduction of sustainable digital technologies can result from the influence of the user's social environment personified by family and friends. This influence operates through two fundamental mechanisms: First, adopters directly receive information and opinions from their friends and family that affect the adoption decision. Second, the adopters adapt their behavior to the opinions and actions in the surrounding field (Angst et al., 2010; Strang and Soule, 1998).

Data and methodology

Industrial background

Our study is centered around small and family-owned organizations that are typical producers of renewable energy from biogas and operate in Germany with less than ten employees. Many of these organizations have roots in agriculture but have transitioned into energy production through biogas and experienced subsequent growth. These small organizations with few employees can use digital technologies to sustain biogas production. In addition, the energy mix in Germany has changed significantly, and the proportion of renewable energy reached about 46% in 2019 (Statista, 2019). The German government used subsidies to encourage this development: Renewable energy producers received a fixed price to ensure a sustainable business. As the produced energy is sold at the electricity market for a variable price, the producers receive the margin between the fixed and the average energy price. Several power plants run out of former subsidies and will only receive a reduced subsidiary.

Consequently, these plant owners were compelled to seek new financial avenues to sustain their operations effectively. One possibility is to benefit from the fluctuations in the electricity market. The subsidized difference between the electricity market and the defined price is usually averaged over months. Therefore, it would be beneficial for the renewable energy producer to sell electricity only when the demand is high, and the price is above the monthly average. In this case, the renewable energy producer will increase the margin between the average and current market prices as an additional profit. To benefit from this, renewable energy producers can use digital technologies that could be integrated into a "virtual power plant" (Dellermann et al., 2017). Here, a smart grid with big data analytic technologies is used to sell the electricity at the market at the best price and enables the biogas plants to stay both environmentally friendly and profitable.

Like other radical innovations, adopting these digital technologies is accompanied by risks and uncertainties in social, technological, and organizational areas (Hall and Martin, 2005). The technology is new for many companies, and they have no previous experience with it. Furthermore, the introduction relates to financial costs and happens in the context of state laws. Thus, we argue that the adoption decision is unclear and likely to be affected by the abovementioned factors.

Data collection procedure

Our data collection procedure was twofold. First, in the second half of 2019, we sent our survey to 277 biogas plant owners in Germany and received 53 complete answers (response rate 19.1%). The sample size is reasonable for conducting fsQCA (Marx, 2006; Meuer, 2014; Ragin, 1987; Ragin, 2000; Rihoux et al., 2013). Second, we validated and extended our insights by discussing the findings with five experts from the energy industry (Kraus et al., 2018). The experts are senior managers, board members, and one power plant owner. In addition, we also conducted an on-site visit to one farm, collecting information from observations and narrative interviews with the plant owners.

Research Methodology

We analyze our data with fsQCA as this methodology conceptualizes cases "as combinations of theoretical attributes of interest rather than as disaggregation of their attributes that are treated in isolation from each other" (Misangyi et al., 2017, p. 260). Conjunction, equifinality, and causal asymmetry separate fsQCA from other qualitative and quantitative research approaches (Misangyi et al., 2017).

Conjectural causality, also called „causal recipes" (Ragin, 2008, p. 109), shows different combinations in which attributes lead to an outcome. The focus shifts of causal explanation from identifying antecedents with independent effects to examining the combination of conditions (Misangyi et al., 2017). Equifinality describes that several casual recipes might lead to the same outcome (Ragin, 2008). Unlike regression, which cannot cover equifinality, fsQCA enables the detection of several solutions for one outcome (Vis, 2012). Finally, causal asymmetry describes that the presence and absence of a condition might lead to the same outcome depending on the interplay with other attributes (Ragin, 2008).

The central assumption of configurational theory is that the "parts of a social entity take their meaning from the whole and cannot be understood in isolation" (Meyer et al., 1993, p. 1178). We argue that this argument fits perfectly in the considerations of adoption theory. Following this reasoning, adopting innovation depends on economic, ecological, and social factors. For example, one can expect that even a high relative advantage might not enable adoption if there is no compatibility, and the adopter has little entrepreneurial orientation.

Hence, when explaining the adoption of innovations, it is likely that "variables found to be causally related in one configuration may be unrelated or even inversely related in another" (Meyer et al., 1993, p. 1178). In sum, the configurational perspective is instrumental in exploring our research question because of its ability to provide a holistic view of causation and overcome theoretical fragmentation (Busenbark et al., 2016; Misangyi and Acharya, 2014).

Measurement procedure and set-theoretic analysis

All conditions and the outcome are measured with multi-items and operationalized with a five-point Likert scale. In addition, we conducted a pre-test. The formulation of the items followed previous works and considered the context knowledge received from energy industry experts. We assessed the internal consistency of the subscales and computed composite reliability (CR) and average variance extracted (AVE) (Eisinga et al., 2013) (see Table 19). Table 20 depicts the correlations. We use the heterotrait-monotrait ratio of correlations criterion to assess discriminant validity. The highest value is 0.732 and below the threshold suggested by Henseler et al. (2015). We tested for non-response bias and checked the early and latter half of the sample. There were no abnormalities (Armstrong and Overton, 1977).

Because we collected self-reported data from one respondent within an organization, the possibility of common method bias exists (Podsakoff et al. 2003; Podsakoff et al. 2012). Our study design followed ex-ante recommendations to reduce common method bias (e.g., questions had no specific order). Ex-post Haman's single factor test has been applied. The results show that the items loaded on different factors, with the first factor accounting for 23.873% of the variance. Cruz (2022) provided a further argument against common method bias. He argued that the use of the best source of information is preferable. In our case, this corresponds to interviewing the best-informed person in the company, which in our case are the biogas plant owners, as they are also the managers of the companies in our cases.

Table 19 Construct specifications and item loadings.

	Item	Load	Mean	S.D,
Adoption (Moore & Benbasat, 1991; Plouffe et al., 2001; Teo, Wei, & Benbasat, 2003)				
Spearman-Brown-Coefficient = .940	I am interested in the topic of virtual power plants.	-	4.19	1.375
	I plan to participate in a virtual power plant within the next few months.	-	4.01	1.497
Relative advantage (Moore & Benbasat, 1991; Plouffe et al., 2001; Teo, Wei, & Benbasat, 2003)				
Cronbachs alpha = .86 CR = .916 AVE = .785	I expect to increase my profit by participating in a virtual power plant.	.890	3.96	1.084
	By participating in a virtual power plant, I expect to continue generating added value in addition to maximizing profit. (For example, additional benefits through a better overview and control of my electricity or heat generation with my systems).	.854	3.83	1.080
	By participating in a virtual power plant, I expect the benefits to outweigh the disadvantages.	.914	4.30	.952
Compatibility (Karahanna et al., 2006)				
Cronbachs alpha = .788 CR = .872 AVE = .631	Participation in a virtual power plant requires new skills from me. (negative coding)	.810	2.13	.768
	It seems easy to participate in a virtual power plant.	.688	3.14	1.229
	Participation in a virtual power plant requires changes to my work processes. (negative coding)	.809	2.23	1.086
	Participation in a virtual power plant requires structural changes to my equipment. (negative coding)	.860	2.29	1.316
Green attitude (Hume, 2010, Pagel & Gobeli, 2009)				
Cronbachs alpha = .818 CR = .939 AVE = .757	Politics should focus on sustainability and sustainable business practices.	.928	4.52	.641
	Through my actions, I take responsibility for the environment (recycling, renewable energies, biofuel, etc.).	.928	4.33	.810
	I want a sustainable, regional and decentralized energy supply.	.785	4.48	.754
	As few electricity grids as possible should be built.	.868	4.14	.978
	I would like to make a contribution to the decentralized energy supply.	.826	4.38	.860
Individual Entrepreneurial Orientation (IEO) (Langkamp Bolton & Lane, 2012)				
Cronbachs alpha = .856				
Risk				
Cronbachs alpha = .809 CR = .888 AVE = .725	I like to go out boldly by venturing into the unknown.	.829	3.73	.850
	I am willing to invest a lot of time and / or money in something that can generate a high return.	.841	3.88	.816
	I tend to be "courageous" in high-risk situations.	.884	3.62	.796
Innovativeness				
Cronbachs alpha = .817 CR = .880 AVE = .647	I often try new and unusual activities that are not typical, but not necessarily risky.	.714	3.85	.718
	In general, I prefer a strong emphasis on unique approaches to projects rather than reviewing proven approaches.	.825	3.53	.987
	I prefer to try my own, unique way of learning new things instead of doing it like ever	.802	3.75	.821
	I prefer to try my own way when learning new things.	.869	3.65	.936
Proactivity				
Cronbachs alpha = .854 CR = .912 AVE = .777	Normally I am acting in anticipation of future problems, needs or changes and therefore plan in advance.	.821	4.11	.640
	I prefer to act actively and promote issues around my energy production.	.895	4.00	.620
	I tend to plan projects in advance.	.925	4.15	.732
Social Pressure (Eckhardt et al., 2009)				
Spearman-Brown-Coefficient = .825	My family, friends and neighbors expect me to use green technology.	-	3.45	.970
	My family, friends and neighbors recommend using green technology.	-	3.50	1.110
Competitive Pressure (Helmig, Spraul, & Ingenhoff, 2016)				
Spearman-Brown-Coefficient = .842	In my professional environment, I perceive that the topic of virtual power plants is gaining importance.	-	3.81	1.03
	My professional environment is very interested in the topic of virtual power plants.	-	3.57	1.10

Notes: CR = Composite Reliability; AVE = Average Variance Extracted

Table 20 Correlation matrix.

	1	2	3	4	5	6
1. Adoption						
2. Relative Advantage	-.061					
3. Compatibility	.362**	.279*				
4. Green Attitude	.403**	.045	.392**			
5. Individual Entrepreneurial Orientation	.522**	.009	.25	.191		
6. Social Pressure	.529**	.092	.363**	.316*	.402**	
7.Competitive Pressure	.193	-.089	.342*	.27	.312*	.317*

We conducted the fsQCA, the set theoretic analysis and followed the procedure suggested by Fiss (2011), Furnari et al. (2021), and Ragin (2008). Table 21 depicts our procedure. This procedure treats variables not as absolute numbers but as an indicator of set membership (e.g., if an adopter is a member in the set of adopters with a high level of entrepreneurial orientation or not). By linking the membership of causal conditions to the membership in the outcome group, it is possible to assess whether configurations of causal conditions are necessary or sufficient causes for the stated outcome (Ragin, 2008). The fsQCA procedure encompasses the calibration and sensitivity tests, the necessity and sufficiency analysis, the truth table analysis, and the sensitivity analysis.

Results

Identifying single necessary and sufficient conditions

None of the conditions nor their negations outreached the require consistency score greater than .9 for a necessary condition (Table 22).

The causal conditions compatibility and the individual entrepreneurial orientation exceed the cutoff of .8 for a single sufficient condition (Ragin, 2006). However, both conditions' unique coverage (covU) is very low (0.015 and 0.002, respectively). Thus, those solutions have only very little empirical relevance (Schneider and Wagemann, 2010).

Table 21 Set theoretic analysis.

Analysis software	R-Studio (1.2.1335) and R (3.5.3) R packages: QCA and SetMethods
Calibration and sensitivity test	*Calibration of all conditions* into fuzzy membership scores using the crossover point, the fully-in membership score and fully-out membership score (Fiss, 2011; Ragin, 2008) *Calibration of the outcome* combined both items and followed corresponding procedure: - neither interest nor plans to adopt the innovation: 0.0 - fully out. - indifferent answer regarding the adoption, we assign the crossover point 0.5 and add 0.01 to avoid difficulties with the intersection of sets (Fiss, 2011) - participants who plan the adoption within the next months and are interested in the innovation are fully in (1) - participants who partly disagreed or agreed with the questions were assigned 0.25 and 0.75 Discussion of the calibration anchors with senior managers of an energy provider
Necessity and sufficiency analysis	Identification of single necessity and sufficient conditions as well as analysis with x-y plots
Truth table analysis	Structuring the truth table with all potential combinations of causal conditions 2^k combinations (k = number of causal conditions) (Ragin, 2008) Refine truth table with consistency (.86), coverage (2), and frequency (2) thresholds (Duşa, 2019; Fiss, 2011; Greckhamer et al., 2013; Misangyi & Acharya, 2014) Identification of core and peripheral conditions

	Discussion of the results with experts from the energy sector
Sensitivity analysis	20% and the 80% quantile as thresholds for full non-membership and full membership (Greckhamer et al., 2018; Schneider and Wagemann, 2012) Changing the calibration anchors concerning the Crossover point to the median, Changed the frequency threshold to 1, Varied the threshold of proportional reduction in inconsistency The general patterns remained, and only minor variations concerning the number of solutions and neutral permutations occurred

Identifying sufficient solutions

Next, we analyzed the truth table for causal recipes sufficient for adopting virtual power plants. Table 23 illustrates the six solutions (four distinct solutions) for a high adoption level. Solution 1 and Solution 3 have two neutral permutations (1a, 1b, 3a, 3b). These permutations differ only in peripheral but not core elements (Fiss, 2011). Solution 4 contains the core conditions of solution 1 and solution 3. Our overall solution coverage is .510. These numbers are also comparable with other QCA studies (Meuer, 2014; Meuer et al., 2015). Finally, we calculated the solutions for the non-adoption and identified no solution (Reck and Fliaster, 2022).

We assigned representative labels to highlight the empirically distinct characteristics of these configurations, since those labels facilitate the identification and discussion (Gruber et al., 2010; Homburg et al., 2008).

Solution 1: Entrepreneurial market actor: All entrepreneurial market actors are characterized by high innovativeness, entrepreneurial orientation, and act in an economically competitive environment. For the group of adopters in solution 1a, the technology is seen as advantageous compared to the other available technologies and appears compatible with the

Table 22 Test for single necessary and sufficient conditions.

	Necessity		Sufficiency		
ADOPTION	consistency	coverange	consistency	coverange	unique coverange
RELATIVE ADVANTAGE	0.609	0.677	0.677	0.609	0.028
COMPATIBILITY	0.549	0.819	0.819	0.549	0.015
GREEN ATTITUDE	0.703	0.777	0.777	0.703	0.042
INDIVIDUAL ENTREPRENEURIAL ORIENTATION	0.650	0.857	0.857	0.650	0.002
SOCIAL PRESSURE	0.667	0.768	0.768	0.667	0.000
COMPETITIVE PRESSURE	0.673	0.775	0.775	0.673	0.016
relative advantage	0.511	0.739	0.739	0.511	0.033
compatibility	0.555	0.603	0.603	0.555	0.022
green attitude	0.398	0.580	0.580	0.398	0.014
individual entrepreneurial orientation	0.483	0.580	0.580	0.483	0.012
social pressure	0.493	0.683	0.683	0.493	0.019
competitive pressure	0.481	0.666	0.666	0.481	0.001

Note: capital letters indicate the present of a condition, lowercase letters indicate the absence of a condition

Table 23 Solution chart.

	Solution					
	Entrepreneurial Market Actor		Green Enthusiast	Conformist		Holistic Player
	1a	1b	2	3a	3b	4
Economic Dimension						
Relative Advantage	•	⊗	⊗	⊗	•	•
Compatibility	•	⊗	⊗	●	●	●
Individual Entrepreneurial Orientation	●	●	⊗	⊗	•	●
Competitive Pressure	●	●	⨂	•	⊗	●
Ecological Value Dimension						
Green Attitude	⊗	•	●	•	⊗	•
Social Dimension						
Social Pressure	⊗	•	⊗	●	●	●
Consistency	0.927	0.962	0.879	0.957	0.871	0.920
Raw Coverage	0.150	0.221	0.165	0.187	0.140	0.236
Unique Coverage	0.023	0.084	0.042	0.047	0.019	0.076
Overall Solution Consistency			0.905			
Overall Solution Coverage			0.510			

Notes: large black dots indicate present core conditions, small black dots present peripheral conditions; large crossed circles indicate absent core conditions, small crossed circles indicate absent peripheral conditions

existing operation. These adopters see no pressure in their social environment and are not characterized by mainly green attitudes. The other group (solution 1b) possesses the opposite characteristics. Thus, these adopters experience social pressure towards adoption and have a clear green conviction themselves. They do not see the relative advantage and no easy compatibility.

The two core conditions of these biogas plan owners rely on an economic rationale. The high individual entrepreneurial orientation emphasizes the importance of a proactive, innovative, and risk-friendly orientation within the strategy-making process of the organization.

The origin of competitive pressure is an external economic influence. In the interviews, the experts highlighted that competitive pressure has two origins. First, other biogas plant owners are pioneers and have already implemented the virtual power plant benefit regarding finance, efficiency, and coordination. Second, competitive pressure arises from large energy producers, which have economies of scale due to their size and resources. The adopters perceive a weaker strategic position and try to innovate. The individual entrepreneurial orientation fosters this motivation for change since new revenue streams seem to enhance organizations' position.

Regarding solution 1a, the adopters focus on economic and economic-associated conditions within technology, organization, and environment. This solution aligns with existing literature on adopting technology innovations and our assumption of the economic orientation (DePietro et al., 1990; Zhu et al., 2006).

Solution 1b extends the economic rationale by ecological motives. These adopters perceive neither the relative advantage nor expect high compatibility. Instead, the green attitude of the adopter interacts with the core conditions. This solution aligns with existing literature that revealed the importance of green responsibility and is amplified by the characteristics of small organizations as they are open to the opinion of family members and friends (Bansal and Roth, 2000; Eckhardt et al., 2009). Finally, the green responsibility is in line with the interaction of ecological and economic performance (Schaltegger and Wagner, 2006).

Solution 2: Green enthusiast: Green enthusiasts are characterized by strongly pronounced green values and no perceived competitive pressure. Regarding the peripheral conditions, all remaining ones have low membership scores.

The green attitude shows the internal motivation for promoting green values. The experts explained that these adopters live the green principles and want to foster the energy transition. As intrinsic motivation is high, competitive pressure is not recognized. This solution follows previous studies within sustainability management (Bopp et al., 2019). In the interviews, we received two explanations for the interaction between intrinsic motivation and little competitive pressure. First, some adopters are at the spearhead of adopting digital innovations and thus do not perceive this kind of competitive pressure from other biogas producers. Second, adopters said they do not see the pressure from competitors because they see themselves and other biogas producers as passengers of the same boat. A positive attitude toward green innovations can lead to adoption, and adopters see a personal relevance that might trigger emotional reactions and lead to the adoption (Ozaki, 2011).

Solution 3: Conformist: Conformists perceive social pressure and identify the technology as compatible with existing operations. Adopters of solution 3a notice no relative advantage of the technology and are not entrepreneurial. They are characterized by a high level of risk aversion and a wait-and-see attitude. However, they perceive competitive pressure and are convinced of sustainable values. Solution 3b is the reflection of solution 3a. Thus, these individuals are more entrepreneurially active and see the technological advantages. However, they do not notice competitive pressure or have a green streak.

Conformist adopters think it is easy to adopt digital innovations. In addition, the high score of social pressure complements the compatibility and aligns with the wishes of family and friends. Previous studies revealed the impact of normative and social impact on the adoption. Due to the high compatibility, adopters see an easy way to bow to the normative pressure from the social environment, since they do not have to change their working patterns.

Adopters of solution 3a see the competitive environment and have a green attitude. On the one hand, a green attitude is a fertile ground where innovation can prosper. On the other hand, competitive pressure extends the social pressure, and the adopters see themselves in a situation where they want to follow their own and external norms, expectations, and market changes.

Solution 3b shows a different principle that amplifies the core conditions. The combination of high compatibility, recognition of the technology as beneficial, and entrepreneurial activities shows the importance of economic aspects like efficiency, plant control, and revenue. Individual entrepreneurial orientation aligns with relative advantage as both focus on the benefits of innovation. These adopters have no green motivation, but the external pressure from social norms and the economic benefits lead to an adoption.

Solution 4: Holistic player: Adopters within the last group combine the core conditions of entrepreneurial market actors and conformists. Thus, they are innovative and entrepreneurial, see high technology compatibility with the existing business, and perceive the competitive and social pressure within their environment. The peripheral conditions' relative advantage and green attitude are also present.

These adopters see the risks due to the changes in the energy sector and the global discussions toward a green future. The interplay of individual entrepreneurial orientation and compatibility strengthens the adopter's position to adopt the digital innovations that are likely to enable a sustainable business. The green attitude corresponds to social pressure, and the relative advantage fits the compatibility and the entrepreneurial mindset.

Discussion

Configurational perspective in adoption research

Adoption research, particularly in innovation management, frequently indicated intricate interplays among distinctive impact factors. However, prior investigations have often merely implied rather than explicitly addressed those causal interdependencies (DePietro et al., 1990; Frambach and Schillewaert, 2002; Lyytinen and Damsgaard, 2011). This study enriches adoption research by applying a configurational perspective and embracing the complexities of causality. Our paper elucidates the pivotal function of these interactions that affect the adoption of digital technologies for green applications. By underscoring causal complexity, the configurational approach contributes to a more holistic and comprehensive understanding of the underlying mechanisms that propel the adoption of innovations.

Within our investigation, the three core features of complex causality addressed by fsQCA — conjunction, equifinality, and causal asymmetry—manifest prominently (Misangyi et al., 2017). First, regarding conjunction, we found that adoption results not from any single cause, such as, for instance, expected economic benefits prominently addressed in previous works, but comes out of multiple interdependent conditions.

The observation affirms the second characteristic, where multiple solutions elucidate the resultant phenomenon. Contrary to several other adoption inquiries (Zhu et al., 2006), we found four distinct configurations of impact factors, that is, "causal recipes" (Ragin, 2008, p. 109) that lead to adoption. Both features, conjunction, and equifinality, are vividly illustrated within our solution chart. For example, within solution 1, the combination of entrepreneurial orientation and competitive pressure emerges as pivotal for adoption determination. In contrast, the core conditions in solution 3 are compatibility and social pressure. While the Boolean operator "AND" elucidates the conjunction and signifies the interaction among individual conditions within a solution, the Boolean operator "OR" epitomizes the equifinality, reflecting different possible pathways to the given outcome.

Likewise, the third key characteristic of causal complexity — asymmetry — also plays a vital role in our solutions. While some solutions attribute pivotal significance to competitive pressure (solution 1), in other solutions, competitive pressure is absent (solution 2). These intriguing, nuanced interactions become conspicuous through the logical operator "NOT" within the Boolean statement.

Interacting conditions and revealed mechanisms

Shifting the focus towards examining the impact exerted by individual conditions, we particularly adhere to recent works by Furnari et al. (2021), who provided valuable guidance for configurational theorizing. Figure 31 highlights the core interacting mechanisms for the adoption of digital sustainable innovations. We show that four distinct mechanisms appear within the adoption of digital sustainable innovations. By doing so we underline that different organizations rely on different aspects that can be contrary to each other.

Economic rationale: Our study unveils scenarios where economic considerations alone steer the adoption verdict. In Solution 1a, adoption is driven by the interplay between the entrepreneurial propensity of the biogas plant owner and the competitive pressures they experience. This interaction underscores how the competitive landscape's economic stressors, coupled with a readiness to undertake financial risks for innovation deployment, culminate in the decision to adopt. This finding resonates with research by Baird and Thomas (1985), Lieberman and Montgomery (1988), and Lumpkin and Dess (1996), who demonstrated the augmentation of competitive standing through individual entrepreneurial orientation. Entrepreneurial market actors react to competitive exigencies via innovation adoption to fortify their market positions. Integral to this process, the individual entrepreneurial orientation stimulates the formulation of strategic imperatives during the adoption journey (Bolton and Lane, 2012; Rauch et al., 2009). Consequently, the joint impact of these economic facets emerges as a catalyst for the adoption choice.

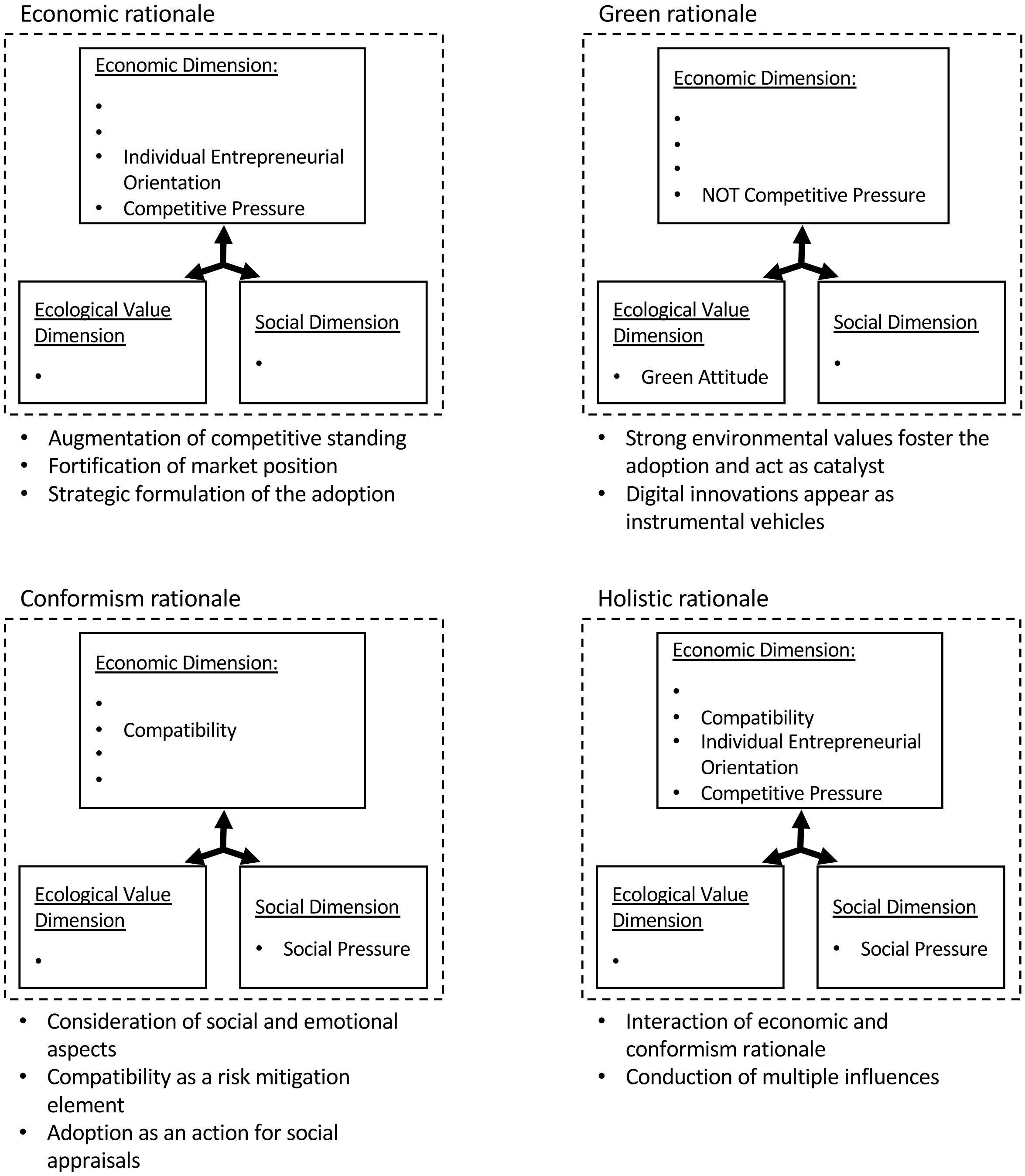

Figure 31 Core interacting mechanisms for the adoption of digital sustainable innovations (empty bullet points signal indifferent or peripheral conditions).

Green rationale: While the solutions mentioned above exhibit a specific reliance on the economic dimension, an alternative perspective emerges within solution 2, "Green Enthusiast," where the ecological aspect is extended by the conspicuous absence of an economic element — specifically, the absence of competitive pressure. Previous studies found that small business owners driven, among others, by strong environmental values are more likely to adopt pro-environmental measures (Bopp et al., 2019). In a parallel vein, Fineman (1996) also uncovered that managers' emotional dispositions and values related to environmental consciousness serve as potent catalysts for "green" actions.

Within the context of biogas plants and technological innovations with ecological dimensions, the impetus of green attitudes and motivation also fuels the adoption drive. Pioneers of this adoption perceive digital innovations as instrumental vehicles that allow them to act in line with their environmental values thanks to the embedded green effect of these innovations. This mechanism plays a paramount role in digital sustainability (Pan and Zhang, 2020), and our findings enrich the literature, showing that enterprises might adopt digital green innovations even without a primary economic incentive.

Conformism rationale: Our study reveals that causal complexity goes beyond purely economic considerations. This insight encourages a departure from a prevalent assertion within classical adoption literature, which posits that factors of economic nature singularly define the decision-making process (see for critical discussion Ansari et al., 2010). Solution 3 reflects a combined impact of the economic factor of compatibility and the social contagion. While previous research has emphasized the relevance of social contagion acting through network ties (Iyengar et al., 2011), our study augments this literature, revealing the interplay between social and economic factors as predictors of adoption.

Previous studies have found that managers of family firms - which also applies to our biogas plant sample - make strategic decisions striving to increase socioemotional wealth and thus also consider social and emotional aspects (Gómez-Mejía et al., 2007). Thus, managers consciously take risks to achieve socioemotional wealth. Our findings show that managers can deliberately limit these risks by paying attention to the economic factor of compatibility of the innovation with existing operations (Dickinger et al., 2008). In our cases, compatibility emerges as a pivotal explanatory element that focuses on the risk mitigation mechanism. This perspective delineates how biogas plant managers operate not in "blind" compliance with familial aspirations but with judicious discernment. Through the synergistic interplay of social pressure and compatibility, the objectives of appeasing the needs and desires of family and friends while simultaneously minimizing the encumbrance of risks and uncertainties are achieved.

The literature on the mechanism of social ties and adoption theorizes that conformity is essential for strategic decisions like adopting innovations. Westphal et al. (1997) found that the acquisition of legitimacy accompanies the act of adoption. Additionally, they accentuated that conformity is particularly pronounced among late adopters, thereby revealing the presence of an adaptive mechanism. Within the framework of our study, this adaptation mechanism finds resonance in the context of small businesses. Here, the impetus of social pressure gravitates towards familial and social circles intimately linked to the business owners within their immediate social milieu.

This insight elucidates that conformity is not solely fostered through inter-company dynamics but also intertwined with the proprietor's social networks. This perspective aligns with Aldrich and Fiol's (1994) depiction of innovation introduction as a conspicuous action that invites social appraisals. Consequently, the influence of conformity extends beyond temporal dimensions, as witnessed by Westphal et al. (1997), to include the values and perspectives of family and friends, who emerge as significant drivers shaping conformity tendencies.

Holistic player: Regarding the holistic player, it becomes evident that the two interactions elucidated earlier exhibit a synergistic relationship. Consequently, these mechanisms manifest in tandem with specific stakeholders (e.g., competitors, and family and friends). This convergence implies that these interactions, namely the individual entrepreneurial orientation alongside competitive pressure and the social pressure alongside compatibility, also interweave and operate in unison within this composite context.

Theoretical contribution

Our research contributes significantly to the existing management literature by examining the multifaceted influences on the adoption decision, encompassing economic, ecological, and social dimensions. In summary, we present three key contributions that advance understanding of adoption dynamics in the context of digital innovations with green elements. First, previous academic research and practice-oriented work primarily focused on adopting digital technologies from an economic (e.g., Zhu et al. 2006) or environmental perspective (e.g., Murillo-Luna et al. 2008). We combine the digital and green faces of the innovations and argue that adopting these requires more than one dimension in most situations. Therefore, we connect the facets and demonstrate the relevance of the interaction of different facets within the adoption of technological and digital innovations.

Second, our study shows the necessity of extending economic and green facets by population-level mechanisms. While previous studies have investigated the green values and the perceived economic benefits from digitization, we demonstrate the relevance and impact of social embeddedness within the adoption (Angst et al., 2010; Iyengar et al., 2011; Valente, 2012). We emphasize the role of social embeddedness and population-level mechanisms in adopting digital and green innovations. This perspective acknowledges that organizational adoption decisions are not isolated choices made by managers but are embedded within a broader social context. By drawing attention to the impact of social pressures and the influence of one's social network, we shed light on the complex dynamics that underlie the adoption process.

Finally, our study contributes to the adoption literature in general. While some researchers have already investigated innovation implementation under a configurational perspective (Meuer, 2014; Sun et al., 2020), green and digital adoption is not investigated using fsQCA. We reveal that not only one solution leads to the adoption, and we show that different rationales are essential for the adoption decision. By drawing on the assumptions of the configurational theory, we explored four "causal recipes" (Ragin, 2008) for the determinants of the adoption of technological innovations. These causal recipes also provide insight for research into the adoption literature in general and can be used as a starting point for future studies. In doing so, we extend the insights regarding the interaction of conditions such as individual entrepreneurial orientation and competitive pressure, as well as social pressure and compatibility.

Practical implications

Our findings provide several implications. First, our insights help with the evaluation of the motives for the adoption of innovations. This insight enables a structured adoption decision and allows managers to rethink strategic decisions. This evaluation allows managers to elaborate appropriate plans for adjusting technological competencies and organizational characteristics. In addition, it provides a comprehensive understanding of their position regarding different values and the influences on their decisions. Second, this understanding might also help companies to diffuse their innovations. They can adapt products and services regarding those facets and ensure a better fit between the innovation and the adopters' values. Finally, they can provide additional help to ensure better adoption, such as additional information or training.

Conclusion

In this study, we delved into the integrated examination of multiple factors influencing the adoption of green digital technologies. We investigated data from 53 'green innovators' involved in the German energy sector and uncovered distinctive archetypes of adopters characterized by varying configurations of adoption antecedents. These archetypes—entrepreneurial market actors, green enthusiasts, conformists, and holistic players—underscore the diverse rationales shaping technology adoption of green digital innovations. The application of the fsQCA methodology allowed us to reveal nuanced interactions among economic, ecological, and societal conditions, providing a deeper understanding of the intricate dynamics driving adoption behavior. By acknowledging the complexity and interplay of these influences, our study serves as a steppingstone towards a more holistic approach in examining technology adoption within the evolving landscape of sustainable and digital innovation.

However, our work has limitations that provide promising avenues for further research. First, our study focused on adopting digital innovations in small organizations as a firm's size might affect its willingness to adopt, for instance, by the availability of financial and other resources. Future research should conduct similar studies addressing different categories of organizations both within the renewable energy industry and in other sectors (Ozaki, 2011). Second, our adoption study conceptually focused on the organizational level of analysis. However, it is people in organizations who make adoption decisions. Therefore, future studies should consider individual perspectives and the interplay between managers. Especially in larger organizations, this interpersonal dynamic among decision-makers can be crucial.

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5. Publication 5: Stakeholder influence on the adoption of digital innovations – A configurational perspective on the Internet of Things

5.1. Notes on submitted Paper

This paper on "Stakeholder influence on the adoption of digital innovations – A configurational perspective" was co-authored by myself and my dissertation supervision Prof. Dr. Alexander Fliaster. The paper was accepted for presentation at the 38th European Group for Organizational Studies (EGOS) Colloquium in Vienna, Austria in 2022 after a double-blind peer-review process. The paper is under review in a B- journal in business administration (VHB: B, VHB Publication Media Rating 2024).

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5.2. Academic Paper

Abstract

Extant research indicates that the adoption of digital technologies may be affected by intra-organisational factors and stakeholder influence. However, insights from past studies, which have mainly considered isolated factors following the logic of 'correlational theorising', are inconsistent. This study argues that the set-theoretic approach can solve these shortcomings and theorise that the configurations rather than the net effects of individual factors explain adoption of digital technologies. We build a configurational theoretical framework, enriching the key factors examined (salience of primary and secondary stakeholders and stakeholder integration skill) with the factors mostly neglected in the literature (coordination among stakeholders and entrepreneurial orientation). We address the adoption of the Internet of Things technologies based on a unique dataset of 81 German companies and identify and discuss four distinctive configurations that lead to their adoption. The study enhances the research on the adoption of digital innovation and stakeholder management literature.

Keywords: digital innovation, stakeholder, adoption, QCA, fsQCA

Introduction

Organisations' adoption of new technologies, tools, and practices has emerged as a crucial area of innovation research (Ansari, Fiss, and Zajac 2010; Hauser, Tellis, and Griffin 2006). Although previous studies have explored the various factors that influence adoption (van Oorschot, Hofman, and Halman 2018; Zhu et al. 2006), the role of stakeholders in this process remains relatively unexplored. Our research fills this gap by investigating the configurations of stakeholder characteristics, organisational characteristics, and networks that contribute to the adoption of digital innovations.

The literature has identified three relevant dimensions for adopting innovation from the perspective of stakeholder theory. First, the salience of individual stakeholders, defined by Mitchell, Agle, and Wood (1997) as the configuration of power, urgency, and legitimacy, determines their impact on technology adoption (Huang, Ding, and Kao 2009). Second, scholars demonstrate that the influence of stakeholders on potential adopters is likely to be determined by network characteristics, such as the dyadic relationships between stakeholders and the adopter (Fliaster and Kolloch 2017; Rowley 1997). Third, studies indicate that organisational characteristics such as stakeholder integration skills influence adoption (Bundy, Shropshire, and Buchholtz 2013).

We argue that a two-fold research gap emerges regarding stakeholders' roles in adoption. First, the studies primarily addressed key dimensions separately. Delbridge and Fiss (2013) argue that organisation and management research often uses 'correlational theorising' and 'traditional bivariate theories'. While these studies identify various net effects, they neglect the possible interplay between the key antecedents of adoption. This criticism is valid for adoption and stakeholder theories as well. Indeed, scholars are increasingly calling for the use of configurational methods in innovation studies (Kabengele and Hahn 2021) and stakeholder research (Crilly, Zollo, and Hansen 2012). Kumar et al. (2022) demonstrated the growing use of QCA in business and management research, while Holm, Hotho, and Rabbiosi (2021) examined several configurations of stakeholder characteristics that lead to salience.

We theorise that three key dimensions – stakeholder characteristics, adopter characteristics, and network ties of stakeholders – collectively affect adoption. On the one hand, salient stakeholders may not rely on other groups of stakeholders or robust networks. Instead, they might be able to use their salience and influence organisations to foster adoption directly. On the other hand, individual stakeholders with low salience can collaborate with other stakeholders, orchestrating their efforts to enforce the adoption of innovation in the organisation. Shubham et al. (2018) found that coordinating agreements between stakeholders fosters adoption in some cases, whereas in others, the direct relationships between stakeholders and organisations are decisive. Moreover, different studies provide partly controversial insights regarding the relevance of secondary stakeholders in adoption (Eesley and Lenox 2006), and the impact of arm's length and strong ties on innovation adoption (Uzzi 1996).

Furthermore, we argue that the activities of stakeholders can meet fertile ground, especially in organisations that strive to integrate stakeholders or are generally more open to innovation. Highly entrepreneurial organisations are more open to innovation and might be prone to adopting novel technological solutions, even without the influence of stakeholders. Thus, we argue that the interactions between the predictors of adoption are neither linear nor correlated. Odziemkowska and Henisz (2021) show that heterogeneous stakeholder influence is beneficial and moderated by their interaction, while Shubham et al. (2018) highlighted the moderating role of primary stakeholders in the influence of secondary stakeholders. Eggers et al. (2020) emphasise the configurations of organisational factors such as entrepreneurial and customer orientation. These insights indicate that the factors are interrelated in complex ways and jointly affect adoption.

Second, most previous research on the interface between stakeholders and adoption theories has focused on sustainable and environment-friendly organisational practices (Fliaster and Kolloch 2017). Little is known about the impact of stakeholders and their networks on digital innovation adoption. This gap is striking as digitalisation has become a critical source of competitive advantage, helping organisations increase efficiency and growth (Björkdahl 2020). Accordingly, several studies have investigated the adoption of new information systems and other digital innovations (Cozzio et al. 2023; Kohli and Melville 2019). Internet of Things (IoT) applications transform real-world objects into intelligent virtual objects, connect them, and enable control and exchange of data. This increases an organisation’s business performance (Papert and Pflaum 2017). However, almost no study focuses on stakeholders. Stakeholder theory provides a valuable framework for throwing light on the antecedents of digital innovation adoption and the interplay between these antecedents.

Our research question is: Which configurations of stakeholders' characteristics, organisational characteristics, and networks contribute to adopting digital innovations? After studying the current findings on stakeholder and adoption theory, we develop a set-theoretical framework. We explain the fundamental assumptions of the fsQCA methodology, introduce IoT applications, and describe data collection and analysis. We present and discuss the results, highlight and explain their implications, and conclude by addressing the limitations and suggesting avenues for future research.

This study makes three major contributions to the literature. First, it enhances research on innovation adoption by showing that it is not a singular antecedent, but several configurations that predict the organisational adoption of new technologies. We build a new comprehensive framework comprising the attributes of adopters (integration skills and entrepreneurial orientation), stakeholder salience, and coordination among stakeholders.

Second, we extend the stakeholder management and organisational network literature by illuminating the different effects of networks among stakeholders on the one hand and dyadic relations between the organisation and its stakeholders on the other. Third, we augment the literature on digitalisation by providing new insights into the impact of stakeholders on adopting digital innovations such as the IoT.

Theoretical background

Stakeholders in the context of adoption research

Following Freeman (1984, 46), we define stakeholders as 'any group or individual who can affect or is affected by the achievement of the organisation's objectives'. Existing research focuses on four different aspects of stakeholder activities in the context of adoption. First, researchers focus on the kind of impact stakeholders exert on the adopters and mostly understand stakeholder impact as a form of 'pressure' the stakeholder exerts to get the focal organisation to adopt an innovation. Thus, the literature defines stakeholder pressure as the capacity and skill to influence the decisions of the focal organisation (Fassin 2009; Helmig, Spraul, and Ingenhoff 2016). Whereas some scholars reveal 'relatively predictable' results of stakeholder pressure (Holzer 2008, 62), others highlight the complex interactions and different underlying mechanisms of stakeholder pressure, considering both positive pressures and forces to adopt (Berardi 2013).

Helmig et al. (2016) and Ozdemir et al. (2023) applied the force perspective in the adoption of sustainable and social innovations. Stakeholder influence has received little attention in technological innovation. However, scholars emphasise that stakeholders play a supportive role in promoting the adoption of innovative technologies (Gupta et al. 2019; Teo, Wei, and Benbasat 2003) as they possess resources that are instrumental to adoption (Fichman 2004). This aspect is vital in collaborative innovations, such as IoT applications, which benefit from interactions among different actors (Ozdemir et al. 2023; Papert and Pflaum 2017). Additionally, Laut, Dumbach, and Eskofier (2021) showed that different stakeholders might be needed to implement digital technologies, as sparse resources are required.

Second, stakeholders play different roles in the adoption of innovation. The stakeholder theory distinguishes primary and secondary stakeholders (Miles 2017), both in the context of strategic management decisions (Clarkson 1995) and in the context of the innovation value chain (Hall and Martin 2005). Primary stakeholders directly influence the focal organisation to adopt innovation, whereas secondary stakeholders are more likely to use indirect methods and influence primary stakeholders to impact the target company (Frooman 1999). Ozdemir et al. (2023) have validated the importance of primary stakeholders in collaborative innovation and acknowledge the influence of secondary stakeholders.

Third, stakeholders use different influencing strategies and do not act independently from each other (Gupta et al. 2019; Li, Xia, and Zajac 2018). While most stakeholder studies follow Freeman (1984) and focus on the dyadic relationships between the company and its various stakeholders (Chatterjee et al. 2021), scholars have also challenged this 'hub-and-spoke' perspective, arguing that stakeholder networks play a crucial role in innovation adoption (Rowley 1997). Multiple stakeholders can align their activities to influence the focal organisation (Polonsky and Ottman 1998). Despite promising empirical insights into the impact of stakeholder networks on innovation adoption (Fliaster and Kolloch 2017), research on this critical issue is still in its early stages (Johnson-Cramer et al. 2022).

Fourth, several characteristics of the focal organisation matter when adopting innovation. Organisations have developed different strategies to anticipate and respond to stakeholder activities. Bundy et al. (2013) argued that organisational identity and strategic frames determine organisational responsiveness to stakeholders. Organisations demonstrate different reactions, such as authentic accommodation and no response. However, few empirical studies have addressed stakeholder sensitivity, particularly regarding the adoption of digital innovation (Ahmed, Eryilmaz, and Alzahrani 2022). In summary, while research has addressed various important antecedents of innovation adoption from a stakeholder perspective, insights are partly inconsistent, and several aspects are underexplored. Only a few studies have explored the configuration and interplay between these dimensions.

Developing the configurational framework

Previous studies have mostly focused on the isolated linear effects of adoption triggers, such as stakeholder salience and integration skills. They deploy the mode of reasoning of 'the more of X, the more of Y' (Delbridge and Fiss 2013, 328). In contrast to this logic of 'correlational theorising' (Delbridge and Fiss 2013, 325), configurational models assume that interdependent factors lead to a given outcome. We study the influence of stakeholders on adoption with configurational logic and carefully select the conditions that refer to stakeholder characteristics, coordination among stakeholders, and the adopting organisation. Thus, we integrate theoretically relevant conditions and a low overlap of underlying concepts (Fiss 2011; Furnari et al. 2021). We follow Furnari et al.'s (2021, 783) suggestions and design our framework based on a three-stage process approach. In the scoping stage, we identify 'key attributes theorised to combine with one another to explain the phenomenon' of innovation adoption. In the linking stage, we specify 'how and why the attributes connect or interrelate with each other to form a configuration'. Finally, in the naming stage, we focus 'on articulating the underlying orchestrating themes and labelling the identified configurations'. All three stages are interdependent and are linked by employing feedback loops. We also rely on recommendations from Greckhamer et al. (2018), including the essential characteristics that might influence adoption from a stakeholder perspective, while keeping our framework parsimonious to avoid theoretical overlap. Figure 32 illustrates the configurational framework. In the following section, we explain the five building conditions in detail.

Stakeholder characteristics

Stakeholder theory distinguishes between primary stakeholders such as customers, suppliers, owners, and working councils, and secondary stakeholders such as governmental institutions (Clarkson 1995; Shubham et al. 2018). Although secondary stakeholders are not indispensable for a firm's economic survival, they influence innovation adoption. While primary stakeholders influence potential adopters directly, secondary stakeholders, such as environmentalist NGOs, might exert an indirect impact, influencing potential adopters via primary stakeholders (Frooman 1999; Helmig et al. 2016).

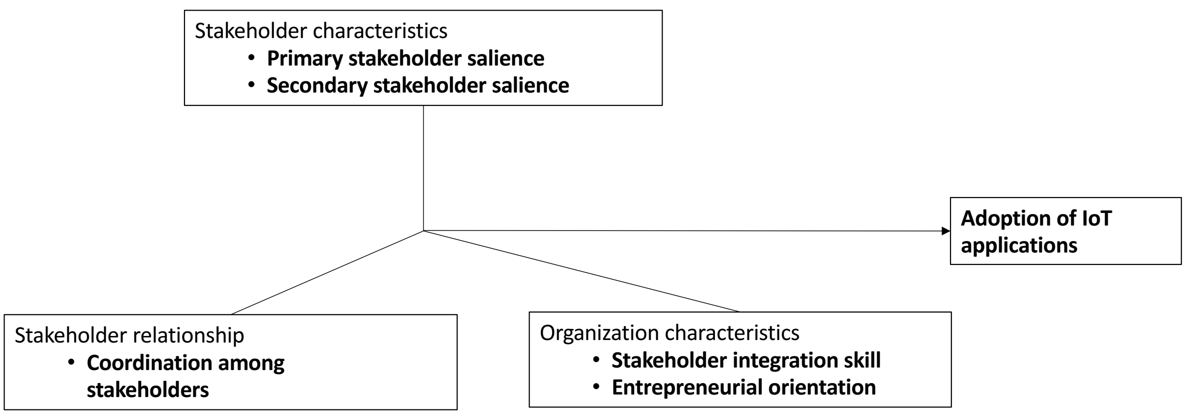

Figure 32 A theoretical configurational framework for IoT adoption from a stakeholder perspective.

However, this issue has limited and inconsistent empirical evidence (Ahmed et al., 2022). Marshall et al. (2010) found that secondary stakeholders do not significantly influence adoption, whereas Shubham et al. (2018) revealed that primary stakeholders mediate the influence of secondary stakeholders. Hence, we include both in our configurational model to shed light on the underexplored impacts of different types of stakeholders.

Stakeholder salience is instrumental because it directly addresses why companies prioritise stakeholders and their requests. Mitchell et al. (1997) and Mitchell, Lee, and Agle (2017) define stakeholder salience as a combination of power, urgency, and legitimacy attributes and 'the degree to which managers give priority to competing stakeholder claims' (Mitchell et al. 1997, 854). Power depends on the features of the stakeholders and the organisation and their dyadic relationships. Urgency refers to the 'degree to which stakeholder claims call for immediate attention' (Mitchell et al. 1997, 867). Thus, the basis of urgency refers, on the one hand, to the speed of response by the organisation to the stakeholder's demand, and, on the other hand, to the importance of the requirement. Legitimacy refers to the focal company's assumption that a stakeholder's actions 'are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions' (Suchman 1995, 574). Thus, if more salient stakeholders urge the company to adopt innovation, the company will be more likely to prioritise their requests and make more efforts to adopt the novel technology.

Stakeholder relationships

We theorise that stakeholders with little salience can influence adoption, as they build coalitions, coordinate efforts, and increase their influence on organisations. Previous literature emphasised this facet as 'multiple and interdependent interactions that simultaneously exist in stakeholder environments' (Rowley 1997, 887). Stakeholder relationships are likely to affect innovation adoption, as these relationships might foster interdependencies and coordinated efforts among individual stakeholders. Barnes et al. (2003) reveal that formal arrangements among stakeholders, such as stakeholder partnerships, affect innovation adoption.

In addition to formal agreements, the current empirical research addresses informal networks among stakeholders, showing that stakeholders might informally exchange information and orchestrate their efforts to support or hinder innovation adoption (Fliaster and Kolloch 2017). In this manner, stakeholders can be visible as actors, appear in a group, or remain in the background of other actors, and exert an indirect influence on the company. In summary, stakeholders can choose indirect strategies in addition to direct ones, exerting influence through allied stakeholders with whom they have previously been motivated to collaborate (Frooman 1999). This allows primary and secondary stakeholders to advance their interests based on their relationships. Coordination between stakeholders is essential in digital innovation and is characterised by the joint generation of added value. We assume that stakeholders with low salience can join forces to collectively exert greater influence and foster the diffusion of digital innovation. Thus, we include coordination among stakeholders, which we define as the exchange and orchestration of stakeholders within a research framework.

Organisational characteristics

The third dimension of our research framework involves the organisational characteristics that affect the adoption of digital innovations and relate to the identified characteristics of stakeholders and their relationships and interactions (Barrane et al. 2020). Two organisational features are essential in this context. First, from the stakeholder perspective, what matters is not only stakeholders' salience and coordination but also how focal organisations treat stakeholder influence. In this context, Vaquero Martin, Reinhardt, and Gurtner (2016) address the concept of stakeholder integration skill, which defines an essential strategic capability allowing the company 'to establish positive collaborative relationships with a wide variety of stakeholders' (Plaza-Ubeda, de Burgos-Jiménez, and Carmona-Moreno 2010, 419). Specifically, stakeholder integration skills include stakeholders' knowledge, the interaction between the organisation and its stakeholders, and the organisation's adaptive behaviour (Plaza-Ubeda et al. 2010). This organisational capability enables the identification of stakeholders and a deeper understanding of their specific interests, activities, and opportunities for collaboration. Therefore, this capability is likely to be instrumental in adopting digital innovation. We theorise that stakeholder integration skills help organisations recognise the salience of individual stakeholders interested in digitalisation and their influential roles in the network. Moreover, organisations with high stakeholder integration skills may be better able to consider the interests of less salient stakeholders if their ideas and propositions on digitalisation benefit them.

The second feature is a company's entrepreneurial orientation, which is likely to affect its willingness to explore and deploy new knowledge and problem solutions, thus contributing to the adoption of digital innovations (Laut et al. 2021; Marshall et al. 2015). Entrepreneurial orientation is essential in innovations characterised by complexity and uncertainty (Covin and Slevin 1989; Marshall et al. 2015). It encompasses innovativeness, risk-taking, competitive aggressiveness, proactiveness, and autonomy (Covin and Slevin 1989; Lumpkin and Dess 1996). Organisations with these characteristics are not just open to innovation adoption, but also actively seek to develop innovative solutions and recognise creative ideas from their stakeholders. Stakeholders' activities regarding the development and use of IoT are not just noticed, but they find fertile ground in the organisation and are picked up and implemented.

Finally, we consider the interplay between these two organisational characteristics. Amankwah-Amoah, Danso, and Adomako (2019) demonstrated that high entrepreneurial orientation positively impacts organisational innovation, but stakeholder integration skills also moderate their impact. This finding underscores the complexity of organisational innovation and how factors interact in complex, equifinal, and asymmetric ways. In line with previous adoption studies, we define the outcome variable as the adoption of IoT applications within an organisation (Kennedy and Fiss 2009).

Methodology

fsQCA identifies combinations of theoretically relevant factors and outcomes (Misangyi et al. 2017). Thus, its configurational perspective is consistent with and suitable for our theoretical lens (Fiss 2011). The fsQCA allows for an in-depth exploration of interactions and identifies complex causal recipes instead of the isolated impact of separate variables (Fiss et al. 2013; Ragin 2008). This section describes the central characteristics of fsQCA, including causal relations, set membership, subsets, and counterfactual analysis. Ragin (2008) provides an in-depth explanation of set-theoretic considerations.

The fundamental tenets of causal relationships are conjunctural causation, equifinality, and causal asymmetry. Conjunctural causation underlines thinking holistically and understanding 'causally relevant conditions as intersections of forces and events' (Ragin 2008, 109). Equifinality means that multiple alternative paths to an outcome exist (Furnari et al. 2021), while causal asymmetry refers to the phenomenon 'that the presence as well as the absence of any attribute may produce the same outcome, depending on its combination with other attributes' (Misangyi et al. 2017, 261).

IoT applications: The empirical setting

IoT applications are suitable for our study because they are theoretically relevant samples (Greckhamer et al. 2018; Ragin 2008) for three essential reasons. First, the value of IoT applications results from the data exchange between connected partners (Papert and Pflaum 2017). IoT applications continuously collect, store, analyse, and process sensor-generated data that include information about the device and its user, its context, and the environment. They transform real-world objects into intelligent virtual objects by connecting them using a unified infrastructure (Madakam, Ramaswamy, and Tripathi 2015). Previous research indicates that the interconnection between organisations, that is, the coordinated deployment of IoT by several ecosystem actors, makes the largest contribution to business performance. Because entire value networks can be linked, the coordination, control of processes, and use of data are made possible within the company and beyond its borders. In this case, stakeholder interactions and coordination are likely to be important. Papert and Pflaum (2017) showed that various actors inside and outside a company network implement IoT services. Thus, primary stakeholders (e.g. suppliers, customers, and owners) are likely to interact to adopt IoT applications.

Second, the IoT currently represents one of the most potent technological innovations shaping the transformation of many business organisations (Papert and Pflaum 2017). Moreover, secondary stakeholders, such as governmental institutions, encourage IoT adoption by business organisations (Laut et al. 2021).

Third, specific risks have a significant and unintended negative impact on organisations and reduce their intention to use IoT applications. Brous, Janssen, and Herder (2018) identify technology risks such as unauthorised access or data misuse, regulatory risks such as data ownership, and organisational risks (new organisational structures). Therefore, the IoT is a good example of the organisational adoption of complex innovations associated with risks and benefits.

Data collection and validation

Our data collection and analysis followed the best fsQCA practices (Greckhamer et al. 2018; Misangyi et al. 2017; Wagemann, Buche, and Siewert 2016). Data collection via questionnaires is widely used in adoption studies (Frambach, Fiss, and Ingenbleek 2016; Kennedy and Fiss 2009), inter-organisational network research (Reck and Fliaster 2022), and

QCA (Leischnig, Henneberg, and Thornton 2016). We identified German top managers from different organisations on the LinkedIn platform, occupying positions such as Chief Strategy Officer, who were familiar with the stakeholders and the firm's network with them (Rank and Strenge 2018; Reck and Fliaster 2022). By 2021, we had reached 1200 firms. However, only 81 top managers completed the survey in full, providing valid data. Since only 206 of the 1200 accessed the online questionnaire, the response rate was 39.3%. The overall response rate was 6.8%. These responses align with those of other studies that use similar methods in quantitative adoption research (Barlatier et al. 2022). Our sample size was suitable for QCA, a methodology originally designed for smaller sample sizes (10–50 cases) and was later shown to be effective for analysing situations with over 50 cases (Greckhamer, Misangyi, and Fiss 2013; Greckhamer et al. 2018).

The questionnaire was based on the existing literature and was pre-tested by 10 experts and top managers. All causal conditions relied on multiple items assessed via a 5-point Likert scale (1 =strongly disagree to 5 = strongly agree). Our study distinguishes between four groups of primary stakeholders (suppliers, customers, owners, and employee representatives), and government institutions as secondary stakeholders (Afuah and Bahram 1995; Hall and Martin 2005). We used the items established by Agle, Mitchell, and Sonnenfeld (1999) to measure stakeholder salience for each of the five stakeholder groups, referring to the dimensions of power, urgency, and legitimacy. To capture the direction of influence, we asked whether stakeholder groups' attitudes were in favour of or against the adoption of IoT. For alignment and coordination among stakeholders, we followed Rodan and Galunic (2004) and Rowley (1997). The operationalisation of entrepreneurial orientation is based on the items used by Covin and Slevin (1989) and Rank and Strenge (2018). The outcome variable refers to the extent of IoT adoption within a company (Kennedy and Fiss 2009). The items and scales were verified. Table 24 contains the items, factor loadings, Cronbach's alpha, AVE, CR, and mean. Table 25 lists the correlation matrices. Nonresponse bias was not found to be a problem (Armstrong and Overton 1977). We took several steps to mitigate the risk of common method bias while adhering to best practices. We performed ex-ante and ex-post validations, structured the items in random order, used different scale formats, and conducted Haman's single-factor test (Podsakoff, MacKenzie, and Podsakoff 2012; Podsakoff et al. 2024). The first factor accounts for 15.11% of the variance, indicating that the common method bias was unlikely to be problematic.

Table 24 Items, factor loadings, Cronbach's alpha, AVE, CR, and means.

		Load	α	Mean
Stakeholder Salience (For each stakeholder group customer, supplier, owner, working council, governmental institutions)				
Power	Our *stakeholder group* has power in respect of our company (whether or not they exercise that power).	0.686 - 0.913	0.694 - 0.876	3.111 - 4.481
AVE: 0.604 – 0.806 CR: 0.820 – 0.926	Our *stakeholder group* can access our business and influence it (whether or not they exercise their influence).	0.780 - 0.905		2.840 - 4.556
	Our *stakeholder group* has the power to enforce its claim.	0.818 - 0.910		3.000 - 4.413
Urgency	When it matters to them, our *stakeholder group* exhibits urgency in its relationship with our firm regarding IoT implementation.	0.815 - 0.892	0.807 - 0.882	3.111 - 3.617
AVE: 0.724 – 0.814 CR: 0.887 – 0.929	Our *stakeholder group* actively sought the attention of our management team in the context of IoT implementation.	0.849 - 0.904		3.049 - 3.432
	Our *stakeholder group* urgently communicates their claims to our firm regarding IoT implementation.	0.882 - 0.931		2.911 - 3.333
Legitimacy	The claims of our *stakeholder group*, with regard to IoT implementation, are viewed by our management team as legitimate.	0.849 - 0.887	0.742 - 0.781	3.321 - 3.765

AVE: 0.631 – 0.697 CR: 0.834 – 0.873	Our management believes that *stakeholder group* claims regarding IoT implementation are unwarranted or inappropriate. *	0.638 - 0.770		3.160 - 3.481
	The demands of our *stakeholder group*, in terms of IoT implementation, are legitimate in the eyes of our management.	0.837 - 0.895		3.256 - 3.863
Coordination between stakeholders				
Coordination	Our stakeholders from different groups organize themselves into associations, working groups, or other coalitions.	0,867	0,926	3,469
AVE: 0.775 CR: 0.945	Our stakeholders adjust their demands on our company depending on how stakeholders from other groups behave.	0,898		3,494
	Stakeholders from different groups exchange information and knowledge with each other.	0,873		3,420
	Stakeholders from different groups coordinate their activities in relation to our company.	0,890		3,272
	Stakeholders from different groups maintain informal relationships with each other (e.g., through their respective decision makers).	0,873		3,272
Stakeholder integration skill				
Knowledge	The company keeps documented information on the previous relationships with stakeholders (important meetings, conflicts, agreements, judicial or extrajudicial demands).	0,875	0,719	3,333
AVE: 0.646 CR: 0.842	Knowledge of all stakeholders and their demands is essential for the management	0,882		3,469

	(performance, relationships among them, positions of power, importance, satisfaction).			
	The company dedicates little time and few resources to knowing the characteristics of its stakeholders (relationships between different stakeholders, potential threats, cooperation).	0,627		2,691
Interaction	The company consults the stakeholders and asks them for information before making decisions.	0,872	0,858	3,259
AVE: 0.780 CR: 0.914	Stakeholders participate in the company's decision-making process.	0,899		3,037
	The company strives to develop new contacts with all the stakeholders.	0,879		3,210
Adaptational Behaviour	There is frequent managerial debate about the demands of the stakeholders.	0,869	0,747	3,420
AVE: 0.674 CR: 0.860	The company is willing to change its objectives in line with stakeholders' demands.	0,852		3,370
	The company dedicates little time and few resources to adapting to stakeholders' demands.	0,736		3,062
Entrepreneurial Orientation				
Competition	Our direct competitors are investing heavily in IoT applications.	0,866	0,750	3,235
AVE: 0.673 CR: 0.860	Without IoT applications, our competitiveness would be at risk.	0,863		3,420
	There are a significant number of startups and new competitors coming into our industry with IoT applications.	0,724		3,309

Innovativeness	In general, top managers of my company favour a strong emphasis on R & D technological leadership and innovations.	0,848	0,820	3,400
AVE: 0.735 CR: 0.893	In the last five years, my company has been marketing many new product lines or services.	0,875		3,407
	In my company, changes in product or service lines have been quite dramatic.	0,849		3,198
Proactivity	In the last years, my company has initiated actions that the competition then responded to.	0,835	0,832	3,263
AVE: 0.750 CR: 0.900	My company was often the first to introduce new products/services, administrative techniques, and operating technologies in recent years.	0,891		3,173
	In recent years, my company has preferred a competitive "undo-the-competitors" posture.	0,872		3,013
Risk	In the last years, my company had a strong proclivity for high-risk projects (with chances of very high returns).	0,882	0,840	2,926
AVE: 0.760 CR: 0.905	In the last years, my company believed that wide-ranging acts are necessary to achieve the company's objectives due to the nature of the environment.	0,845		3,284
	When confronted with decision-making situations, and uncertainty, my company has adopted a bold, aggressive posture to maximize the probability of exploiting potential opportunities.	0,887		3,213
* reversed coded α: Cronbach's α; CR: composite reliability; AVE: average variance extracted.				

Note: We define stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984, p. 46)

Table 25 Correlation chart on the conditions and outcome.

	1	2	3	4	5
1 IoT adoption					
2 Primary stakeholder salience	.526**				
3 Secondary stakeholder salience	.131	-.056			
4 Coordination between stakeholders	.415**	.085	.009		
5 Stakeholder integration skill	.409**	.134	.06	.259*	
6 Entrepreneurial orientation	.323**	.01	.037	.105	-.078

Data analysis with fsQCA

The data were analysed using R-studio, SetMethods (Version 3.0), and QCA (Version 3.13), following Fiss (2011), Greckhamer et al. (2018), Ragin (2008), and Schneider and Wagemann (2012). We follow the recommended procedure and rely on the steps calibration, analysis of necessary conditions, and truth table analysis with the sufficiency analysis. First, in the calibration, the Likert-scale answers were transferred to Boolean membership scores ranging from 0 to 1. Thus, we obtained the degree to which a given case belonged to each condition. Table 26 lists the calibration anchors used in this study. We depict the calibration of EO as an example. A Likert scale value of less than or equal to 2.0 is assigned a membership value of 0, a value equal to or more than 4.5 is assigned a membership value of 1, and a value of 4.11 is assigned a membership value of 0.899. Such a case is quite strong for entrepreneurially oriented organisations. By contrast, a Likert scale value of 2.4 corresponds to a membership value of 0.165, aligning with nonentrepreneurial organisations.

Second, we analysed the necessary conditions. The fsQCA relies on subset relations, and two different causalities exist between conditions and outcomes: necessity and sufficiency. Necessity indicates that almost all cases with a specific outcome also contain a specific or a combination of attributes. Sufficiency means that a combination of conditions leads to a specific outcome in almost all cases. Thus, a combination of conditions constitutes a subset of specific outcomes. To assess the necessary and sufficient conditions, the fsQCA uses values of consistency and coverage (Ragin 2008).

In the third step, the analysis of sufficiency, we conducted a truth table analysis and obtained the configurations through counterfactual analysis (Fiss 2011). Following a previous study, we used a consistency threshold of .8, a proportional reduction in inconsistency (PRI) cutoff of .7, and a frequency cutoff of 2 (Fiss 2011; Greckhamer et al. 2018). We checked the thresholds for deviant cases using x-y plots (Schneider and Wagemann 2012). The fsQCA eliminates irrelevant conditions and simplifies assumptions based on counterfactual configurations (Ragin 2008). We identified the parsimonious and the intermediate solutions (Greckhammer et al. 2018). The parsimonious solution focused on the core of the configuration. Consequently, these results have more decisive causal components (Misangyi et al. 2017, 276). By contrast, intermediate solutions contain peripheral attributes that support the core attributes (Fiss 2011).

FsQCA relies on counterfactual analysis to generate various solutions (Ragin 2008). We integrate primary stakeholder salience and stakeholder integration skills as easy counterfactuals because research has proven their relevance in adoption from a stakeholder perspective (Huang et al. 2009; Vaquero Martin et al. 2016).

Results

By analysing a single necessity, we found no condition exceeding the threshold of .9 (Greckhamer et al., 2018). Thus, neither stakeholder characteristics nor network relationships nor organisational characteristics are necessary conditions for adopting IoT applications (Table 27).

Table 26 Calibration anchors.

	Mean	SD	Fully out	Crossover point	Fully in
Primary stakeholder salience	3.53	.54	2.6	3.501	4.4
Secondary stakeholder salience	3.10	.78	1.5	3.001	4.5
Coordination between stakeholders	3.39	1.07	1.7	3.501	4.7
Stakeholder integration skill	3.21	.85	1.7	3.3	4.4
Entrepreneurial orientation	3.21	.82	2.0	2.999	4.5
IoT adoption	5.17	2.15	1.9	5.1	7.1

Note: A Likert scale ranging from 1 to 5 assessed primary stakeholder salience, secondary stakeholder salience, coordination among stakeholders, stakeholder integration skills, and entrepreneurial orientation. The scale used to measure IoT adoption ranged from 1 to 8.

Next, we calculated sufficient solutions for the outcome and its negation. We identified five configurations that explain the adoption of IoT applications and grouped them into four major solutions. Only one solution (all absent conditions) led to nonadoption. Table 28presents the solutions that explain the adoption of IoT applications and the results for consistency and coverage. Here, we provide an example of this interpretation. The first solution comprises the core conditions of ‘primary stakeholders' salience’ and ‘coordination among stakeholders’. The absent peripheral condition of ‘secondary stakeholder salience’ extends the configuration. A consistency value of .941 represents the number of cases falling into the configuration and featuring the outcome. Overall, the solution consistency reflects the same measure for all identified solutions. Raw coverage represents the proportion of all cases in the sample that exhibit the specified configuration and the corresponding performance outcome. Unique coverage reflects the same measure but is calculated based on the cases exclusively covered by the specified configuration. The overall solution coverage refers to the

Table 27 Results of the analysis for single necessary conditions and single sufficient conditions.

	Necessity			Sufficiency			
	inclN	RoN	covN	inclS	PRI	covS	covU
Primary stakeholder salience	.728	.817	.783	.783	.700	.728	.015
Secondary stakeholder salience	.645	.731	.669	.669	.541	.645	.002
Coordination between stakeholders	.708	.775	.737	.737	.651	.708	.004
Stakeholder integration skill	.699	.787	.744	.744	.659	.699	.006
Entrepreneurial orientation	.673	.756	.705	.705	.601	.673	.020
~Primary stakeholder salience	.491	.695	.546	.546	.384	.491	.026
~Secondary stakeholder salience	.581	.773	.672	.672	.550	.581	.029
~Coordination between stakeholders	.471	.707	.542	.542	.389	.471	.039
~Stakeholder integration skill	.490	.702	.551	.551	.393	.490	.007
~Entrepreneurial orientation	.526	.733	.602	.602	.461	.526	.028

Table 28 The solution chart.

	Solution				
	Coordinated network of strong business partners	*Stakeholders' supportive follower*	*Entrepreneurial integrator*	*Integrator of coordinated stakeholders' demands*	
	1	**2**	**3**	**4a**	**4b**
Stakeholder characteristics (SH)					
Primary SH salience	●	●	•		
Secondary SH salience	⊗	⨂	●		•
Stakeholder relationship					
Coordination among SH	●			●	●
Organization characteristic					
SH integration skill		●	●	●	●
Entrepreneurial Orientation		⊗	●	•	
Consistency	.941	.895	.955	.910	.894
Raw Coverage	.897	.796	.902	.840	.810
Unique Coverage	.074	.023	.042	.025	.070
Overall Solution Consistency			.874		
Overall Solution Coverage			.690		

Notes: large black dots indicate present core conditions, small black dots present peripheral conditions; large crossed circles indicate absent core conditions, small crossed circles indicate absent peripheral conditions

raw coverage of the entire set of identified configurations for the outcome. The value of 0.69 signifies that the five configurations encompass the most adopting cases in our sample. Finally, we conduct robustness checks (Greckhamer et al. 2018). The crossover points were changed according to the Likert scale, means, and medians. Next, we checked the calibration anchors for 10% and 90% percentiles. The frequency cutoff was changed to 1. The solutions changed only marginally. We also checked the solutions for the control variables of firm size, revenue, firm age, and form of organisation.

Solution 1, 'the coordinated network of strong business partners', refers to salient primary stakeholders who orchestrate their activities. These stakeholders have the power, urgency, and legitimacy to promote IoT adoption in organisations. Stakeholders communicate with each other and coordinate the requirements; this coordination allows them to speak in one voice. The absence of secondary stakeholder salience extends the core conditions. In summary, the coordinated efforts of salient primary stakeholders are decisive.

Our analysis indicated that this configuration is associated with building new IoT-based ecosystems that require technological compatibility among all business partners. Examples are found in industries such as automobiles and food. A typical case represents an organisation in a coordinated network of strong business partners within the automobile sector, precisely a first-tier supplier of an OEM. Primary stakeholders, including OEMs, software providers, and suppliers, support organisations to adopt IoT applications. Coordination is essential for adopting IoT applications in the production processes. Primary stakeholders have already developed an IoT platform that can be adopted. The adopting organisation does not play a leading entrepreneurial role, as the coordinated efforts of its primary stakeholders drive adoption. Secondary stakeholders are not involved in organisation-specific applications because the IoT system is intended for a specific OEM.

Solution 2, ‘stakeholders’ supportive follower’, refers to companies that have developed sophisticated stakeholder integration skills to build close ties with salient primary stakeholders. Only primary stakeholders are salient promoters of IoT adoption, whereas secondary stakeholders lack power, urgency, or legitimacy from a potential adopter’s perspective. The focal company has vital stakeholder integration skills, and the stakeholders do not need to coordinate their efforts. The focal company spends substantial time and effort focusing on the salient primary stakeholders important to its business.

The peripheral condition of the absent entrepreneurial orientation adds to the core conditions. Companies lacking high entrepreneurial orientation build trustful collaborative relationships with influential business partners, promoting the adoption process by exchanging fine-grained information and solving joint problems. Although these organisations do not appear to be highly entrepreneurial, their capabilities of networking and interacting with partners help them to adopt innovation.

A typical example of this solution is found in the manufacturing industry. Internal and external primary stakeholders, including owners and customers, actively support the development of a C-part storage system (e.g. screws and nuts) based on IoT technology. The development process integrates suppliers, customers, and owners closely, and builds on previous offerings and involves incremental collaborative innovations. The organisation seeks partners with specific skills and competencies, such as IoT knowledge and programming skills, to enhance the system, making significant efforts to meet stakeholder demands.

Solution 3, ‘entrepreneurial integrator’, has the three core conditions: salient secondary stakeholders, stakeholder integration skills, and entrepreneurial orientation. These organisations are well-informed and engaged in strategic governmental initiatives and funding opportunities. Thus, public institutions can influence the adoption of IoT through research projects and funding. Companies adopt the IoT in line with governmental industrial and digitalisation policies. While stakeholder integration skills underpin the trusting relationship that a company maintains with its stakeholders, entrepreneurial orientation shows the drive and ambition of the organisation to develop and adopt IoT applications in research projects funded by public institutions. The salience of primary stakeholders extends the core conditions. The combination of responsiveness to stakeholder priorities and an entrepreneurial drive pushes companies to adopt innovation.

A typical case here is a company in the healthcare industry. Government institutions and public funding programs support the development and implementation of IoT applications. This company collaborates with various partners in these funding programs to develop and implement IoT solutions. The project involves close integration between the organisation, its partners, and governmental institutions to secure funding and adopt IoT applications. Entrepreneurial orientation is crucial because innovative project partners are responsible for developing and implementing IoT solutions. This collaborative effort includes partners from various industries and research institutes.

Solution 4, ‘integrator of coordinated stakeholders' demands’, has neither primary nor secondary stakeholder salience as a core condition. Instead, the orchestrated efforts of many stakeholders and the company's ability to consider stakeholder objectives trigger adoption. One of the two peripheral conditions extends the solution. Solution 4a includes organisations with a high entrepreneurial orientation. Thus, organisational innovativeness drives adoption. In solution 4b, the core conditions were extended by secondary stakeholder salience. Therefore, salience is essential if an organisation has no internal movement.

A typical example is a company that collaborates with organisations across various industries, such as mechanical engineering and production. As a digital leader and innovator in the IoT, the company possesses extensive experience and expertise in IoT applications. With its broad application potential for IoT in diverse industries and settings, it facilitates coordination among different stakeholders, such as industry associations. Strong stakeholder integration capabilities enable the company to meet specific demands effectively. Close interaction, feedback, knowledge sharing, and adaptive processes ensure seamless integration.

Discussion

Theoretical facets of the configurational analysis

Our study reveals four mechanisms that lead to the adoption of innovative IoT applications where value results from exchanges between partners. We draw recommendations explaining causally complex phenomena and explain the implications of our empirical findings from adopting innovation and stakeholder management perspectives (Furnari et al. 2021).

First, our study shows that configurations, rather than the isolated net effects of individual factors, explain whether companies have adopted new technologies. Our analysis confirms the theoretical argument that these configurations build on three core elements: stakeholder salience, relationships among stakeholders, and adopters' skills and behaviour. In different configurations, these key factors may play conducive, prohibitive, or irrelevant roles while interacting with each other. While most previous studies advocate that salient stakeholders play a decisive role in innovation adoption (Huang et al. 2009; Yuen et al. 2017; Wu et al. 2023), our configurational analysis paints a much more nuanced picture: the salience of secondary stakeholders undermines adoption in Solutions 1 and 2, fosters it in Solution 3, and does not play a role in Solution 4a. The coordinated efforts of several stakeholders are crucial. Hence, we conclude that the set-theoretic perspective sheds light on causally complex phenomena such as innovation adoption. Providing empirical support to the critique of linear 'correlational theorising ' (Fiss, Marx, and Cambré 2013; Kabengele and Hahn 2021), our study captures the three critical features of complex causality advocated by the configurational perspective: conjunction, which means that innovation in stakeholder environments does not result from a single antecedent but from several interdependent conditions; equifinality, as there are four different configurations that lead to adoption, and causal asymmetry, as theoretically derived attributes such as stakeholder salience have different (inversely related) impacts in the configurations (Misangyi et al. 2017).

Second, although no solution is based exclusively on one of the three dimensions, a high degree of stakeholder receptiveness seems especially conducive to the adoption of IoT in several configurations. Even if no salient stakeholders promote innovation, or if there are no coordinated efforts by many innovation advocates, the organisational capability to consider stakeholders' interests and change accordingly fosters adoption. This fact extends the view held in previous studies, such as Wu et al. (2023), emphasising the importance of salient stakeholders. We show that an organisation's characteristics (Su, Zhang, and Wu 2014), relationships, and coordination (Gupta et al. 2019) are not detached, and demonstrate that the interaction between the different conditions is critical.

Third, our study uncovered different types of relationships between the key factors. On the one hand, the salience of primary stakeholders and coordination between stakeholder groups complement each other, strengthening the stakeholders' impact on the company and fostering its adoption. On the other hand, coordination between different stakeholder groups and stakeholder salience serve as substitutes: innovation can be promoted in a single powerful stakeholder group (Senna, Roca, and Barros 2023; Yang, Fu, and Zhang 2021) that demands fast IoT adoption, and when there are several stakeholders who lack individual salience but are effective in coordinating their activities (Kolade et al. 2022; Naghshineh et al 2021). The latter finding also enriches previous insights indicating that information exchange and informal network ties among stakeholders foster the adoption of novel technological solutions (Fliaster and Kolloch 2017).

The fourth theoretical insight relates to the role of entrepreneurial orientation. Research has shown that entrepreneurial companies are the leading adopters of novel technologies and problem solutions (Andersén 2022; Eggers et al. 2020; Marshall et al. 2015). Our research challenges this wisdom by demonstrating that entrepreneurial orientation is not necessary for a company to actively adopt (digital) innovation. Although, within our dataset, Solutions 3 and 4a provide that entrepreneurial orientation is indeed conducive to adoption, it is causally irrelevant in a do-not-care situation (Fiss 2011) in other configurations, such as Solutions 1 and 4b, and in Solution 2, it is the absence of entrepreneurial orientation that fosters the adoption of digital innovation. We theorise that the inverse relationship can be traced back to the strategy of technology followership pursued by the focal company. Facing a very powerful and demanding stakeholder (e.g. customers), the firm develops sophisticated integration skills to establish a close relationship with this stakeholder, striving to meet the stakeholders' demands and adapt the internal processes and technologies if requested. In this case, the company does not assume the position of a technology leader and acts as a supportive follower for the stakeholder rather than proactively initiating radical changes.

Practical implications

Our study has practical implications for organisations and stakeholders. First, from the perspective of potential technology adopters, vital stakeholder integration skills are found to be a multipurpose instrument. Research has shown that dedicating time, resources, and effort to learn more about stakeholders and changing their interests contributes to corporate sustainability and social responsibility. Our study suggests that in many situations, developing strong stakeholder integration skills is a powerful approach to promoting a company's digital transformation. Based on our findings, individual managers or other actors in a company can build relationships with specific stakeholders or foster collaboration among them, thus driving digital technology adoption in their company. Transformation agents can seek external advocates to support their adoption plans. In this way, concerns and resistance can be addressed not only by management but also by internal and external stakeholders.

Second, we identify two mechanisms through which primary stakeholders can influence other companies to adopt digital innovation. Although raising urgent requests is effective in several situations, this strategy does not apply to stakeholders who lack power or whose claims seem not legitimate. For less salient stakeholders, coordination with constituencies from their own and other groups (e.g. suppliers and customers) is instrumental in forcing the target company to digitise. We also show that stakeholder groups should consider company characteristics and corresponding strategy selection so that they can implement more target-specific approaches.

Finally, this study provides insights for governments to promote the diffusion of modern digital technology. We challenge the argument that salient secondary stakeholders demanding that firms urgently adopt digital innovations is the most effective approach. Instead, we propose a more strategic approach: rather than focusing solely on potential adopters, authorities can promote coordination and orchestration across stakeholder groups. The indirect influence strategy discussed in the literature (Frooman 1999) appears to be an appropriate approach for both primary and secondary stakeholders interested in the diffusion of digital innovation.

Conclusion

Our study contributes to the understanding of IoT adoption by considering the stakeholder theory. First, by applying a configurational perspective, we explore the interaction of individual conditions. We demonstrate that the interplay of factors in multiple combinations leads to adoption, emphasizing the relevance of equifinality, multifinality, and asymmetry. Second, we integrate the organizational network literature into our considerations and show that the way networking is conducted interacts with other factors. This reveals that stakeholders exploit different networking opportunities to influence adoption within the company. Third, we contribute to the understanding of the adoption of digital innovations in the corporate context and expand adoption research from the stakeholder perspective.

Our study has some limitations that provide starting points for future research. First, we relied on individual respondents who completed the survey at a single time point. Multiple data sources can improve data quality. Previous studies have highlighted the suitability of such datasets and demonstrated their effectiveness and widespread use (Frambach et al. 2016; Leroy, Palanski, and Simons 2012). While scholars have highlighted potential issues regarding common method variance (Podsakoff et al., 2012; 2024), recent meta-reviews (e.g. Bozionelos and Simmering 2022; Lance et al. 2010) and data simulations (Fuller et al. 2016) demonstrate that common method variance concerns may be exaggerated. Furthermore, although previous studies stress the importance of the best-informed responder within organisations (Cruz 2022) and reveal the effectiveness of this source (Frambach et al. 2016), we adhered to Rindfleisch et al. (2008) and used a cross-sectional approach to reduce common method bias. Common method variance checks revealed no concerns, especially since we enriched our results and discussed them using exemplary cases.

Another limitation relates to the fact that we aggregated data collection at the stakeholder group level (and their relationships with the company) and did not study individual stakeholders. Thus, we used average values and did not consider individual relationships. Although this approach appears in innovation and strategic management studies (Frisch and Huppenbauer 2014; Wolf 2011), we advocate that future research examines individual ties.

Third, this study focuses on the adoption of IoT applications in the German-speaking business world. We cannot rule out the possibility that governmental authorities that are relevant secondary stakeholders in our sample might pursue different technologies and industrial policies, and thus, play different roles in the adoption of innovations in other countries. However, IoT applications are generally characterised by a higher degree of connectivity and interaction with ecosystems. For other innovations, including digital innovations, the need to collaborate and deal with interdependencies may be lower for companies, and other stakeholders may come to the fore. Therefore, further studies are required to investigate the antecedents of adopting other innovations in different business environments.

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6. Publication 6: What Drives Individuals to Participate in Co-creation of Artificial Intelligence for Sustainability

6.1. Notes on submitted Paper

This paper on “What Drives Individuals to Participate in Co-creation of Artificial Intelligence for Sustainability” was co-authored by myself, my dissertation supervisor Prof. Dr. Alexander Fliaster, and Elena See. The paper was accepted for presentation at the 83rd Annual Meeting of the Academy of Management in Boston, USA in 2023 after a double-blind peer-review process. A previous version of the paper was discussed at the QCA Paper Development Workshop at the Academy of Management Meeting 2022 in Seattle, USA. The paper is submitted to Technovation, a B-journal in business administration and in the revise and resubmit process (VHB: B, VHB Publication Media Rating 2024).

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6.2. Academic Paper

Abstract

Artificial intelligence (AI) is becoming an integral part to tackle sustainability challenges, like green and social issues. Co-creation is a suitable way to collect data and involve individuals in the development of AI. However, co-creation and sustainable AI have been previously studied separately. Hence, no insights have been gained on the factors that influence individuals to participate in co-creation for sustainable AI. We take a configurational perspective to examine which combinations of personality factors (openness to ideas, susceptibility to social influence, autonomous motivation, and values) and AI technology-related factors (importance of privacy, trust in AI) affect individuals' participation in these co-creation projects. We conducted factorial survey experiments, using vignettes to collect data from 196 individuals with 784 vignettes, and analyzed the data with fsQCA. We identify different solutions and reveal the interacting mechanisms of our conditions. We find that altruistic and biospheric value orientation have different effects, trust in AI has a large influence on participation, and susceptibility to social contagion and openness to ideas act as substitutes for various solutions. Furthermore, people with autonomous motivation, trust in AI, and altruistic or biospheric value orientation, as well as little concerns regarding data protection participate irrespective of the type of project.

Keywords: co-creation, innovation, sustainability, artificial intelligence, fsQCA, experiments, vignette

Introduction

Coping with the societal grand challenges and achieving a sustainable future requires efforts from several actors at various levels (United Nations, 2015; George et al., 2016). First, business organizations can develop innovative sustainable products, processes, and business models (Schaltegger et al., 2016). Second, individuals can contribute to sustainability by changing their consumer demand, prevailing lifestyles, and consumption patterns, e.g., traveling and eating (Köhler et al., 2019). Third, organizations and individuals can develop innovations jointly (Cillo et al., 2019). In this case, organizations must enable collaboration, but individuals must be willing to accept the organization's invitation and 'walk through the open door'.

One approach to developing sustainable innovations at the intersections of organizations and individuals is co-creation (Hoyer et al., 2010). Companies actively use co-creation to foster digital innovations, such as artificial intelligence (AI) (Sjödin et al., 2020). What is more, the co-creation approach promotes “digital sustainability”, that is, the development of digital innovations that deliver economic, green, and social value (Rodrigo & Palacios, 2021, Stuermer et al., 2017). In doing so, organizations can collect and use data generated through co-creation to develop AI to generate sustainable value. Previous studies investigated the organizational implementation of AI (Haenlein & Kaplan, 2019) and the integration of individuals in co-creation projects (Bogers et al., 2010). However, much remains about using co-creation to develop sustainable AI.

First, only little research exists at the intersection of co-creation, sustainability, and AI. Aquilani et al. (2020) investigated the role of co-creation regarding digital technologies and sustainable movements. Leone et al. (2021) examined the influence of different stakeholders in co-creation processes and the use of AI to achieve social benefits like patient care and a patient's healthcare journey. However, an in-depth exploration of individual and organizational factors that trigger or hinder the participation of individuals in co-creation projects on AI for sustainability has not occurred yet.

Consequently, previous studies identified the need for a deeper understanding of factors that fostered the participation of consumers in co-creation and called for the investigation of “needs, wants, preferences, and the motivation” (Hoyer et al., 2010, p. 289). In a similar vein, Suhada et al. (2021) studied the motivation to contribute to co-creation. However, from the theoretical perspective, it is yet unclear what exactly are the antecedents for an individual decision to participate in such co-creation activities. For instance, we theorize that not only the needs and motivation but other factors like personality traits and individual values are likely to affect individual decisions to participate in the co-creation of digital innovations for sustainability.

Furthermore, recent quantitative co-creation studies deployed methods such as SEM (Jain et al., 2021; Nadeem et al., 2020) and PLS (Foroudi et al., 2019). In doing so, past work has only identified the net effects of isolated impact factors. As a result, previous research falls short in addressing causal complexity, that is, “situations where multiple explanatory factors combine in complex and at times contradictory ways, and where there is equifinality, that is, multiple alternative paths to an outcome" (Furnari et al., 2021: 3). In light of configurational thinking this is a shortcoming (Ragin, 2008; Fiss, 2011). Current innovation and organizational studies increasingly consider those complex situations (e.g., Hajiheydari et al., 2021; Juntunen et al., 2019). Gligor & Bozkurt (2020) compared fuzzy set Qualitative Comparative Analysis (fsQCA) and multiple regression analysis in the context of an organization and customer interaction and showed the high explanatory power of fsQCA as a rich and important perspective. In addition, first studies have begun to demonstrate the importance of configurational thinking concerning co-creation settings (Peng et al., 2022). They revealed different pathways that lead to high customer relationship by using co-creation.

While AI is conducive to sustainability and co-creation has proved to be instrumental for the design of this AI, there is still a lack of understanding of *which factors affect the participation of individuals in the co-creation efforts and how these relevant factors interact.*

We first introduce the co-creation approach and briefly overview AI technologies. Second, we develop the configurational framework and explicate its building blocks (conditions) and their possible interactions from the theoretical perspective. Third, we describe our research methodology, explain factorial survey experiments in particular vignettes, outline the data collection, and describe the configurational analysis. Fourth, we present and discuss the results. Finally, we provide a conclusion and discuss the limitations of our study.

Theoretical Background

Co-creation in the sustainable and digital context

Current research deploys the concept of co-creation, especially in service marketing and innovation studies, to address the participatory value creation between individuals and organizations (Alves et al., 2016). Co-creation is a joint accomplishment of a value-creation process by multiple parties "through shared inventiveness, design, and other discretionary behaviors" (Ostrom et al. 2010, p. 24). Thus, individuals contribute their skills and knowledge to the organization's innovation process (Bogers et al., 2010; Hoyer et al., 2010). Lusch and Vargo (2006) emphasize the customer's role in co-creation, interacting consciously or unconsciously with the organization. Customer integration promises higher product success, more efficient and focused organizational processes, and a closer organization-customer relationship (Ostrom et al., 2010).

Individual customers have different levels of knowledge, skills, experience, and other characteristics (Ostrom et al., 2010), and they might be motivated by different factors, such as personality and perceived benefits, factors to participate in co-creation projects (Füller, 2010; Hoyer et al., 2010). Scholars argue "the emotional gratification of participating in the service experience, their need to control their service experience and their perceptions of the trustworthiness of the organization" shape customers' decision to participate in co-creation (Bolton & Saxena-Iyer, 2009, p. 95).

Current research on co-creation addressed the interaction between co-creation, customers, and brands (Kim & Baker, 2020; Merz et al., 2018), the impact of co-creation on the innovation process, and organizational change (Roberts et al., 2022; Lin et al., 2022; Roberts et al., 2022;), the dynamic and interplay of actors in co-creation (Bhattacharjya et al., 2023) and the relationship of co-creation and sharing economy (Akhmedova et al., 2020; Nadeem et al., 2020; Nadeem et al., 2021).

In the context of digitalization and sustainability Sjödin et al. (2020) analyzed co-creation concerning digital servitization and addressed its influence on digital developments, highlighting the agile micro-service innovations. Schiavone et al. (2021) studied value co-creation and digital business models within an ecosystem in healthcare and showed the resulting value contributions for various stakeholders. Jain et al. (2021) investigated the relationship between customer innovativeness and adoption intention in the co-creation process related to digital clienteling. Mele et al. (2021) explored co-creation concerning digital technologies and decision-making. Lafuente et al. (2023) studied different co-creation networks and the impact of digital competencies.

Studies that addressed co-creation about sustainability discerned sustainable green (Ma et al., 2019) and social innovations (Kumari et al., 2019). In the green innovation context, the influence of customer knowledge, capabilities, and readiness on communication has been studied (Frempong et al., 2020). Kruger et al. (2018) addressed the sustainable opportunities offered by co-creation. Ma et al. (2019) showed the potential of co-creation for sustainable production and consumption in changing roles between government, customer, and producer. Concerning social aspects, opportunities (De Silva & Wright, 2019), as well as social responsibility, have been explored (Simpson et al., 2020; Iglesias et al., 2020). De Silva et al. (2021) investigated the combined generation of societal and business value in the context of co-creation. Chaudhuri et al. (2023) studied the resources and capabilities for the co-creation in the healthcare sector.

Furthermore, research assumed that the willingness of individuals like customers to collaborate on co-creation might be affected by their characteristics. Brown et al. (2004) considered the role of personality attributes and the individuals' trust in situations and technologies. Yi and Gong (2013) studied the impact of individuals' interest in new knowledge and willingness to share knowledge. Other studies investigated the effect of personality traits, such as openness to experience, on co-creation (Faullant et al., 2016). Furthermore, other "Big Five" traits, particularly conscientiousness and agreeableness, support the willingness to engage in collaborative activities in existing literature (Matzler et al., 2008; Graziano & Eisenberg, 1997).

Artificial Intelligence as digital technology in an organizational context

Russell and Norvig (1995) considered AI as a technology that focuses on creating and understanding intelligent agents. We follow their conceptualization and define AI as automating human tasks, actions, and responses in problem-solving, decision-making, and learning. Building on the characteristics of AI that allow its application in products and processes and enable their automation and augmentation, AI has essential application potential in business organizations (Krakowski et al., 2022; Raisch & Krakowski, 2021). Current literature reviews revealed the impact of AI on strategy (Haenlein & Kaplan, 2019) and innovation management (Haefner et al., 2021). Dwivedi et al. (2021) showed the potentials and opportunities of AI in the context of organizations, such as transformation opportunities that arise from AI, and related these new application opportunities to the achievement of the UN's Grand Challenges. Keding (2021) differentiates the topics of AI research into antecedents and consequences and groups the research on antecedents into data-driven work, management readiness, and organizational factors. The consequences are divided into an individual and an organizational level. Similarly, Haenlein and Kaplan (2019) discussed the origins and developments of AI on the micro, meso, and macro level. Finally, the co-creation literature showed that AI is applied for both process adaptation (Mele et al., 2021; Leone et al., 2021) and co-creation applications (Lalicic & Weismayer, 2021).

AI for sustainability

AI can be used in diverse scenarios, with different intentions and unforeseeable consequences, just like other disruptive technologies (Guandalini, 2022). Thus, AI can be used both in a sustainable context and in a purely commercial or potentially even harmful context. For example, the operation of AI applications requires much energy (Jones, 2018), and organizations have technological capabilities that can be misused without guidelines (Vinuesa et al., 2020).

George et al. (2021), as well as George & Schillebeeckx (2022), pointed out that sustainability and digitalization may seem contradictory at first glance, but in the context of digital sustainability, digital technologies can make an essential contribution to sustainability. Consequently, digital technologies such as AI contribute to realizing the UN Sustainable Development Goals (SDG) (Del Rio Castro et al., 2021; Guandalini, 2022). Kar et al. (2022) conducted a literature review and revealed AI's impact on sustainability in water management, transportation, healthcare, manufacturing, construction, and financial services. They demonstrated that AI methods often provide an integral part of prospering different dimensions of sustainability. In a similar vein, Dwivedi et al. (2021) argued that AI can improve the sustainability of products and services.

Although sustainable AI is still in its infancy (George et al., 2020), van Wynsberghe (2021) described such use as 'AI for sustainability' in her consideration of 'Sustainable AI'. She defined AI for sustainability as the goal "to explore the application of AI to achieve sustainability in some manner of speaking, for example, AI and machine learning (ML) to achieve the United Nations Sustainable Development Goals (SDGs)" (p. 214). Thus, the implementation and use of AI are foregrounded in this consideration. We follow this understanding and focus in our study on the usage of AI in projects focusing on different sustainable dimensions, like green and social.

Configurational framework

We follow best practices for configurational studies recommended in the literature (Fiss, 2011; Furnari et al., 2021; Greckhamer et al., 2018) and integrated insights from innovation studies with the research on personality psychology that explores individual differences in thoughts and behaviors. We extend those insights by current co-creation studies that have begun to consider the role of personality (Kruger et al., 2018).

Previous work on personality psychology comprises the four domains of personality traits, narrative identity, motives, and skills (Roberts & Yoon, 2022). Those domains are based on an organizing taxonomy and focus on different facets. The conditions within those dimensions are suitable for configurational thinking since persons can rely on their specific skills or personality traits to become a participant in co-creation. In addition, current research on personality psychology calls for new methods to gain additional insights (Baumeister et al., 2007; Roberts & Yoon, 2022). Following personality psychology, the individual decision to participate in co-creation is likely to be affected by the personality traits and desires, and values that constitute another core domain of personality – motivation (Roberts & Yoon, 2022).

We enrich our configurational model by building on management research findings, particularly studies on co-creation, digital technologies, and artificial intelligence. We theorize that individual decisions to participate in co-creation are likely to be affected by technology-related factors, such as trust in AI, a novel and controversial technology (Longoni et al., 2019).

In the following sections, we explain these building blocks of our overarching model in detail, focusing on the relevance of the conditions, possible interactions among them, and methodological rigor. Figure 33 depicts this configurational framework.

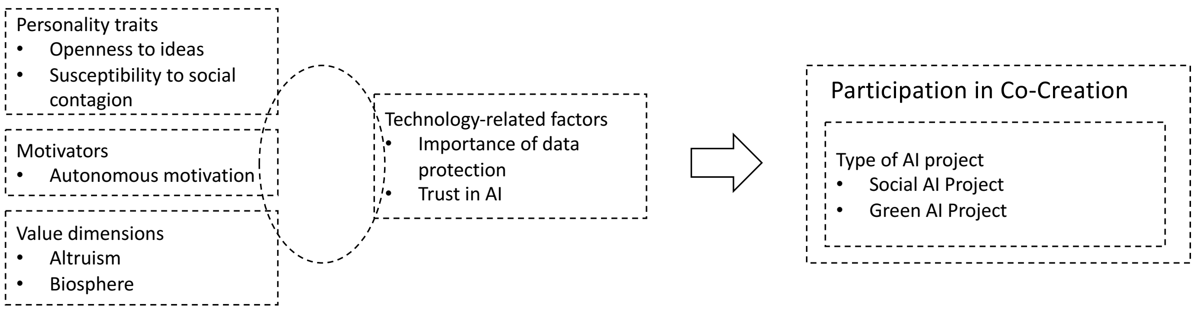

Figure 33 Configurational Framework for the conditions influencing the participation of individuals in green and social co-creation projects.

Note: The value dimensions are associated with the specific types of AI projects. Altruistic value orientation refers to social AI projects, biospheric value orientation refers to green projects. Active participation is associated with personal interactions between organizations and individuals such as experiments in lab or field. Automated information exchange is associated with interactions such as automated data sending.

Outcome

As shown in Figure 33, the outcome of our model is composed of two dimensions: the type of AI project and the type of interaction within the co-creation setting. Accordingly, we designed four different hypothetical scenarios that cover four distinct outcomes. These scenarios are presented with the help of vignettes and explained in Table 29.

All vignettes refer to sustainable, namely ecological and social, contexts. Here, AI serves as the tool described above to achieve sustainability in the sense of AI sustainability. We consider two types of AI projects that reflect two dimensions of sustainability mentioned above (United Nations, 2015) –projects related to environmental (ecological) and those related to social issues. The ecological aspect refers to the utilization of the environment and natural resources. The social aspect describes establishing regulations and values society wants to live, such as social justice (Robinson & Tinker, 1997; Stubbs & Cocklin, C. 2008).

Regarding interaction type, individuals can directly contact the companies, participate in a close exchange (e.g., in a lab), or contribute by automatically providing data. In the second case, the interaction usually consists of a one-time consent by the individual. Subsequently, the data is transferred to the organization without additional effort from the individual (Russo-Spena & Mele, 2012).

Conditions

Personality traits

Openness to ideas: Past research indicated that personality traits predict participation in co-creation activities (Brown et al. 2004). Openness to experience is one of the “Big Five Factors” (Goldberg 1993; McCrae & Costa, 2008) and is related to creative behavior (George & Zhou, 2001) and proved to be important in collaborative projects (Faullant et al., 2016) where individuals have to deal with different opinions and novel views. Individuals with high levels of this trait tend “to enjoy new experiences and seek opportunities to learn new things” (LePine & van Dyne, 2001, p. 328). They show no fear of the unknown, like new technologies, and participate proactively in new developments. Ostrom et al. (2014) argue that openness to ideas is relevant for co-creation since at the core of co-creation is the joint development and improvement of things.

Table 29 Structure of the vignettes within the dimensions type of AI project and type of interaction to co-creation.

Dimension	Level	Vignette	Reference
Type of AI project		An organization develops an AI application, which ...	
	green	...analyzes data to reduce traffic volume and CO2 emissions.	Boukerche & Wang, 2020
	social	...analyzes health data to improve treatments for diseases.	Garbuio & Lin, 2019
Type of interaction to co-creation		The organization is looking for people to support the development of the AI by...	
	active	...direct, face-to-face interaction with the organization on its platforms or with its employees (e.g., data collection in the lab).	Russo-Spena & Mele, 2012; Tan & Zhan, 2017
	automated	... agreeing to automated collection of personal data running in the background (e.g., after one-time confirmation, user data is continuously shared with the organization).	Chen et al., 2012; Russo-Spena & Mele, 2012

Susceptibility to social contagion: We theorize that individual decision to participate in co-creation projects is also affected by another personality trait that does not belong to the Big Five Factors. While the Five Factor Model represents one of the most salient and robust personality traits frameworks, psychology scholars call it to extend "beyond the Big Five" and identify essential personality variables missing from the Five Factor Model (Hough et al., 2015). We answer this call by including the susceptibility to social (e.g., interpersonal) influence or contagion (Bearden et al., 1989; Zhang et al., 2018) into our framework. In general, susceptibility to social contagion is a general trait that describes influenceability, that is, an individual's tendency to be affected by others. Individuals may seek information from others (Yi & Gong, 2013), whose influence guides an individual's decision (Aral, 2011). Plé and

Demangeot (2020) highlighted the effect of social contagion on the willingness to participate in co-creation. Social contagion is divided into informative and normative social influence (Bearden et al., 1989; Zhang et al., 2018). Deutsch and Gerard (1955) defined informative social influence as the "influence to accept information obtained from another as evidence about reality" (p. 629). This involves weighing the pros and cons of an action (Iyengar et al., 2015, p. 410). Normative social influence describes "an influence to conform with the positive expectations of another" (Deutsch & Gerard, 1955, p. 629). Thus, the actual decision is made according to the standard of which decision the reference group would prefer.

Value Dimension

Values are individual, abstract beliefs that help people assess a situation and guide their actions accordingly (de Groot & Steg, 2008). In other words, value beliefs serve as "guiding principles in the individual's life" (Schwartz 1992, p. 17). Since we focus on the differences and similarities between green and social AI projects, we integrate value dimensions into our framework that refer to these two areas. Stern et al. (1993) has considered social and biospheric values to analyze how individuals are willing to respond to environmental issues. Since considering values depends on the outcome, we explore the impact of altruistic value orientation in social AI co-creation projects and the biospheric values in green AI co-creation projects. Concerning the altruistic value orientation, we draw, for instance, on the conceptualization by DeGroot and Steg (2008), who referred to aspects such as "working for the welfare of others" and "care for the weak", among others. Concerning the biospheric value orientation, we draw on Dunlap et al. (2000), who developed parameters for these values based on the "New Environmental Paradigm". Hence, we include two issues in our research framework – "the fragility of nature's balance" and "the possibility of an ecocrisis" (Dunlap et al., 2000, p. 432).

Autonomous motivation

In addition to the value component concerning the domain of motivation, we also build on the self-determination theory (SDT) (Deci & Ryan, 1985). Based on the "catalyzers, concomitants, and consequences" criteria, SDT discerns between autonomous motivation and controlled motivation (Deci et al., 2017, p. 20). Autonomous motivation is likely to positively affect individual decisions to participate in sustainable AI projects as this type of motivation describes "people being engaged in an activity with a full sense of willingness, volition, and choice" (Deci et al., 2017, p. 20). Since our co-creation study focuses not on material incentives, we do not include controlled motivators like extrinsic ones in our framework.

Past work demonstrated that autonomous motivation improves individual work contributions and satisfaction (Gagné & Deci, 2005). SDT discerns between two forms of autonomous motivation – intrinsic and internalizing extrinsic motivation. Intrinsic motivation refers to the link between activity and goal (Fishbach & Woolley, 2022). Ryan et al. (2022) revealed in their meta-review that intrinsic motivation is essential in complex situations requiring a high engagement level. In the context of AI co-creation activities, we draw on previous studies that found that the participants' interest in participating, the enjoyment of the activity, and participation out of curiosity positively impact co-creation (Füller, 2010). Concerning internalized-extrinsic factors, previous co-creation studies considered the impact of participants' desire to support and the benefits they gain for themselves, such as learning effects, accomplishment feelings after successful participation, and an increasing reputation (Füller, 2010).

Ryan et al. (2022) showed that extrinsic motivation is particularly beneficial in the context of algorithmic tasks and is a hindrance in creative and complex tasks. Furthermore, in co-creation, autonomous motivation rather than controlled motivation and extrinsic motivation is crucial (Roberts et al., 2014). Consequently, we will focus on autonomous motivation in the following.

Technology and technological capability related factors

Since the willingness to participate in co-creation depends on project-specific factors, the individual's attitude regarding AI-related factors must be considered. In this context, the acceptance of the technology, which is affected by privacy concerns and existing trust in the technology, is important (Dhagarra et al., 2020). Prudent handling of customer data is essential to increase trust in an organization and the willingness to share data (Mattison Thompson & Siamagka, 2022). Thus, this study examines trust in the technology and aspects of privacy.

Importance of data protection: If an organization uses AI, this technology collects and processes an enormous amount of data, which means there is a risk on the customer side that this data is not sufficiently protected. Privacy describes "the ability to manage information about oneself" (Belanger et al., 2002, p. 249). Privacy concerns depend on various factors that vary from person to person (Malhotra et al., 2004). Bansal et al. (2010) reveal that the reasons for skepticism depend on personal factors of the user triggered by previous negative experiences, and that they are influenced by the degree of sensitivity of the donated data. Further, users' security concerns may relate to both the organization of collecting the data and the technology used (Malhotra et al., 2004). Previous work thematized several dimensions into which personal data protection concerns can be classified. In this study, we focus on the unauthorized disclosure of data (Smith et al., 1996). It refers to the companies' handling of the collected data; therefore, organizations need to take these reservations of participants seriously and incorporate appropriate mechanisms to counter them into their co-creation processes and strategies (Park et al., 2021).

Trust in AI: Trust in technology is generally determined by its "functionality, helpfulness, and reliability" (McKnight et al., 2011 p. 9). One key reason why user distrust AI is that they might be concerned that an algorithm cannot adequately address their individual situation and needs (Longoni et al., 2019). To counter distrust, users need to receive sufficient information about the algorithm and its results (Kim et al., 2021). Thus, AI must meet certain characteristics, "transparency, accountability, fairness, and explainability" (Shin, 2020, p. 557).

Methodology

fsQCA

We apply fsQCA and focus on the interaction between the individual conditions rather than net effects (Fiss, 2011). In recent years, this methodology developed by Ragin (2008) has received increased attention in management and innovation management research (Fiss, 2011; Poorkavoos et al., 2016; Reck & Fliaster, 2022). While research on co-creation mostly used traditional methods such as regression analysis, scholars only recently began to apply QCA (Navarro et al., 2016; Peng et al., 2022). Recent innovation studies that address individual decision-making also show the relevance of the configurational perspective (Laut & Vojer, 2021). The decision of individuals to participate in co-creation is a complex phenomenon, as factors from different domains influence the decision interdependently. Furnari et al. (2021) highlight the importance of QCA for analyzing phenomena where the object of study depends on the interaction of conditions.

fsQCA defines cases "as combinations of theoretical attributes of interest rather than as disaggregation of their attributes being treated in isolation" (Misangyi et al. 2017, p. 260). Subsequently, fsQCA differs from classical qualitative and quantitative methods by the characteristics of causal asymmetry, equifinality, and conjunction (Misangyi et al., 2017). Conjectural causality emphasizes that different combinations of conditions can lead to the same outcome. Ragin (2008) clarifies that the focus is on the interaction, not the isolated individual effects. Equifinality means multiple solutions can lead to the outcome (Fiss, 2007). Causal asymmetry postulates that in different solutions, depending on the interaction with the other conditions, the presence or absence of a particular condition can lead to the same outcome (Ragin, 2008).

The configurational perspective is particularly appropriate since the three dimensions of causal complexity can be observed in individual decision-making regarding the participation of AI co-creation. As mentioned above, from the theoretical perspective, this decision can be simultaneously affected by several conditions and, thus, by different configurations. Moreover, the fsQCA methodology allows us to identify whether some conditions, such as, for example, personality traits and values, substitute each other and build multiple equifinal pathways to participation.

Factorial survey experiments – vignettes

Vignettes are descriptions of situations whose dimensions differ in their levels or characteristics. Changes in the dimensions identify whether there is a difference in evaluating a specific situation when individual elements are changed (Mutz, 2011). Vignettes have a high internal validity. We measure the outcomes with 'hypothetical situations' vignettes, which are presented to the respondents as text. Using vignettes provides a concrete understanding of respondents' assessment processes and criteria (Auspurg & Hinz, 2015). Existing business research applies the vignette methodology in consumer research (Martin, 2018) and ethical problem research (Dickel & Graeff, 2018). Vignettes are often used within a factor analysis but can be combined with other analysis methods, including QCA (Azadegan et al., 2020). Especially in the context of QCA, vignettes offer the possibility to achieve further validation regarding common method effects since the vignettes allow the generation of external conditions (Crilly, 2022). In applying vignettes, we followed methodological recommendations from previous studies. The vignettes are retrieved randomly to avoid framing effects (Auspurg & Hinz, 2015). The number of vignettes we collected is consistent with the literature (Auspurg & Hinz, 2015; Sauer et al., 2011).

Data collection & validation

We conducted an online survey in Germany in the first half of 2022. We focused to the requirements that QCA places on participants for the analysis and that participants have prior experience with co-creation projects. Since we need both participants in sustainable co-creation projects and non-participants in co-creation projects, we invited individuals from both groups to contribute to the study. The individuals with experience in AI co-creation projects contributed to health & social, energy, and sport co-creation projects. Thus, we can ensure that we consider individuals with experience in co-creation projects with AI and sustainability. Automated experience on co-creation projects was ensured through prior participation in co-creation projects with automated data sharing.

We received 196 valid questionnaires and 784 vignettes. The questionnaire refers to users' perspectives of AI applications, using multi-item five-point Likert scales to explore individual factors that affect users' participation in co-creation projects for such applications. All items have been asked as mandatory questions to avoid non-response. All questions and the vignettes of the outcome were validated with a pretest of 20 persons. In addition, we discussed the vignettes with eight experienced AI researchers who use laboratory experiments and automated data collections with different value dimensions and industries (sport, healthcare, production).

Measurement of all conditions is based on previous literature. Table 30 shows the descriptive statistics, and Table 31 depicts the literature sources, questions, factor loadings, mean, standard deviation, CR, AVE, Cronbach's alpha, and Spearman-Brown.

Table 30 Descriptive statistics.

Age		
	11-20	2%
	21-30	69%
	31-40	13%
	41-50	5%
	51-59	9%
	60 and older	2%
Gender		
	Male	53%
	Female	46%
	diverse	1%
Education		
	Elementary/ high school diploma	1%
	Secondary school leaving certificate	3%
	General university entrance qualification	20%
	Completed vocational training	6%
	Technician or master craftsman	3%
	University degree	62%
	Doctorate	4%
Technological and digital competences		
	Very low	0%
	Low	7%
	Medium	13%
	High	55%
	Very high	25%

Table 31 Questionnaire, factor loadings, mean, standard deviation (R indicates reverse coding).

	Item	*Loading*	*M*	*SD*
Openness to ideas (Soto & John, 2009)				
AVE=0.632 CR=0.837	I am someone who is curious about many different things.	0,787	4,170	0,700
α=0.702	I am someone who is inventive.	0,693	3,280	0,870
	I am someone who likes to reflect, play with ideas.	0,804	4,000	0,784
Susceptibility to social contagion (Bearden et al., 1989; Zhang et al., 2018)				
normative AVE=0.704	It is important that others like the co-creation projects I participate.	0,837	3,290	0,923
CR=0.877 α=0.789	When I participate in co-creation projects, I usually participate in co-creation projects that I think others approve of.	0,876	2,910	1,034
	If other people can see that I am participating in a co-creation project, I often participate in a co-creation project that they expect me to participate in.	0,802	2,780	0,972
informative AVE=0.675 CR=0.861 α=0.752	To be sure I am participating in the right co-creation project, I often observe what co-creation projects others are participating in.	0,714	2,700	1,074
	If I have little experience with a co-creation project, I often ask my friends about the collaborative project.	0,855	3,340	0,998
	I frequently gather information from friends or family about a product before I participate in a co-creation project.	0,886	3,260	1,011

	Item	*Loading*	*M*	*SD*
Biospheric value orientation (Dunlap et al., 2000)				
Fragility of nature's balance	When humans interfere with nature it often produces disastrous consequences.	0,791	3,990	0,856
AVE=0.642 CR=0.843 α=0.719	The balance of nature is strong enough to cope with the impacts of modern industrial nations. -R-	0,775	4,130	0,784
	The balance of nature is very delicate and easily upset.	0,836	4,150	0,793
Possibility of an ecocrisis AVE=0.734	Humans are severely abusing the environment.	0,855	4,280	0,770
CR=0.892 α=0.815	The so-called „ecological crisis“ facing humankind has been greatly exaggerated. -R-	0,818	4,210	0,909
	If things continue on their present course, we will soon experience a major ecological catastrophe.	0,895	4,170	0,921
Altruistic value orientation (Otto & Bolle; 2011)				
AVE=0.789 CR=0.882	I would help push a stranger's car out of the snow.	0,888	4,350	0,703
Spearman-Brown=0.732	I would delay an elevator and hold the door open for a stranger	0,888	4,440	0,717
Autonomous motivation (Guay et al., 2000; Salgado et al., 2020)				
Intrinsic AVE=0.762	I think engaging in a co-creation project is an interesting activity.	0,881	3,960	0,690
CR=0.906 α=0.840	I think engaging in a co-creation project is a pleasant activity.	0,844	3,640	0,802
	I think engaging in a co-creation project is fun.	0,893	3,840	0,760

	Item	Loading	M	SD
Internalized-extrinsic AVE=0.633 CR=0.838 α=0.705	Participating in a co-creation project enhances my reputation as an expert.	0,762	3,510	0,807
	I derive satisfaction from influencing technology development.	0,778	3,690	0,847
	Participating in a co-creation project enhances my knowledge about the technology and its usage.	0,844	4,010	0,761
Importance of data protection (Smith et al., 1996)				
Unauthorized secondary use AVE=0.790 CR=0.919 α=0.865	It bothers me to give personal information to so many companies.	0,896	3,700	1,064
	When companies ask me for personal information, I sometimes think twice before providing.	0,864	3,580	1,100
	It usually bothers me when companies ask me for personal information.	0,906	3,670	1,001
Trust in AI (Johnson, 2007)				
AVE=0.807 CR=0.926 α=0.879	I can rely on Artificial Intelligence to execute processes reliably.	0,883	3,010	0,966
	Given the state of existing Artificial Intelligence, I believe that technology related errors are quite rare.	0,872	2,710	1,009
	In my opinion, Artificial Intelligence is very reliable.	0,938	3,070	1,013

We assessed the outcome using four theoretical scenarios (see Table 29). In addition, we checked for discriminant validity and conducted the test for heterotrait-monotrait (Henseler et al., 2015). The highest value is 0.716 and thus below the threshold of 0.85. Since questionnaires might be affected by common method bias (CMB), we perform ex-ante and ex-post measures. We conducted Harman's Single-Factor Test according to Podsakoff et al. (2003). The first factor explains 14.82% of the variance.

Even though the Harman Single-Factor Test is well-established and widely used in management research, there is criticism regarding its potential to detect CMB (Aguirre-Urreta & Hu, 2019; Malhotra et al., 2006). Podsakoff et al. (2003) emphasize that an absence of a general factor is no necessary evidence for the absence of CMB. One recommended procedure to check for CMB is using external conditions in the analysis (Antonakis et al. 2010; Podsakoff et al. 2012).

Van Gerwen et al. (2018) argued that factorial survey experiments with vignettes help overcome CMB. They advocated that the exogenous variation within independent conditions facilitates a distinction between cause and effect. This is ensured by determining the independent conditions and defining the vignettes before the participants answer. This allows causal inferences about the effects of the hypothetical situation, increasing the survey's validity. As the independent conditions (green and social AI project; active and automated interaction) are established before respondents answer the questions, using a vignette experiment prevents the data from CMB (Podsakoff et al., 2003).

In the context of fsQCA, external conditions are included in the framework. The exogenous conditions are independent of the individual perceptions of the participants (like sex and religion) and are not affected by CMB. The subsequent analysis validates whether the solutions are sufficiently similar concerning the different exogenous conditions (Crilly, 2022).

In our analysis, we generated the conditions from the vignettes and focus on four exogenous conditions social and green AI projects and direct and automated interaction. We performed the fsQCA analysis with the four exogenous conditions in the next step. Due to the joint consideration of the different vignettes, the two value dimensions of social and biospheric attitudes cannot be considered because they are only relevant to specific AI projects. Furthermore, we followed best practices regarding a comprehensible model size and conduct an additional analysis with fewer conditions since the four additional conditions would increase the complexity by a factor of 16 (24). Thus, we conduct two different fsQCAs.

Next, we verified the similarities between the different solutions of both analyses. Given the complexity, we focused on the reduced framework which is depicted in Table 38 and see significant similarities within the solutions. The personal characteristics and drivers of solutions 4, 5, and 6 are identical. A subset superset interaction exists within solutions 1 and 3, 4, 5, and 6. Since the vignettes and the external dimensions are essential for participation, we see differences in some respects (e.g., solution 2). Three points underline the similarity. First, different patterns appear over different exogenous conditions. Second, subset superset relations appear between different patterns. Third, the importance of specific conditions manifests above several solutions. Thus, we are confident that CMB does not affect our collected data. Table 32 presents the correlation matrix, means, and standard deviations.

Configurational analysis

We conducted the fsQCA with the software R-studio (1.2.1335) and R (3.5.3). In addition, we used the packages QCA (3.6) and SetMethods (2.5) (Duşa, 2018). We followed Ragin (2008) and identified configurations with high and low rates for the participation of individuals in the co-creation of AI projects by using the variables as indicators of set membership scores between 0 (fully out) and 1 (fully in). To assess necessity and sufficiency, we linked the membership scores of the conditions and the membership score of the outcome (Ragin, 2008). Following best practices for fsQCA analysis (Furnari et al., 2021; Greckhamer et al., 2018; Schneider & Wagemann, 2012), we conducted four steps: calibration, necessity and sufficiency analysis, truth table analysis, and validation.

Table 32 Correlation matrix.

	Mean	SD	1	2	3	4	5	6	7	8
Participation social AI Project	3,309	0,882								
Participation green AI Project	3,260	0,876	,612**							
Openness to ideas	3,816	0,624	0,006	0,102						
Susceptibility to social contagion	3,045	0,719	,216**	,143*	-,144*					
Altruistic value orientation	4,395	0,631	0,045	,142*	,299**	0,035				
Biospheric value orientation	4,156	0,638	-0,031	,150*	,213**	-0,047	,246**			
Data protection	3,773	0,569	,249**	,197**	,355**	,188**	,393**	0,128		
Trust in AI	3,904	0,752	-,231**	-,174*	,268**	-0,054	,261**	,243**	0,103	
Autonomous motivation	2,929	0,894	,325**	,259**	-0,126	,200**	0,011	-0,026	,185**	-,293**
Note: Participation social AI Project and Participation green AI Project refer to the means of all vignettes										

Calibration: First, we calibrated the conditions and the outcome in fuzzy set membership values between 0 and 1 using three anchors (full non-membership score, full membership score, crossover point) (Fiss, 2011; Ragin, 2008). A case with a value of 0 in a condition means that the case is not a member of that condition. If the case has a condition with a value of 1, the case is a member of this specific condition. We determined the anchors in two steps (Greckhamer et al., 2018; Schneider & Wagemann, 2012): We began with the Likert scale. Then, we considered the calibration's mean, standard deviation, and variance, as these differed to some extent. Table 33 depicts the calibration anchors of the conditions.

Table 34 shows the calibration anchors for the outcome of the combined consideration of green and social. For the calibration of the outcome, we focus on the consideration of green and social AI co-creation projects (green - [active & automated]; social - [active & automated]). We considered the sum of the specific vignettes to calibrate the combined consideration.

Necessity and sufficiency analysis: Second, we checked for necessity as well as single sufficiency. We also used x-y-plots to validate our results and checked for deviant cases.

Truth Table Analysis: Third, we structured the cases into the truth table for the corresponding outcomes (Ragin, 2008). For the refinement, we followed the established thresholds for large n studies (inclusion = 0.8; consistency = 0.7; coverage = 2) (Fiss, 2011; Greckhamer et al., 2018; Schneider & Wagemann, 2010). We calculated the parsimonious and intermediate solutions and linked both solutions (Fiss, 2011). The distinction between those solutions is related to the difference between core and peripheral conditions. The core condition refers to conditions that occur both in the parsimonious and intermediate solution. Peripheral conditions, on the contrary, only appear in the intermediate solution. Consequently, core conditions have greater importance for interpretation. The peripheral conditions complement the core conditions and are more interchangeable. Consequently, several permutations of peripheral conditions can occur within one solution of core conditions, which is based on the equifinality principle (Fiss, 2011).

Table 33 Calibration anchors of the conditions.

	OPE	SOC	BIO	ALT	DAT	TRU	AUTO
Fully non-membership score	2.400	1.400	2.400	2.910	1.400	1.400	2.000
Crossover point	3.900	3.001	3.991	4.210	3.801	3.001	3.510
Fully membership score	4.600	4.400	4.900	4.900	4.800	4.400	4.600

Table 34 Calibration anchors of the outcomes for the combined consideration of green and social (green - [active & automated]; social - [active & automated]).

	green - [active & automated]	social - [active & automated]	higher participation – green & social
Fully non-membership score	2.600	2.600	2.600
Crossover point	6.100	6.100	6.400
Fully membership score	9.200	9.200	9.200

Validation: Finally, we validated our results by varying the crossover points and values for the full non-membership and membership scores. There were no significant changes. Furthermore, we check the control questions (e.g., age, education level, and gender) and find no anomalies.

Results

Both tables refer to different categories of sustainable values. Five solutions lead to participation in social co-creation AI projects, and four solutions for green AI projects. All solutions have a unique coverage above 0 and are empirically relevant. The solutions for higher participation deviate from the previous solutions. The solutions for higher participation in social co-creation AI projects rely on the solutions S3 and S5, and the solutions for higher participation in green co-creation AI projects rely on the interaction of the solutions G1 and G2 and solution G4.

Table 35 depicts the results for necessity. No necessary condition is found.

Next, we analyzed the truth tables for the outcomes. Table 36 depicts the solution chart for social co-creation AI projects and Table 37 for green co-creation AI projects. Table Appendix 2 shows the solution charts for higher participation.

Both tables refer to different categories of sustainable values. Five solutions lead to participation in social co-creation AI projects, and four solutions for green AI projects. All solutions have a unique coverage above 0 and are empirically relevant. The solutions for higher participation deviate from the previous solutions. The solutions for higher participation in social co-creation AI projects rely on the solutions S3 and S5, and the solutions for higher participation in green co-creation AI projects rely on the interaction of the solutions G1 and G2 and solution G4.

Table 35 Results for single necessity analysis.

	social - [active & automated]	green - [active & automated]		social - [active & automated]	green - [active & automated]
OPE	.671	.691	~OPE	.592	.598
SOC	.710	.716	~SOC	.587	. 593
ALT	.773	n. a.	~ALT	.432	n. a.
BIO	n. a.	.791	~BIO	n. a.	.485
AUTO	.831	.825	~AUTO	.456	.471
DAT	.636	.656	~DAT	.630	.626
TRU	.685	.684	~TRU	.584	.600

Discussion

We discuss the patterns concerning the interaction of the individual conditions outlined in the framework and focus on empirically distinctive characteristics, particularly evident in the expression of the core conditions (Furnari et al., 2021).

Co-creation in social AI projects

Solution S1 relies on the interaction of susceptibility to social contagion, autonomous motivation, and trust in AI. This solution enriches the insights gained in previous work. Moreira-Fontán et al. (2019) showed a positive relationship between technology perception and autonomous motivation. In addition, individuals with high social influenceability are more prone to participate in social AI activities if surrounded by others supporting those co-creation activities.

Table 36 Solution chart for the conditions that lead to a participation in social AI projects with participation (crossover: 6.1).

	Solution						
	S1a	S1b	S1c	S2	S3	S4	S5
Openness to ideas	⊗			●		⨂	●
Susceptibility to social contagion	●	●	●	⨂		●	●
Altruistic value orientation		•		⨂	●	⊗	⨂
Autonomous motivation	●	●	●		●		•
Importance of data protection			⊗	⊗	⨂	⨂	●
Trust in AI	●	●	●	●	●	●	⊗
Consistency	0.903	0.899	0.918	0.940	0.907	0.931	0.932
Raw Coverage	0.386	0.441	0.403	0.207	0.417	0.227	0.218
Unique Coverage	0.009	0.027	0.005	0.006	0.040	0.015	0.043
Overall Solution Consistency				**0.893**			
Overall Solution Coverage				**0.616**			

Note: large black dots indicate present core conditions; small black dots present peripheral conditions; small, crossed circles indicate absent peripheral conditions; large, crossed circles indicate absent core conditions.

Table 37 Solution chart for the conditions that lead to a participation in green projects with participation (crossover: 6.1).

	Solution				
	G1a	G1b	G2	G3	G4
Openness to ideas	●	●		⨂	
Susceptibility to social contagion				●	●
Biospheric value orientation	●	●	●	●	●
Autonomous motivation		•	•		●
Importance of data protection	⨂	⨂	⨂		
Trust in AI	•		●	●	●
Consistency	0.940	0.933	0.918	0.908	0.908
Raw Coverage	0.367	0.410	0.426	0.390	0.457
Unique Coverage	0.006	0.055	0.016	0.018	0.029
Overall Solution Consistency			**0.897**		
Overall Solution Coverage			**0.592**		

Notes: large black dots indicate present core conditions; small black dots present peripheral conditions; small, crossed circles indicate absent peripheral conditions; large, crossed circles indicate absent core conditions

Solution S2 refers to individuals who are open to new ideas and trust AI. Oksanen et al. (2020) already revealed a positive correlation between openness and trust in AI. We assume those people are likely to be innovative, independent-minded persons interested in novel technological knowledge and tools, are not motivated by altruistic values, and tend to reject social influence. Thus, it is instead the innovativeness and interest in technology than the social factors that drive their readiness to participate in social AI projects.

The third archetype of social AI co-creators (solution S3) represents people who are not afraid of data protection issues, trust AI, and are driven by autonomous motivation and altruistic values. A similar pattern (with the "green value" component instead of altruistic value orientation) appears in the green solution chart, too (Table 8, G2). Since this mechanism works in different value dimensions, we conclude that the interaction of autonomous motivation, technology perception, and specific value work for different sustainable projects. Thus, the application context seems interchangeable due to the enthusiasm for AI.

Solution S4 relies on trust in AI and susceptibility to interpersonal contagion. In addition, those co-creators do not pay attention to data protection and show no openness to new knowledge ideas. Thus, they seem to participate in co-creation, being influenced, informed, and convinced by others. A remarkable difference can be observed by comparison of S4 to S1: While S1 and S4 build on susceptibility to social contagion and trust in digital technologies, fun, and intrinsic interest drives the autonomously motivated S1 individuals. At the same time, the S4 people look more like "followers" being not open to new ideas.

Another important conclusion can be drawn from the comparison of S4 and S2: Openness to ideas and susceptibility to social contagion are substitutes for those solutions. Thus, for individuals with a positive attitude towards AI, openness to ideas or susceptibility to social influence is sufficient for participation in social AI projects, although those individuals do not show altruistic value orientation.

Solution S5 also refers to people participating in social AI projects with no altruistic value orientation. Instead, S5 individuals show high openness to new ideas and susceptibility to social contagion. As AI is currently a "voguish" technology, these people seem to follow the trend and are prone to both collect more information about this novelty from their peers and make their own experiences by participating in AI projects. Thus, their propensity for "fashion" is more vital than their distrust of this technology and skepticism regarding the lack of data protection.

In total, we highlight five aspects. First, autonomous motivation is fundamentally essential for participation: All solutions have a present condition or are indifferent. In this relation, it is also essential to remember that the participants in our empirical setting did not receive any financial compensation for their participation in the AI project. Second, trust in AI is only absent in solution S5. In all other solutions, trust in AI is a core condition: This result demonstrates that trust in technology is vital in most cases, but it is not a necessary condition. Third, as already stated above, we see a partial equifinality between openness to novel ideas and susceptibility to social influence: Two configurations (S2 & S4) require one of both conditions. This equifinality is not perfect. However, in configuration S5, both conditions must be present. Finally, we see that people who participate in social activities act not always according to their altruistic value orientation. People are willing to support social projects even without altruistic values if they have the right technology attitude and personality traits.

Co-creation in green AI projects

Solution G1 relies on openness, biospheric value orientation, and lack of data protection concerns. Thus, this category of people seems to be driven by ecological concerns, and they are innovative enough to be eager to be involved in a relatively new type of creative activity aimed at environmental sustainability. In doing so, they also tend to believe in the potential of new technology and ignore potential risks for data protection.

The pattern of solution G2 has already been discussed above in connection with solution S3 in the social context: We observe the same pattern for both value orientations for two sustainable AI projects. Therefore, this solution might work for different sustainable contexts and is relevant for co-creation projects in different settings.

Like solutions G1 and G2, solution G3 also builds on biospheric values. Contrary to G1, however, this category of co-creation participants does not demonstrate openness to novel ideas but a high level of social influenceability. Thus, they swim with the tide and believe that AI helps to put their ecological values into practice. This finding also augments the insights from research on the adoption of innovations. Aral (2011) shows, for instance, that product features influence communication between individuals, and this communication affects the opinion of other individuals regarding these product features. In our case, the product feature is the sustainable objective of the AI application. From the configurational theory perspective, comparing G1 and G2, we observe the equifinality of openness to novel ideas and susceptibility to social contagion.

Solution G4 relies on the same three present core conditions as G3 and includes autonomous motivation. Thus, these individuals possess both internal and external drivers for adoption as the intrinsic fun and interest, as well as the desire to enhance one's reputation, support the influence of the interpersonal environment and contribute to participation in co-creation.

In sum, this section of data analysis can emphasize two additional important aspects. First, unlike altruistic values in social projects, all green projects build on an identical (i.e., biospheric) value orientation. Thus, biosphere values are crucial for participation in green co-creation projects. Second, we observe a substitution of trust in AI and a lack of concerns regarding data protection. If individuals trust AI and do not care about data protection, neither openness to ideas nor susceptibility to social contagion is required.

Solutions for high participation in co-creation

Furthermore, we conducted additional analysis to assess the solutions for the higher willingness to participate in co-creation and AI (crossover 6.4 instead of 6.1, see Table 39). Solution SH3 relies on solution S3, solution SH5 on S5, solution GH1&2 on solutions G1 and G2, and solution GH4 on G4. This analysis shows that the corresponding solutions are critical as they explain a more substantial participation.

Conclusion

Theoretical contribution

Our study provides five insights that can be drawn from a theoretical perspective. First, we demonstrate that different solutions explain participation in green and social co-creation projects. Hence, the content of the co-creation project matters for the individual decision to be involved. Second, we found that biospheric and altruistic value orientations interact with other conditions differently. While biospheric values are critical for participation, altruistic values might be substituted by personality traits, such as openness to ideas and susceptibility to social influence. Third, we show the importance of trust in AI in almost all solutions regardless of project type. Fourth, we found patterns where openness to ideas and susceptibility to social contagion substitute each other. In other words, while one trigger of participation in innovative co-creation activities results from the willingness to be influenced by novel ideas, the other results from the propensity to be influenced by others. Both ways seem to work in specific situations and lead to participation. Fifth, the solution with high autonomous motivation, high trust in AI, unimportant data protection, and a high social (or, respectively, biospheric) value orientation appears in both types of co-creation projects. If the individual has no doubts about the technology, is motivated, and has suitable values, other personal characteristics seem less critical.

Practical implications

Digital innovations can help tackle current sustainability challenges. Co-creation offers business organizations new opportunities to involve individuals and develop technologies together. Our study suggests that companies can deploy differentiated approaches to attract appropriate participants for co-creation projects. For instance, our results demonstrate a strong need for companies to ensure trust in innovative and controversial AI technology when inviting people to AI co-creation projects. Moreover, companies must recognize that they must address value orientations (e.g., the biospheric values) to motivate people to participate in co-creation activities. We found that social influenceability plays a crucial predictive role, especially for social AI projects. Hence, we propose that companies can strategically deploy various approaches to activate social contagion mechanisms (e.g., Aral, 2011; Iyengar et al., 2015), convincing people to participate in co-creation. In the context of green AI projects, it appears that participants should be sensitized to green values since a green attitude is present in all solutions. In this context, it seems appropriate to highlight and clarify the green character of the innovation to address its green values. In addition, policy and regulation can use the findings of our work to strengthen the spread of AI co-creation projects with a sustainable focus on the one hand and to shape framework conditions on the other. For many participants, privacy and trust in AI are interrelated.

Consequently, political and company frameworks can ensure participants' security and trust in AI. Furthermore, politics and industry should communicate existing regulations on data protection and promote further research work in the context of data protection. Likewise, additional information on data handling can help resolve the participants' concerns. The willingness to participate can be increased, primarily through target-group-specific promotion and addressing. Here, individuals can support participation and serve as role models. Thus, deliberate promotion improves social contagion, primarily due to the relevance of the projects' green and social characteristics, stimulating the participants' value dimension.

Limitations

Our study explored configurations of factors that lead individuals to participate in innovative AI co-creation projects that aim at ecological and social objectives. The configurational research methodology used in our research provided valuable insights; however, like all methods, it is not free from limitations. Our study focuses on individuals from Germany. As a result, our statements are limited to this region. Therefore, it is advisable to consider other regions of the world in future studies.

Furthermore, our sample consists of individuals that participated anonymously. Thus, we could not use secondary data, such as interviews, to validate our findings. Despite these limitations, we believe our approach aligns with the current state of the art for large n-QCA studies when considering individuals. We conclude by emphasizing that this study is only one of the first steps in exploring the complexity of co-creation in the critical contexts of digitalization and sustainability and hope that our findings provide valuable leads to future research endeavors.

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Appendix

Table 38 Solution chart for the analysis of common method bias with the conditions direct and automated interaction, social and green AI projects, openness, data protection, trust in AI, and autonomous motivation (Appendix).

	Solution					
	1	**2**	**3**	**4**	**5**	**6**
Exogenous conditions						
Direct interaction	●	●	●	⊗	●	⊗
Indirect interaction	⊗	⊗	⊗	●	⊗	●
Social AI project	●	●	⊗	●	⊗	⊗
Green AI project	⊗	⊗	●	⊗	●	●
Framework						
Openness to ideas				●	●	●
Autonomous motivation	●		●	●	●	●
Importance of data protection		●	●	⊗	⊗	⊗
Trust in AI		●	⊗	●	●	●
Consistency	0.811	0.841	0.858	0.875	0.868	0.878
Raw Coverage	0.221	0.128	0.128	0.080	0.079	0.080
Unique Coverage	0.103	0.009	0.073	0.080	0.024	0.080
Overall Solution Consistency	**0.835**					
Overall Solution Coverage	**0.543**					

Note: large black dots indicate present core conditions; small black dots present peripheral conditions; small, crossed circles indicate absent peripheral conditions; large, crossed circles indicate absent core conditions. There are no peripheral conditions in these solutions.

Table 39 Solution chart for the conditions that lead to a higher participation in social AI projects (SH3, SH5; altruism) (crossover: 6.4) and for the conditions that lead to a higher participation in green AI projects (GH1&2, GH4; biosphere) (crossover: 6.4) (Appendix).

	Solution			
	SH3*	**SH5***	**GH1&2****	**GH4****
Openness to ideas		●	●	
Susceptibility to social contagion		●	⊗	●
Altruism* // Biosphere**	●	⊗	●	●
Autonomous motivation	●	●	●	●
Importance of data protection	⊗	●	⊗	⊗
Trust in AI	●	⊗		●
Consistency	0.892	0.922	0.925	0.911
Raw Coverage	0.431	0.226	0.346	0.389
Unique Coverage	0.275	0.071	0.073	0.116
Overall Solution Consistency	**0.894**		**0.908**	
Overall Solution Coverage	**0.502**		**0.461**	

Note: large black dots indicate present core conditions; small black dots present peripheral conditions; small, crossed circles indicate absent peripheral conditions; large, crossed circles indicate absent core conditions. There are no peripheral conditions in these solutions.

III. Synopsis – Epilogue

1. Key findings within the publications

The publications presented herein address the research questions developed in the introduction across three dimensions: adoption from a configurational perspective, adoption of digital innovations, and adoption theory. These works consider the antecedents of adoption, the decisions surrounding adoption, and the partners involved in the adoption process. Collectively, the publications contribute new empirical insights across all three dimensions, enhancing the understanding of adopting innovations within organizations.

I start with the methodological research questions, emphasizing the configurational perspective. As detailed in the prologue, the fsQCA method is employed in five of the six publications presented (Publications 2 to 6). This approach contributes insights to the burgeoning field of configurational adoption research (Lyytinen & Damsgaard, 2011; Sun et al., 2020; Sun et al., 2024). The contributions within this dissertation are structured around three research questions. First, we expand upon the commonly used correlational perspective by incorporating the configurational lens, which is gaining prominence in recent publications (Sun et al., 2020; Sun et al., 2024). Second, we explain previously diverse and contradictory results, a problem thoroughly discussed in the prologue (Gangwar et al., 2014; Sun, 2024). Third, we explore the interplay of conditions concerning equifinality, causal complexity, multifinality, and causal asymmetry (Furnari et al., 2021; Misangyi et al., 2017; Ragin, 2008). Figure 34 depicts the key findings addressing the research questions.

Regarding the potentials resulting from the absence of a configurational perspective within previous adoption research, it can be noted that all five publications utilizing fsQCA underscore that the configurational viewpoint, alongside existing qualitative and quantitative methods, offers valuable insights into how individual factors interact. Thus, explanatory patterns that facilitate the description and investigation of interactions become visible. Furthermore, the publications demonstrate that the configurational perspective is adept at linking different facets of adoption theories. Publication 2, for instance, connects the concepts of affordances (Autio et al., 2018; Gibson, 1979; Leonardi, 2013; Majchrzak & Markus, 2012), strategic fit (Bettis & Blettner, 2020; Venkataraman, 1989), and compatibility (Karahanna et al., 2006), thereby enhancing our understanding of strategic decision-making processes as influenced by technological capabilities. Publication 4 contributes to the integration of various streams by considering economic (Ansari et al., 2010), environmental (Murillo-Luna et al., 2008; Schmermbeck, 2019), and social factors (Karahanna et al., 1999; Kulviwat et al., 2009; Ozaki, 2011). Publication 5 shows that factors from different areas interact and collectively lead to the adoption of IoT innovations. Publication 6 reveals that configurational examination can be complemented by factorial survey experiments (Auspurg & Hinz, 2015), yielding further insights by examining specific factors and their influence on configurations. Thus, the interaction of conditions in different vignettes or across various outcomes can be examined. Furthermore, considering endogeneity allows for addressing the risk of common method bias and enables subsequent verification.

The presented publications underscore the importance of principles such as equifinality, causal complexity, multifinality, and causal asymmetry (Furnari et al., 2021; Misangyi et al., 2017). They illustrate that these principles are crucial for a holistic view of digital innovation adoption.

Additionally, these publications enhance understanding by integrating previously contradictory findings from adoption research (Sun et al., 2024). As extensively discussed in the prologue, existing adoption research increasingly indicates that factors influencing adoption decisions vary. The foundational principles of QCA allow these contradictions to be

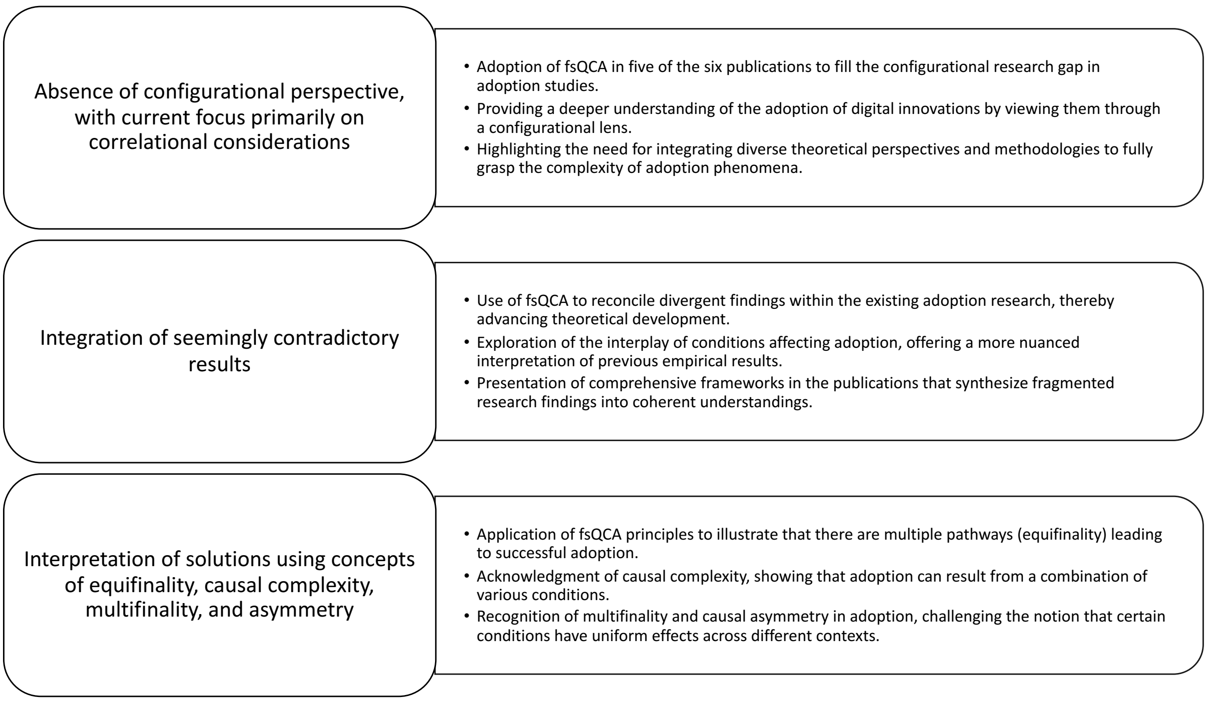

Figure 34 Contributions to the methodological research gaps in adoption research.

addressed in the presented publications, facilitating a deeper comprehension of the complex interplay of conditions. All five publications illustrate that key factors might play conducive, prohibitive, or irrelevant roles while interacting with one another in different configurations. For instance, publication 2 highlights this, especially in the competitive strategies (Porter, 1985) and the differentiation of affordances (Gibson, 1979). Publication 3 addresses the apparent paradox of automation and augmentation in AI (Raisch & Krakowski, 2021), contributing to understanding this interaction. Publication 4 reveals the varied effects of specific conditions like green attitude. In publication 5, this is evident in the stakeholder salience (Mitchel et al., 1997; Shubham et al., 2018), the dimensions of network relationship (Rowley, 1997), and organizational characteristics (Bundy et al., 2013). Publication 6 mainly explains this in the context of AI characteristics, trust, and data protection (McKnight et al., 2011; Smith et al., 1996), and green as well as altruistic values (Aquilani et al., 2020; Leone et al., 2021).

Besides the methodological research contributions, fundamental contributions are situated in the context of adopting digital innovations. In this regard, the publications address unanswered questions in four main areas. First, this dissertation illuminates previously unexplored aspects concerning the antecedents of adopting digital innovations. Second, it focuses on the characteristics of digital innovations in the adoption decision, providing new insights. Third, it clarifies the implications arising from the adoption of digital innovations. Fourth, the results enhance our understanding of digital sustainability by incorporating a sustainability perspective into adopting digital innovations. The core contributions are depicted in Figure 35.

The research contribution, 'antecedents in the adoption of digital innovations,' is addressed in five publications. Publication 1 identifies organizational success factors crucial for service innovations, depending on the nature and degree of change, distinguishing between radical, incremental, and product- and process-related service innovations (Snyder et al., 2016). Publication 2 highlights the importance of the organizational context and strategy (Venkataraman, 1989) in adopting digital innovations. Publication 3 emphasizes the importance of resources (DePietro et al.,1990) in introducing AI as a digital innovation. While

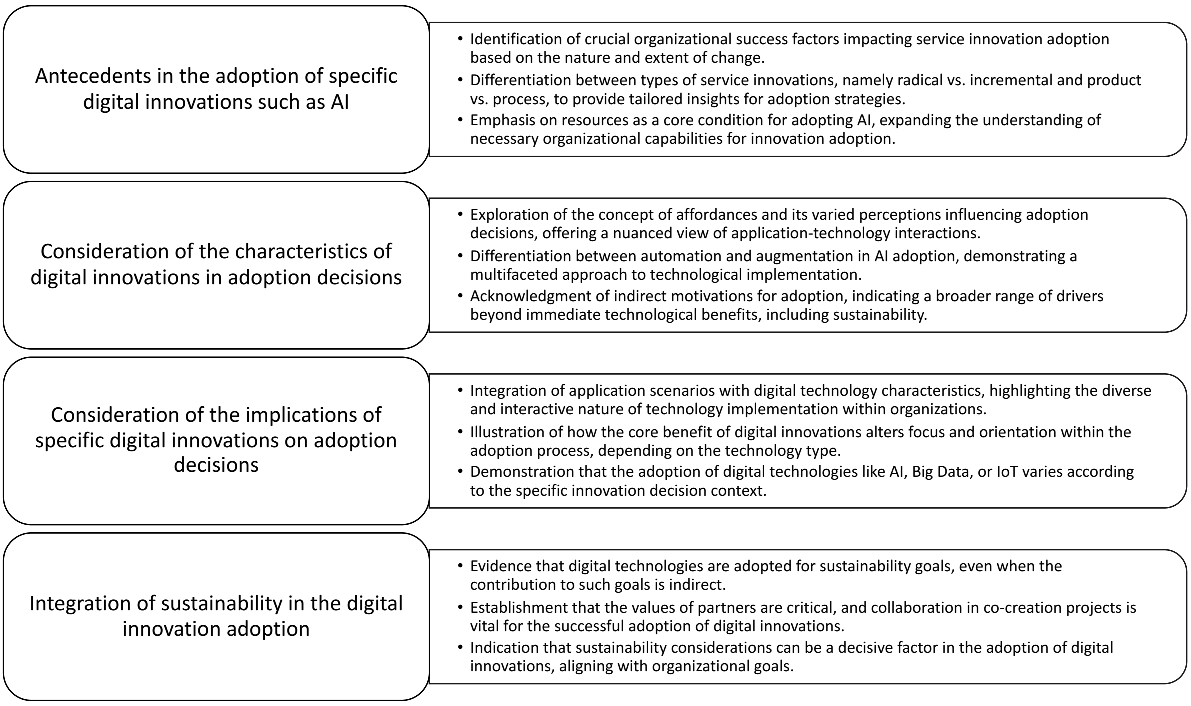

Figure 35 Contributions to the research gaps in digital innovation adoption.

not necessary, resources are a core condition in all identified solutions. Publication 5 complements this by showing that entrepreneurial orientation is not necessary, and organizations can advance the adoption of digital innovations due to external partners (Eggers et al., 2020; Marshall et al., 2015). Publication 6 elucidates the critical role of co-creation partners in specific adoptions, such as AI (Cillo et al., 2019; Hoyer et al., 2010; Sjödin et al., 2020).

The following research contribution centers on the characteristics of digital innovations and their contribution to adoption. Publication 2 discusses the relevance of affordances to adoption, thus contributing to understanding the critical characteristics of the adoption decision. It reveals that perceptions of affordances influence the adoption decision differently, and the varied perceptions of affordances are crucial for adoption (De Luca et al., 2021; Yoo et al., 2012). Similarly, publication 3 shows that companies differentiate between automation and augmentation (Raisch & Krakowski, 2021) when adopting AI and proceed with the adoption for various reasons. The contribution of publication 4 adds that companies also undertake adoption for reasons not directly related to the benefits of the digital technology itself, ensuring the continuation of sustainable business practices (Bopp et al., 2019; Fineman, 1996; Pan & Zhang, 2020). Publication 6 further clarifies that despite different perceptions of digital innovations and different views of the technology, adoption still occurs, with varying rationales contributing to adoption (Aquilani et al., 2020; Sjödin et al., 2020; Suhada et al., 2021).

Additionally, the publications contribute to understanding the implications of digital innovations in the adoption decision. Both publications 2 and 3 contribute to understanding application scenarios and digital technology characteristics by clarifying that the company's implementation and subsequent use of digital technologies are diverse (Yoo et al., 2012). Combined with publication 5, it becomes evident that the core benefit of the adoption decision shifts depending on the specific digital technology, such as AI, Big Data, or IoT, and has varying effects.

The research contribution, 'integration of sustainability in the digital innovation adoption', is addressed in two publications. Publication 4 demonstrates that digital technologies are adopted to achieve sustainability, even if this goal is only met indirectly. Thus, even an indirect contribution of the innovation to the organization's goals can be a decisive factor in adopting digital innovations to achieve sustainability (Pan & Zhang, 2020). Additionally, publication 6 reveals that partners' values are essential and that collaboration in co-creation adoption projects is pivotal for successful adoption (Leone et al., 2021).

In the prologue, I categorized the research questions within the broader scope of adoption research into three areas, highlighting a deficiency in the existing research: a lack of comprehensive integration of different adoption perspectives and theories, insufficient development in integrating the varying dimensions—technological and innovation-related, organizational, and environmental—that influence adoption, and an increasing focus on specific, sometimes external, actors in the context of organizational adoption. The publications contribute towards addressing these three areas. The key findings are summarized in Figure 36.

Regarding the first research gap, 'comprehensive integration of adoption theory perspectives,' publication 1 contributes to understanding the antecedents of service innovation adoption and the necessary adjustments within organizational dimensions such as company structure, knowledge management, decision-making, leadership, and strategy (Duchessi et al., 1993; Ransbotham et al., 2019; Ready et al., 2020; Snyder et al., 2016). Publication 2 emphasizes the influence of strategy on adoption, illustrating how it interacts

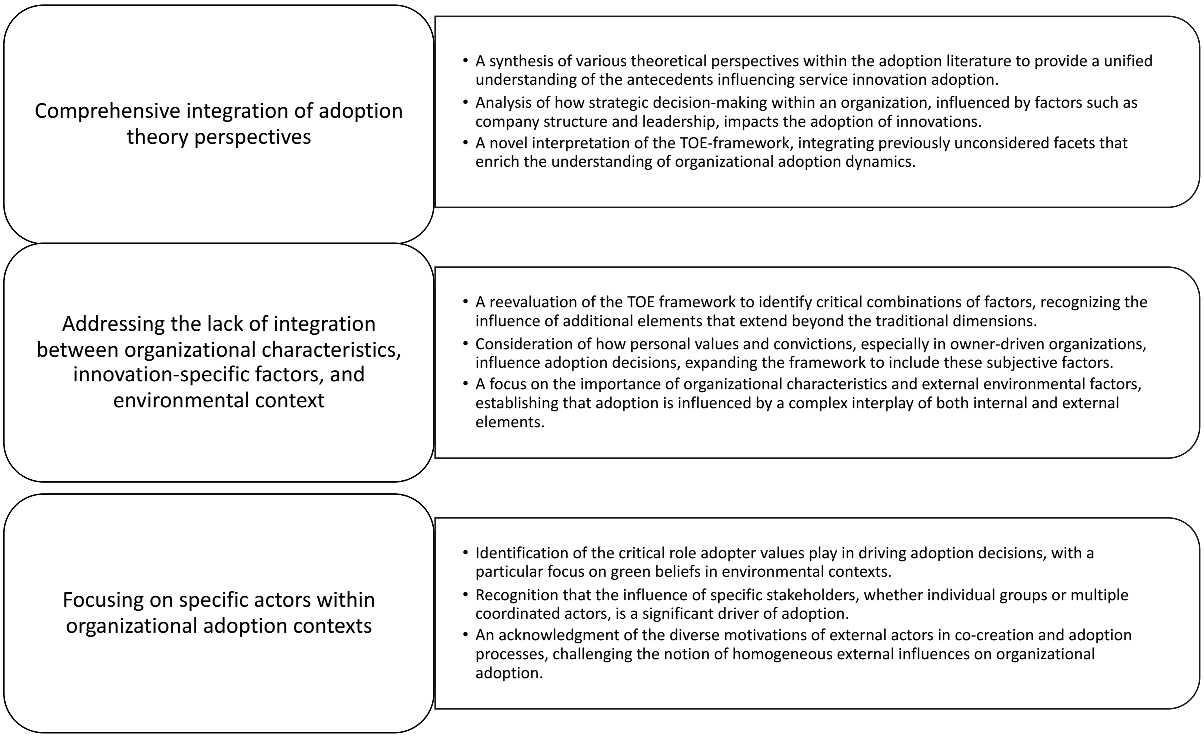

Figure 36 Contributions to the previously unaddressed areas in adoption research.

with other adoption factors, such as compatibility and the environment (Bettis & Blettner, 2020; Congden & Schroeder, 1996; Venkataraman, 1989). Publication 3 reinterprets the widely used TOE framework, enriching the existing dimensions with relevant facets previously unconsidered in this combination (DePietro et al., 1990). Publication 4 indicates the need to consider various value dimensions in adoption, extending beyond the predominantly examined economic perspective to include green values and the social influence of family and friends, aspects often viewed separately before (Ansari et al., 2010; George et al., 2021; Iyengar et al., 2011). The publication 5 bridges stakeholder research, relationships to the company, and organizational factors, linking research strands of network, stakeholder, and organization theory within the adoption process (Fliaster & Kolloch, 2017; Gupta et al., 2019; Rowley, 1997; Yang et al., 2021). Additionally, publication 6 builds on existing knowledge at the intersection of adoption and co-creation research. It underscores the importance of co-creation participants in the adoption process and their motivations to participate, which is still an underexplored research area (Sjödin et al., 2020).

Within the second research gap, 'missing integration between organizational characteristics, innovation-specific characteristics, and environmental characteristics,' publications 2 and 3 review the TOE framework to examine which combinations of factors are crucial for adoption beyond the original factors. Thus, these publications reveal that additional, previously primarily ignored factors play a significant role, which can still be categorized into the three dimensions, emphasizing that specific configurations and considerations are contexts- and adoption-specific (DePietro et al., 1990). Publication 4 demonstrates that personal factors, convictions, values, and organizational factors are critical in organizations whose owners are actively involved. This builds on existing knowledge and adds personality and values to organizational factors (Aldrich & Fiol, 1994; Ansari et al., 2010; Gómez-Mejía et al., 2007; Westphal et al., 1997). Publication 6 further highlights the driver of personality and values, showing that the values of external partners are decisive and thus indirectly influence adoption within the company (Füller, 2010; Hoyer et al., 2010; Ostrom et al., 2010).

The third and final research gap in this dimension, 'focusing on specific actors within the organizational adoption context,' is addressed in publication 4, which underscores the importance of the adopter's values, showing that green beliefs are crucial for adoption decisions, especially in environmental settings (Bopp et al., 2019). Publication 5 accentuates that both individual salient stakeholder groups and multiple coordinating stakeholders significantly advance adoption, indicating that promotion can be driven by either a single strong entity or a coordinated effort of many actors (Kolade et al., 2022; Naghshineh et al., 2021; Nakashima et al., 2023; Senna et al., 2023; Yang et al., 2021). Publication 6 contributes to the understanding that external actors have diverse drivers that facilitate adoption, indicating that assumptions of a homogeneous group are misguided, thus making a significant contribution to the understanding of external actors in adoption (Hoyer et al., 2010).

2. Contributions and implications

This dissertation advances our understanding of innovation adoption within organizations. It offers new empirical insights and methodological approaches that address three primary dimensions: the adoption of digital innovations, the adoption from a configurational perspective, and the evolution of adoption theory.

Within the dissertation, methodological enhancements in adoption research have been achieved by harnessing the fsQCA method (Lyytinen & Damsgaard, 2011; Sun et al., 2024) across five publications, with notable contributions including a richer configurational understanding of adoption processes and the resolution of previously contradictory findings. This approach is praised for its ability to illuminate complex interactions between factors influencing adoption, with the configurational perspective particularly suitable for its utility in connecting disparate adoption theories. These methodological advancements are not only growing in recognition, as shown in recent scholarly works (Sun et al., 2020; Sun et al., 2024) but are also crucial for a holistic view of digital innovation adoption principles highlighted by Furnari et al. (2021) and Misangyi et al. (2017).

In the realm of adoption from a configurational perspective, the publications underscore the value of the configurational viewpoint in offering valuable insights into how individual factors interact. The synergy between strategic fit, affordances, and compatibility, explained in these works (Bettis & Blettner, 2020; Venkataraman, 1989), demonstrates the proficiency of configurational perspective: It allows linking different facets of adoption theories and thereby enriching our understanding of strategic decision-making processes influenced by technological capabilities. Furthermore, incorporating economic, environmental, and social factors (Karahanna et al., 1999; Murillo-Luna et al., 2008) in adoption studies is critical for developing a multidimensional approach.

Critical organizational success factors are identified in examining the adoption of digital innovations, which are crucial in the context of service innovations. Particularly it can be distinguished between radical and incremental as well as process and service (Snyder et al., 2016). This differentiation contributes nuanced insights for organizations contemplating adoption. The importance of resources in adopting AI innovations is also emphasized, extending beyond traditional frameworks (DePietro et al., 1990) to include a core condition in the decision-making process. Additionally, the exploration of the critical role of co-creation partners in specific adoptions, such as AI (Cillo et al., 2019; Hoyer et al., 2010; Sjödin et al., 2020), sheds light on the essential and previously underexplored role of those actors in the adoption process.

By providing a comprehensive integration of adoption theories, this dissertation extends current adoption theory by contextualizing the importance of strategic alignment and enriching the adoption theory of Rogers (2003), the TOE framework (DePietro et al., 1990), and new considerations. The need for an integrated perspective that combines organizational characteristics with innovation-specific and environmental factors is crucial for a holistic understanding of adoption. Furthermore, the research pays particular attention to the values and drivers of specific actors, both internal and external. Within the organizational context, the research contributes to the knowledge of stakeholder influence on adoption decisions, previously limited mainly on environmental settings (Bopp et al., 2019; Naghshineh et al., 2021; Senna et al., 2023; Yang et al., 2021).

In sum, the methodological and theoretical contributions made by the included publications significantly enhance the empirical understanding of the adoption, offering new insights into previously unexplored antecedents and characteristics of digital innovations pivotal in the adoption decision-making process. They also clarify the implications arising from the adoption of digital innovations, especially AI, and incorporate a sustainability perspective into the adoption process, signifying the growing importance of environmental considerations in the strategic adoption of digital innovations.

3. Limitations

While this dissertation and its accompanying publications make substantial research contributions, they are not without limitations. These limitations encompass theoretical, methodological, and case-specific considerations. They provide avenues for future research and contextual understanding of the findings.

Theoretically, in several papers the unit of analysis is the firm, grounded in organizational adoption decisions (DePietro et al., 1990; Rogers, 2003). However, these choices are ultimately made by individuals within the organizations. Therefore, there is an imperative need for future studies to explore the individual perspectives and examine the dynamics between managers, particularly in larger organizations where such interpersonal interactions among decision-makers can significantly influence the adoption outcomes. In publication 4, we integrated the individual characteristics of the owner and took a first step in this direction.

From a methodological perspective, the reliance on data collected from individual respondents at a single point in time presents its constraints. This leads to the potential threat of common method variance (Podsakoff et al., 2003; Podsakoff et al., 2024). While multi-source data collection can enhance data quality, the approach is consistent with established research practices and their proven efficacy in QCA studies (Frambach et al., 2016). Nevertheless, it is acknowledged that future investigations could benefit from a longitudinal or mixed-method approach to capture the nuances of adoption decisions over time. In the context of publication 6, we take a significant step in identifying common method variance within the realm of QCA by incorporating factorial survey experiments and vignettes (Auspurg & Hinz, 2015; Crilly, 2022; Podsakoff et al., 2003; Van Gerwen et al., 2018). This approach enables the detection of common method variance through external conditions and exogenous variation. Integrating factorial survey experiments presents a methodological advancement, allowing for a nuanced exploration of how various conditions influence organizational adoption decisions. This methodological blend addresses potential biases and enhances the robustness of findings by providing a controlled environment to observe the impact of specific variables. This contribution is precious in the field of QCA, where the interplay of conditions is central to understanding complex causal relationships. By systematically manipulating external conditions, we offer a refined lens through which to view the intricate adoption patterns, laying the groundwork for future studies to further explore and validate these effects.

Additionally, in publication 5, data was aggregated at the level of stakeholder groups and their relations with the company; individual stakeholder perspectives were not specifically studied. The aggregation serves the research design but limits the granularity of insights that could be obtained from examining individual stakeholder inputs.

Case-specific limitations are also present. The focus on adopting digital applications within the German-speaking business context suggests caution when generalizing findings to other cultural or linguistic contexts, notably where governmental authorities and regulatory environments may differ significantly.

Finally, some findings are inherently specific to certain types of organizations. For instance, the insights from the study on biogas adoption pertain primarily to small firms with an agricultural background often operating in energy production. Future research endeavors should conduct analogous studies in diverse organizational categories within the renewable energy sector and beyond to test the robustness and generalizability of the findings (Ozaki, 2011).

These limitations, while underscoring the need for careful interpretation of the current findings, also outline the path for future research efforts aimed at enhancing our collective understanding of digital innovation adoption processes.

4. Concluding remarks: Adoption of digital innovations in organizations from a configurational perspective

Adoption has been an essential theme in innovation management for decades (Wolfe, 1994). With the advent of digitalization (Nambisan et al., 2017; Yoo et al., 2012), the significance of this theme has intensified, unfolding new queries and interpretative frameworks for understanding adoption in organizational contexts. Applying QCA presents a fresh perspective, shedding light on the multifaceted nature of adoption.

Interconnection is instrumental in several respects within this paradigm. It enhances our comprehension of how various conditions interact to influence adoption. Additionally, it forges more robust ties between the concept of adoption and other integral facets of innovation management. This interconnection is manifested in network and stakeholder relationships, as exemplified in the adoption of the IoT and through the inclusion of additional partners in adoption and implementation processes.

In this dissertation, I have engaged with these topics both from a theoretical standpoint and through the application of a configurational methodology aimed at unveiling new insights and interdependencies. My analysis underscores the relevance of QCA principles like multifinality, complexity, asymmetry, and equifinality in understanding the adoption itself and in relation to other salient issues in innovation management. Interactions and interdependencies are pervasive and require a comprehensive examination to fully grasp their implications.

By embracing the configurational approach, this dissertation illuminates the complexity of adoption processes, particularly in how different conditions converge to influence outcomes. The findings stress the importance of considering diverse factors, including organizational contexts, digital innovation characteristics, and the broader network of stakeholder relationships.

In conclusion, this body of work contributes to a deeper understanding of the adoption of digital innovations, not as isolated events but as complex phenomena influenced by a web of interconnected conditions and actors. It underscores the need for a holistic approach to innovation management, attuned to the nuanced interplay of factors driving the adoption of technological advancements within organizations.

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