The Impact of Digital Transformation on the Performance of Small and Medium-sized Enterprises

Measuring Change and the Inherent Performance Implications

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Abstract

This dissertation illuminates the complex interplay of digital transformation in Small- and Medium sized Enterprises (SMEs) by examining the relationship from three different angles – namely its quantification through digital maturity, its impact on performance and innovation, and its relevance to crisis management in times of digitalization. Together, these facets form a synergistic framework that provides a previously unavailable perspective through which the intrinsic value and transformative potential of integrating digital technologies into SMEs' business models can be recognized and leveraged. The overall perspective results from three individual, yet sequential studies with a specific focus each.

The first study of this cumulative dissertation "Dynamics of Digital Change – Measuring the Digital Transformation and its Impacts on the Innovation Activities of SMEs" sets the stage by quantifying the levels of digital transformation and exploring their impact on innovation capabilities within SMEs. This foundational understanding underscores the strategic importance of digital transformation and its profound influence on innovation performance, laying the groundwork for the subsequent investigations. The second study "Keeping Pace with the Digitalization – Exploring the U-Shaped Relationship between Digital Orientation and Performance in SMEs" expands the discourse by delving into the nuanced connection between digital orientation and organizational performance. Employing a novel approach to measure digital orientation, the study reveals a positive correlation between digital orientation and SME performance. The study also emphasizes the necessity of a long-term vision for digital transformation, acknowledging the possibility of initial performance dips in the transformation journey but reinforcing the substantial long-term benefits. The third study "Digital Transformation Amid Crisis – Navigating SME Growth and Business Model Disruption" examines the role of digital transformation in crisis management and prevention in the context of the Covid-19 pandemic. The study demonstrates how digital transformation can equip SMEs with enhanced resilience against external shocks like the Covid-19 pandemic.

Collectively, these studies weave an intricate, enlightening narrative that underscores the strategic importance of digital transformation for SMEs in today's digital and disruptive business landscape. Accordingly, this dissertation significantly advances the understanding of digital transformation in SMEs by exploring its nuanced role and impacts. It establishes a quantitative measure of digital maturity, highlighting its correlation with innovation performance and revealing the varying impacts at different maturity stages. The discovery of a U-shaped relationship between digital orientation and SME performance elucidates the strategic importance of digital orientation, indicating that initial digital transformation challenges are outweighed by long-term performance benefits. Moreover, this work positions digital transformation as a strategic buffer during crises, particularly illustrated during the Covid-19 pandemic, suggesting that its benefits in crisis resilience outweigh the implementation costs. Collectively, these findings provide a comprehensive view of digital transformation as a complex, staged journey, offering crucial insights and paving the way for future research.

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Finally, I want to express my gratitude to my friends, who have always been there to lift my spirits when times were tough. At this point, I would like to make a special mention of Karl-Heinz Schaak who supported me significantly during my studies and always believed in me. To my lovely wife: words cannot express my gratitude for your love, understanding, and unwavering support throughout this journey, you have been with me from day one. It is from our shared bond and the warmth of your love that I continually drew strength and inspiration. Finally, I am forever indebted to my parents for their understanding, endless patience, and encouragement when it was most needed. It is an honor to make them proud, and I hope I can continue to do so.

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List of Abbreviations

AI	Artificial Intelligence
BMI	Business Model Innovation
BM	Business Model
CATA	Computer-Aided Text Analysis
Covid-19	Coronavirus Disease 2019
ERP	Enterprise Resource Planning
et al.	et alii (and others)
e.g.	exempli gratia (for example)
ICT	Information and Communication Technology
i.e.	id est (that is)
IoT	Internet of Things
IT	Information Technology
ML	Machine Learning
p.	page
R&D	Research and Development
RBV	Resource-based View
SMEs	Small and Medium-sized Enterprises

Chapter 1

Introduction

The following chapter provides the introduction to this dissertation and highlights the critical relationship between digital transformation and SME performance. The chapter will demonstrate the topicality of this relationship and describe how the studies in this cumulative dissertation will explore the sub-dimensions of digital transformation – namely digital maturity and digital orientation – including consideration of the impact of the Covid-19 pandemic and the role of business models.

Digital transformation becomes pivotal in maintaining an organization's competitive advantage as the economic landscape rapidly evolves due to technological advancements (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014; T. Morgan, Anokhin, Ofstein, & Friske, 2020; Vial, 2019). Digital transformation is triggered by the digitalization paradigm which refers to the fundamental shift and transformation in various aspects of society, economy, and daily life due to the widespread adoption and integration of digital technologies (Berman, 2012; Hess, Benlian, Matt, & Wiesböck, 2016). Accordingly in the organizational context, digital transformation is characterized as an organizational procedure that delineates the substantial alteration of an organization's traits via the adoption and usage of digital technologies (Vial, 2019). The transformative potential of digital technologies presents an opportunity for organizations to elevate their operational efficiency, bolster competitiveness, amplify customer engagement, and reinforce resilience through the pursuit of digital transformation (Autio, Nambisan, Thomas, & Wright, 2018; Eller, Alford, Kallmünzer, & Peters, 2020; Guo & Xu, 2021; Nambisan, Lyytinen, Majchrzak, & Song, 2017; Rachinger, Rauter, Müller, Vorraber, & Schirgi, 2019). However, nowadays these changes also present unique challenges as organizations must navigate both, the crisis resulting from the Covid-19 pandemic and the ongoing digitalization paradigm.

This situation manifests as a pronounced threat to SMEs, wherein the Covid-19 pandemic has notably exposed vulnerabilities within their business models, thereby jeopardizing not only the individual organizations but also the broader economic fabric they support (Klyver & Nielsen, 2021). As the backbone of many economies, providing substantial employment and contributing significantly to economic growth and innovation, the stability and success of SMEs are crucial for overall societal prosperity (European Commission, 2019; Kobe, 2012). Furthermore, SMEs also encounter considerable hurdles in their journey towards digital transformation despite their inherent capacity for quick adaptation i.e., dynamic capabilities and their potential for innovation (Borch & Madsen, 2007). This manifests in the fact that SMEs are trailing behind larger organizations in terms of digital maturity (Bajwa et al., 2008; Eller et al., 2020). In this regard, digital maturity is understood as an evolutionary progression where organizations gradually digitalize over time, through the acquisition of knowledge and the implementation of an assortment of digital technologies (Remane, Hanelt, Wiesboeck, & Kolbe, 2017). The shortfall of SMEs concerning digital maturity can be ascribed to the limitations associated with the liability of smallness, which encompasses restrictions on resources such as financial and human capital (Aldrich & Auster, 1986). These resources are frequently necessary for the effective implementation of resource-demanding digital technologies (Bajwa et al., 2008; Clohessy & Acton, 2019).

In addition to resources, the strategic reorientation of SMEs towards digital transformation, the so-called digital orientation, plays an important role (Bharadwaj, Sawy, Pavlou, & Venkatraman, 2013; Kindermann et al., 2021). Digital orientation is defined as an organization's guiding principle in seeking opportunities fostered by digital technology, aimed at securing a competitive edge (Kindermann et al., 2021). The investigation of digital orientation in SMEs contributes to elucidate their shortfall in digital maturity as the alignment or misalignment with digital orientation can significantly impact the pace and success of their digital transformation journey. As a consequence of the lag in this evolutionary process, the overall competitiveness of SMEs diminishes and their vulnerability to external shocks increases (Adian et al., 2020; Eller et al., 2020; Hassan, Reuter,

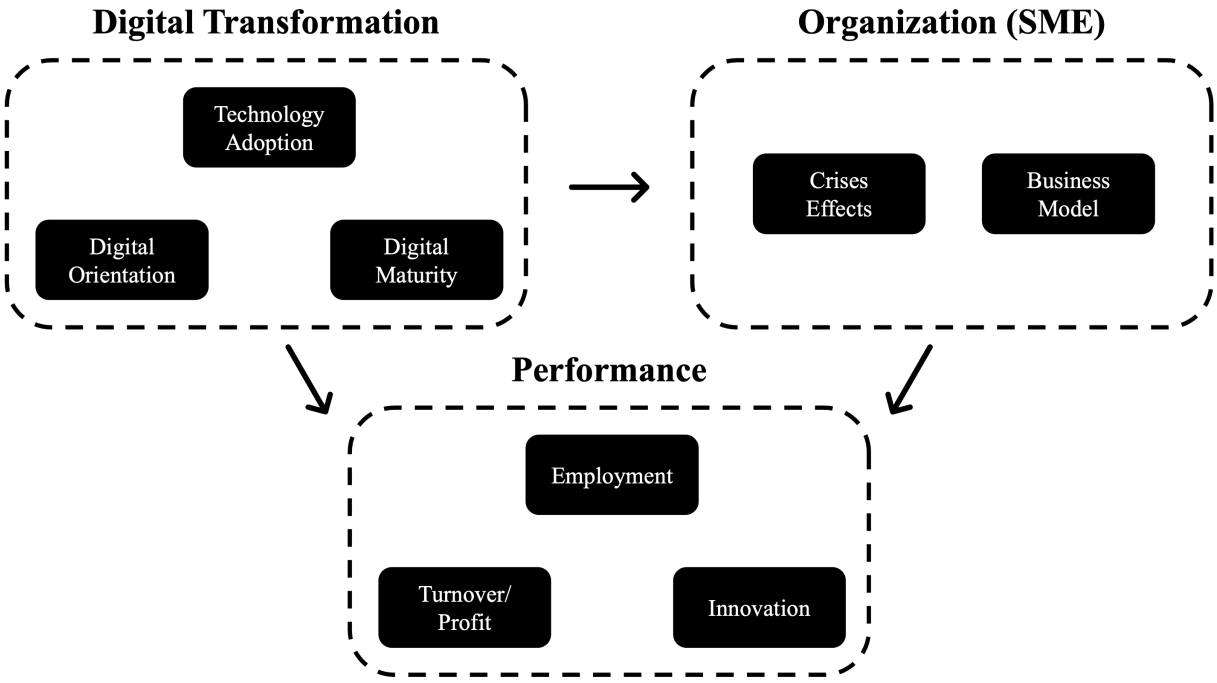
& Bzhalava, 2020; Miklian & Hoelscher, 2022).

However, our understanding of the relationship between digital transformation and SME performance remains inconclusive and underrepresented in the current literature, especially when considering a more granular exploration within the subdimensions of digital transformation or context factors such as the Covid-19 crisis (Chen & Kim, 2023; Kindermann et al., 2021; Nasiri, Saunila, & Ukko, 2022; Verhoef et al., 2021). The prospect of such a dual threat as the Covid-19 crisis and digital transformation, which poses a particular challenge to SMEs, the backbone of many economies, requires a thorough understanding of the course of digital transformation and a consideration of the Covid-19 pandemic in this regard (T. Morgan et al., 2020). Consequently, this dissertation addresses a critical research gap by examining the underexplored impact of digital transformation and its subdimensions on the overall performance of SMEs during regular operations and the unique challenges of the Covid-19 crisis.

The theoretical concepts relevant to this research problem, their corresponding dimensions and the assumed relationships are shown in Figure 1.1, whereby the arrows do not represent causal relationships or effect directions, but merely suggest a relationship between these elements. The impacts of digital transformation on SMEs is a multifaceted issue, encompassing several constructs like digital maturity, orientation, and technology adoption (Leonardi, 2011; Remane et al., 2017; Valdez-de Leon, 2016). These constructs intricately interact, influencing the outcomes of digital transformation in SMEs and further complicate the understanding of this process. In this regard organizations also experience different settings whereas the Covid-19 pandemic as an environmental context factor poses a special challenge occurring in times of the digitalization paradigm. In order to capture these effects on SMEs this dissertation adapts to the business model literature including the business model as indicator of crisis effects on specific parts of an organization. Additionally, the outcome of the digital transformation itself and under the conditions of the Covid-19 pandemic, in terms of organizational performance, has to be considered as a multidimensional matter. Organizational performance is measured diversely across the literature depending on how success is defined. To compensate the diversity

of organizational success definitions this dissertation captures the multidimensionality of organizational success by various performance indicators covering financial performance in terms of turnover and profit, social success in terms of employment, and market competitiveness in terms of innovation output. Therefore, the purpose of this dissertation is to explore digital transformation within SMEs in more depth, to gain insights on how SMEs can leverage digital technologies to boost innovation, enhance financial performance, and remain competitive amidst rapid technological advancements and exogenous shocks.

Figure 1.1: Theoretical Relationship of Digital Transformation, Organization (SME) and Organizational Performance



Source: Own Illustration

In order to explore the proposed relationship, this dissertation approached the overarching theme of digital transformation in SMEs from three different angles, presented through the three studies that form the basis of this research. An overview of the three studies can be found in Table 1.1. The first study focuses on the topic of digital maturity, specifically its measurement and effect on the innovation performance of SMEs. Precisely, this study aims to answer the question: How can digital transformation be empirically measured in the context of quantitative analyses and what influence does the state of digital transformation of an SME exert on its innovation performance? Building upon the measurement

inferences, and the insights concerning the effect of digital transformation on SMEs' innovation output, the second study widens the perspective on this relationship by focusing on an innovative measure of digital orientation and its effect on a more differentiated indicator of SME performance. In this regard the second study aims to answer the question whether digital orientation has an impact on SME performance. Lastly, the third study deviates from the previous studies by context examining the relationship of digital transformation with regard to an SMEs business model and in the context of the Covid-19 crisis. This study aims to illuminate the influence of digital transformation in times of crises under special consideration of an SME's business model and answer the question: What is the nature of the relationship between the underlying business model, digital transformation of SMEs, and their organizational performance during times of crisis?

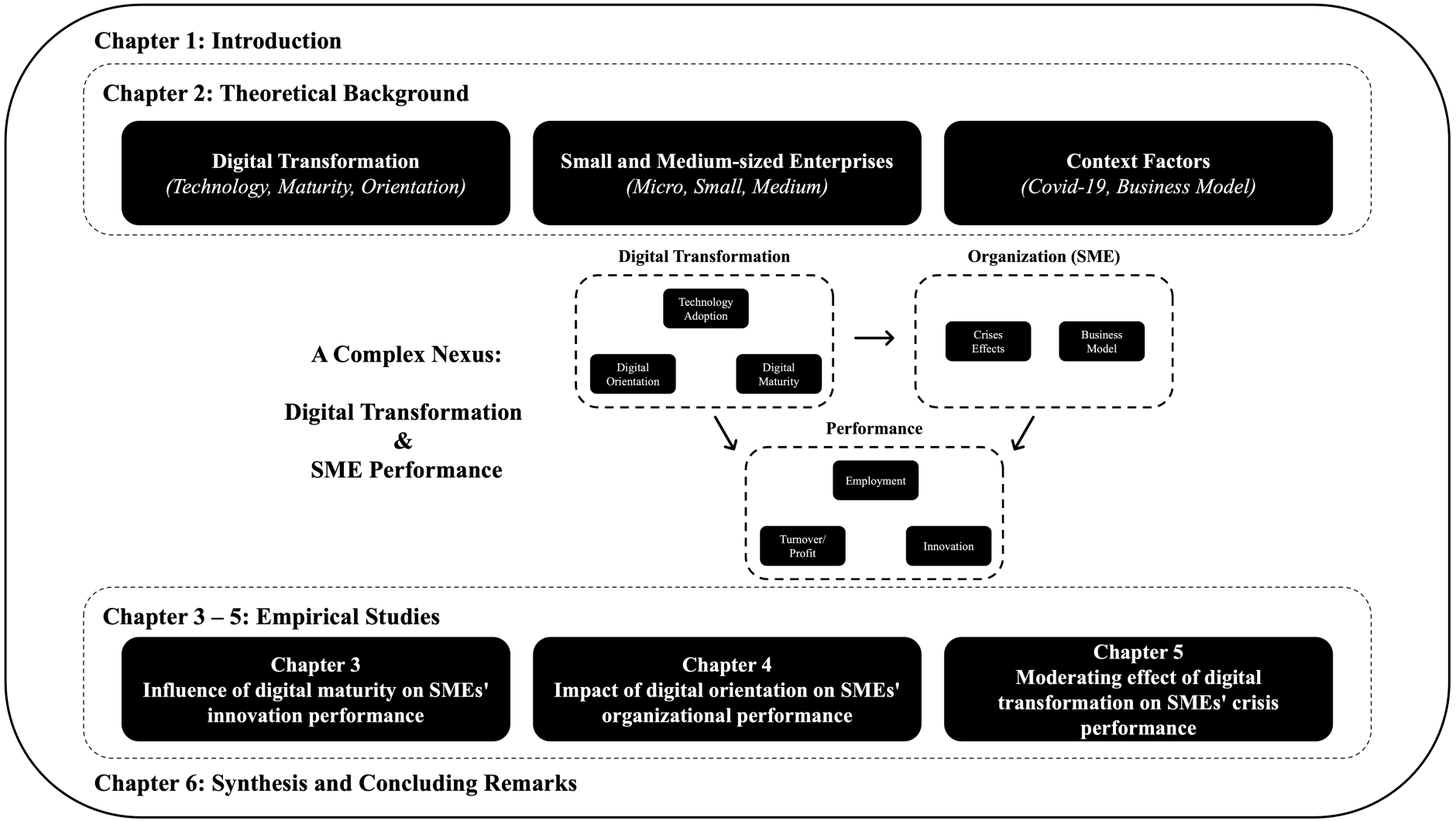
In order to contribute to the insights of digital transformation in SMEs this dissertation is structured into three main parts delineated in six chapters. The structure is illustrated in Figure 1.2. The first main part which encompasses the introduction and the theoretical background highlights the relevance and topicality of the presented research and sets up the theoretical framing for the subsequent studies. The second main part is represented by the sum of three studies which contain the empirical findings concerning the digital transformation process in SMEs. The last main part outlines the findings in a concluding remark, synthesizing the key contributions of each study, and resulting in a consolidated statement of value provided by this dissertation. The synthesis of the overall dissertation offers substantial insights that augment the existing body of literature on SMEs' digital transformation and provides a holistic perspective that benefits both scholars and practitioners engaging with the narrative of digital transformation in SMEs.

Table 1.1: Overview of Research Contributions

Authorship	Research Gap	Main Theoretical Concepts	Methodology	Publication Status	Author Contribution
1) Dynamics of Digital Change – Measuring the Digital Transformation and its Impacts on the Innovation Activities of SMEs					
Escoz Barragan, Kevin; Hassan, Sohaib; Meisner, Konrad; Bazhvala, Levan	Empirical quantification of digital transformation stages; Digital transformation impact on innovation in SMEs	Innovation theory; Digital transformation; Digital Maturity; Dynamic Capabilities; Technology Adoption	Cluster analysis; Ordinal Logistic Regression	Accepted for publication, at: European Journal of Innovation Management (EJIM, IF: 4.75); Presented at: AOM 2021; EURAM 2021	Theory and concept development; Cluster analysis; Writing
2) Keeping Pace with the Digitalization – Exploring the U-Shaped Relationship between Digital Orientation and Performance in SMEs					
Escoz Barragan, Kevin; Becker, Felix	Impact of digital orientation on SME performance	Strategic Alignment; Digital Transformation; Digital Orientation; Dynamic Capabilities; Technology Adoption	Natural language processing (NLP); Compute-aided-text-analysis (CATA); Quadratic regression analysis	Conditionally accepted: Revision, at: Small Business Economics (SBE, IF: 6.4); Presented at: RENT 2022	Theory and concept development; Data analysis and collection; Writing
3) Digital Transformation Amid Crisis – Navigating SME Growth and Business Model Disruption					
Escoz Barragan, Kevin; Becker, Felix; Hassan, Sohaib; Strina, Giuseppe; Pipek, Volker	Relationship of digital transformation and SME performance during the Covid-19 crisis	Crisis Management, Business Model, Digital Transformation, Technology Adoption	Ordinal Logistic Regression	Submitted to: Journal of Small Business Management (JSBM, IF: 6.2); Accepted at: AOM 2023; EURAM 2023	Theory and Concept Development; Data analysis; Writing

Source: Own Illustration

Figure 1.2: Structure of the Dissertation



Source: Own Illustration

Chapter 2

Theoretical Background

In the first section (section 2.1), all terms are defined and delimited individually, despite being presented in a coherent manner. At the beginning of each such discussion of a term, the term is presented once in bold type for the sake of better presentation. Accrodingly, the forthcoming section of this dissertation establishes a comprehensive foundation for the investigations by first defining key terminologies within organizational, digitalization, and crisis contexts. This is necessary to establish a common understanding before discussing the higher order theories and the more specific theoretical framework of this dissertation. Afterwards (section 2.2), the study further delves into the exploration of fundamental theories, including disruption theory, the resource-based view (RBV), and strategic alignment which build the foundation of the theoretical framework. The dissertation then introduces the theoretical framework (section 2.3) that underscores the analysis, focusing on the facets of digital transformation – namely digital maturity and digital orientation – in SMEs, the role of digital transformation during crisis periods, and the intricate relationship between digital transformation and business models amidst crises. Thus, this section contains a thorough theoretical grounding that informs the dissertation's exploration of the digital transformation journey in SMEs.

2.1 Definitions of Key Concepts and Terminology

2.1.1 Organizational Terminology

The categorization of organizations as **SMEs** is generally determined by factors such as the number of employees, annual turnover, or total assets. However, these specific thresholds can vary across countries and industries, which introduces an element of diversity

in the academic and policy-related discourse. An overview of established definitions is provided in Table 2.1.

For instance, the German definition of SMEs, according to the Institut für Mittelstandsforschung Bonn (2016), employs a stratified approach to classification. Micro businesses are characterized as companies with fewer than ten employees and a turnover or balance sheet total not exceeding 2 million euros. Small businesses have less than fifty employees and a turnover or balance sheet total of no more than 10 million euros. Finally, medium-sized companies are those with fewer than 250 employees and either a turnover of fewer than 50 million euros or a balance sheet total of fewer than 43 million euros. In contrast, the U.S. Small Business Administration (2021) defines small businesses (an equivalent term for SMEs) based on the number of employees, which is fewer than 500 for most manufacturing and mining industries, and on annual receipts, which must be less than $7.5 million for many non-manufacturing industries. This focus also underscores the differences in the definitions and specific characteristics used to define SMEs, as the SBA differentiates by economic sector, while the IfM focuses exclusively on the number of employees and annual turnover.

Despite the noted variations, this dissertation adopts the SME definition provided by the European Commission (2003), which includes the following criteria: a maximum of 250 employees and a maximum annual turnover of up to 50 million Euros. This decision is rooted in the global recognition and academic ubiquity of the European Commission's definition, offering greater universality and reliability. Moreover, the chosen definition incorporates both the number of employees and turnover, two critical elements in the research methodology and the investigation of the impact of digital transformation on SMEs.

The implications of this choice for the dissertation are significant. Firstly, it ensures a clear, specific, and globally understood demarcation of the organizations under study, minimizing ambiguities and misinterpretations. Secondly, it facilitates direct comparison with other studies in the same field employing the same or similar definitions, thereby enriching the broader discourse on digital transformation in SMEs. Hence, in adhering to

the European Commission's definition, the dissertation accurately targets and measures the impact of digital transformation on a well-recognized category of businesses, enhancing the robustness, validity of the findings, and their potential for practical application and policy recommendations.

Table 2.1: Comparative Overview of SME Definitions

Source	**Employee Count**	**Annual Turnover | Balance Sheet Total**
European Commission (2003)	Maximum of 250 employees	Maximum annual turnover of up to 50 million Euros
Institut für Mittel-stands-forschung (IfM) Bonn (2005)	Micro: Fewer than 10 employees	Micro: Does not exceed 2 million euros
	Small: Fewer than 50 employees	Small: No more than 10 million euros
	Medium: Fewer than 250 employees	Medium: Turnover fewer than 50 million euros or balance sheet total fewer than 43 million euros
U.S. Small Business Administration (SBA)	Fewer than 500 employees for most manufacturing and mining industries	Less than $7.5 million in average annual receipts for many non-manufacturing industries

Source: Own Illustration, with Reference to European Commission (2003); Institut für Mittelstandsforschung Bonn (2016)

Transitioning from the precise definition of SMEs to the intricate domain of business models, both elements emerge as fundamental to this research. The European Commission's SME definition delineates the subjects of study, while the business model concept highlights their operational strategies. The relationship between these subjects and their respective strategies becomes instrumental in evaluating the effects of digital transformation. By employing the European Commission's definition of SMEs alongside a multifaceted understanding of business models, this research achieves a comprehensive approach to assess the ramifications of digital transformation. Consequently, the ensuing presentation of business model definitions and concepts builds upon, and remains consistent with, the foundational focus on SMEs.

Business models, despite the absence of a single, comprehensive definition, tend to

converge around a common theme: they encapsulate how organizations create, deliver, and capture value (Osterwalder & Pigneur, 2010). These models act as a blueprint, portraying the underlying structures, governance, and logic of a business (Amit & Zott, 2001). The understanding of business models can be broadened to encompass various perspectives. For instance, (Teece, 2010) views a business model as a mechanism through which a firm delivers value to customers and converts payments into profits. Further, (Casadesus-Masanell & Ricart, 2010) define the business model as the underlying logic of a firm's operations and value creation for its stakeholders. Adding another dimension, (Zott & Amit, 2010) equate a company's business model with its "Activity System". They describe this system as a network of interdependent activities that transcend the focal firm. These activities may involve the firm's partners, vendors, or customers, but remain firm-centric to allow the focal firm to create value with its partners and to appropriate a portion of the value created. Thus, business models emerge as multifaceted constructs that describe the essence of how firms do business. They encompass the strategic architecture of the firm's value creation, delivery, and capture mechanisms. Through this lens, this research aims to investigate how digital transformation affects these dimensions and, consequently, the performance of SMEs.

To better capture the nuances of conducting business, a variety of classification frameworks have been proposed in the literature. Notably, these include the Business Model Canvas (Osterwalder & Pigneur, 2010), the Magical Business Model Triangle (Gassmann, Frankenberger, & Csik, 2015), and the Strategic Triangle (Amit & Zott, 2001). An overview of these classification frameworks is illustrated in Table 2.2.

The Business Model Canvas (Osterwalder & Pigneur, 2010) presents a visually intuitive, nine-component framework focusing on key partners, activities, resources, value proposition, customer relationships, channels, customer segments, cost structure, and revenue streams. While this model provides an extensive overview, its complexity can overlook the nuanced interactions between components within the dynamic environment of SMEs amidst digital transformation. Moreover, this framework is primarily used for business model innovation rather than mere classification or illustration. In contrast to the Busi-

ness Model Canvas, the Magical Business Model Triangle (Gassmann et al., 2015) simplifies business models into four core elements: the who, what, how, and the value. It provides a straightforward understanding of business models at a meta level, appropriate for superficial classification and illustration. The Strategic Triangle model (Amit & Zott, 2001) aligns with Magical Business Model Triangle but adds another layer by focusing on the value proposition, value configuration, and profit equation. However, this model may neglect essential aspects such as value delivery and creation, which are crucial in understanding the complexities of digital transformation and indispensable for classification and illustration.

Table 2.2: Comparative Overview of Business Model Frameworks

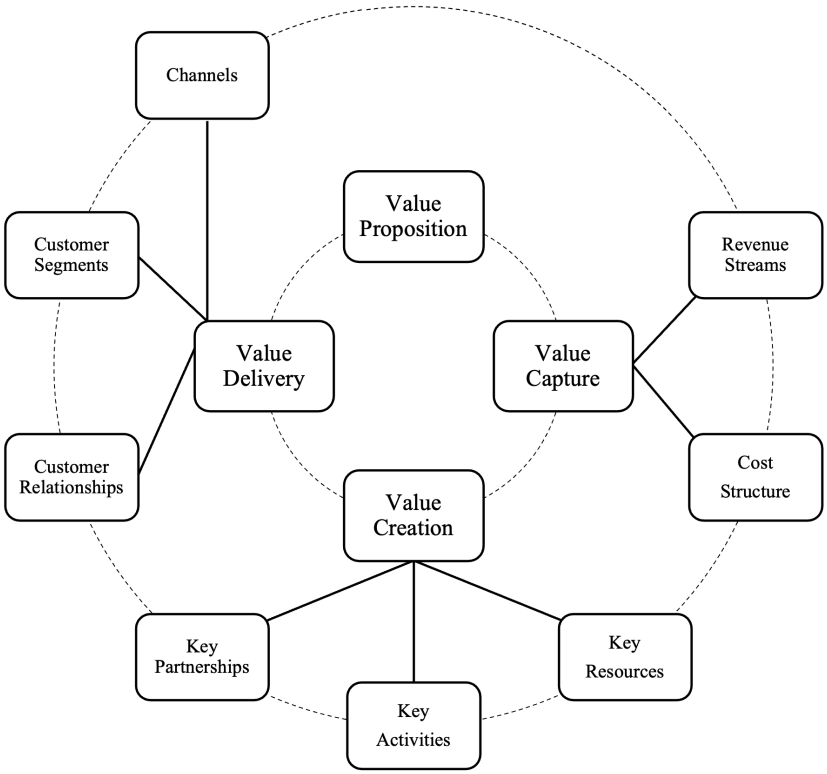
Framework	**Dimensions**	**Author**	**Description**
Strategic Triangle model	3	Amit and Zott (2001)	Provides a three-dimensional meta approach centering around value proposition, configuration, and profit used to understand the architecture of a firm's business model.
Magical Business Model Triangle	4	Gassmann et al. (2015)	Breaks down business models into four fundamental elements on a meta level centered around the questions: what, who, how, and value to understand and classify business models.
Classification Framework	4	Günzel and Holm (2013)	Provides a balanced, four-dimensional meta approach focused on value proposition, delivery, creation, and capture derived from the Business Model Canvas and applied to understand and classify business models.
Business Model Canvas	9	Osterwalder and Pigneur (2010)	Provides a 9 dimensional detailed approach including: value propositions, customer segments, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure serving as a strategic tool that visualizes the building blocks of a business model.

Source: Own Illustration

However, there is another framework derived from the Business Model Canvas by Günzel and Holm (2013), that comprises four essential sub-dimensions of a business model: value proposition, value delivery, value creation, and value capture. Figure 2.1 demonstrates the integration of the Business Model Canvas and the Model after Günzel and Holm (2013). All blocks on the second layer (including value proposition on layer one) represent the nine building blocks of the Business Model Canvas, while the inner circle represents the categories of the framework after Günzel and Holm (2013). The framework's structure places the value proposition as a standalone element, a reflection of its central role in defining the unique offering that a business presents to the market. In contrast, the components of customer segments, channels, and customer relationships from the Business Model Canvas form the value delivery dimensions of the framework. This combination articulates the mechanisms through which the proposed value proposition reaches the identified market segments, as well as the nature of the interaction with customers. On the other hand, the key resources, key activities, and key partners shape the value creation dimensions. These elements underpin the operational aspects necessary to bring the proposed value into existence. Finally, the revenue streams and cost structure elements relate to the value capture dimension, outlining the financial implications and benefits derived from executing the business model. This framework is a more simplified version, elevating the Business Model Canvas to the meta-level of the Magical Business Model Triangle, resulting in a hybrid framework on the meta level appropriate for classification and illustration.

Each of these dimensions plays a crucial role in the context of SMEs undergoing digital transformation and offers a straightforward business model classification and illustration approach. In the context of digital transformation, the framework proves invaluable due to its comprehensive yet concise nature. The value proposition encapsulates the digital services or products offered by SMEs. Value delivery encompasses the digital channels used to reach customers. Value creation captures the processes and activities through which digital resources are transformed into offerings. Finally, value capture reflects the digital mechanisms employed to generate revenue and profit.

Figure 2.1: Integration of the Business Model Categorizations



Source: Own Illustration, with Reference to Osterwalder and Pigneur (2010); Günzel and Holm (2013)

This dissertation adapts the terminology and classification of the framework proposed by Günzel and Holm (2013). The choice is based on the fact that, on the one hand, the model matches the terminology and classification of the Magical Business Model Triangle (who value delivery, what value proposition, how value creation, and the value value capture), but is more consistent in itself. On the other hand, the model can also be integrated with the Business Model Canvas, since the terminology and categories were derived from the nine building blocks of the Business Model Canvas. Accordingly, the model proposed by Günzel and Holm (2013) provides an integrative and conceptually consistent model of business model categorization that reflects the current state of research. Additionally, utilizing this framework offers rich insights into the transformative impact of digitalization on the business model of SMEs. By focusing on the four subdimensions, this dissertation will provide a more holistic and in-depth understanding of how digital transformation shapes SME performance. The choice of this model directly impacts the research outcomes and

interpretations, offering both academic and practical contributions to the understanding of digital transformation in SMEs. Hence, this dissertation's conclusions will be rooted in a broad yet detailed understanding of the business model, illuminating the pathways through which digital transformation impacts SME performance in study three (Title: Upgrading the Business Model? – Crisis Prevention in Times of Digital Transformation).

2.1.2 Digitalization Terminology

Given the escalating discourse surrounding **digitalization**, distinguishing between pivotal terms and concepts becomes paramount. Notably, digitization is not synonymous with digitalization. Brennen and Kreiss (2016) defines digitization as the transition of information from a tangible format to a digital one, making it accessible to computers and other digital systems. Conversely, digitalization refers to the strategic use of digital technology to modify a business model, creating new revenue streams and opportunities (Brennen & Kreiss, 2016). This is in alignment with (Legner et al., 2017) who differentiate between the conversion process in digitization and the broader sociotechnical phenomena in digitalization. Contrary, some sources emphasize the innovative nature of processing, storing, and communicating using binary codes, without a clear demarcation between digitization and digitalization (Lyytinen, Yoo, & Boland Jr., 2016). This is supported by the view that digitization influences a firm's organizational logic, particularly in relation to product platforms (Sandberg, Holmstrom, & Lyytinen, 2020). Accordingly, it is important to acknowledge that a universally accepted definition has yet to be established in the literature.

After considering various definitions and examining their implications, this dissertation has chosen to adopt the definition that most comprehensively bridges the technical and strategic dimensions of the term, ensuring both clarity and relevance for the intended discussions. The choice reflects an understanding that digitalization should be both a reflection of technological capability and its strategic application in real-world contexts. Accordingly, this dissertation adapts the view that at its core, digitalization can be defined as the use and application of digital technologies in contexts of individuals, organizations,

or broader society (Frenzel, Muench, Bruckner, & Veit, 2021). Transferring this to the business context embarks on a profound transformation, harnessing digital tools to improve, innovate, or even disrupt traditional business methods. Through this process, firms can capitalize on varied data reservoirs, securing a competitive advantage (Chesbrough, 2010; Hassan et al., 2020; Zott & Amit, 2017).

Bridging the conceptual space between the understanding of digitalization and digital transformation, it becomes evident that while digitalization provides the foundational understanding of using digital technologies in varied contexts, digital transformation delves deeper into its strategic implications, particularly within organizations. The foundational premise of digitalization, as this dissertation defines it, serves as the stepping stone to the more intricate and nuanced discussions on digital transformation. By aligning technological capability with its strategic significance, digital transformation becomes the natural progression from the mere application of digital tools to their transformative role within organizations. Both concepts, though distinct, are interconnected and pivotal for a comprehensive exploration of how businesses can leverage digital technologies for enhanced performance and adaptability. The proceeding sections will further unpack these complexities, drawing from both the foundational understanding of digitalization and the transformative nature of digital transformation.

The realm of **digital transformation** in academic literature is one characterized by multifaceted definitions and perspectives. At its essence, digital transformation can be perceived through two main lenses: firstly, as the strategic adoption of technology in organizations (Demary, Engels, Röhl, & Rusche, 2016) and secondly, as the resultant profound organizational transformation (Gobble, 2018; Yoo, Boland, Lyytinen, & Majchrzak, 2012). Scholars have emphasized that the key advantage of digital transformation lies not just in the adoption of interconnected technologies but in leveraging these to tap into diverse data-driven sources, creating a competitive advantage that is digitalization-driven (Koch & Windsperger, 2017; Westerman, Tannou, Bonnet, Ferraris, & McAfee, 2012). The common thread across these viewpoints is the recognition of digital transformation as a process that realizes considerable organizational change through the rigorous implemen-

tation of digital technologies (Vial, 2019; Dong, 2019). Such transformation, underpinned by a myriad of digital technologies, yields a competitive edge – a salient trait often difficult for competitors to replicate (Kindermann et al., 2021).

To ensure alignment with prevalent literature while acknowledging its intricacies, this dissertation gravitates towards the definition posited by Vial (2019) that defines digital transformation as an organizational process spurred by the digitalization paradigm that brings about a significant change in an organization's characteristics through the effective implementation and utilization of digital technologies. This choice encapsulates the overarching sentiment of the literature, emphasizing the profound organizational change driven by the strategic integration of digital technologies. It ensures a balanced consideration of both the technological and organizational aspects of digital transformation, facilitating a comprehensive analysis, especially in the context of SMEs. This definition, therefore, serves as a foundational pillar for the subsequent explorations in this dissertation and is consistent with the perspectives of various researchers, who suggest that successful digital transformation involves more than simply adopting new technologies – it entails a comprehensive organizational transformation that fundamentally alters the way a organization interacts with its environment (Gobble, 2018; Appio, Frattini, Petruzzelli, & Neirotti, 2021; Chen & Kim, 2023; Higón, 2012).

When deconstructing digital transformation into its constituent elements, research has pinpointed two critical components. On one hand, digital maturity serves as an indicator of how advanced an organization is in its digital transformation journey, encapsulating its readiness and the extent of technology integration (Appio et al., 2021; Chen & Kim, 2023). On the other hand, digital orientation is posited as a new paradigm of strategic alignment, forming the foundation for organizations to conceptualize and drive their digital strategies methodically (Vial, 2019; Kindermann et al., 2021; Bharadwaj et al., 2013). Both constructs play pivotal roles in shaping the trajectory and outcomes of an organization's digital transformation endeavors. A closer examination and explanation of these constructs offers valuable insights into the nuances of digital transformation, which are discussed in more detail in the following sections on each subcategory.

Digital maturity underlies a common understanding in research as it constitutes the degree to which an organization has successfully integrated and leveraged digital technologies throughout its operations, processes, and capabilities (Wiesböck & Myrach, 2020; Mettler, 2011). It is a decisive benchmark of an organization's readiness and capability to fully exploit the potential of digital transformation and realize its accompanying benefits. This readiness is typically evaluated based on diverse factors, including but not limited to digital strategy, technology adoption, organizational culture, and digital skills (Berghaus & Back, 2016; De Carolis, Macchi, Negri, & Terzi, 2017).

Similar to the research stream on business models, the investigation of digital maturity encompasses a specific sub-stream of research dedicated to digital maturity models. This roots in the concept of digital maturity which centers around the integration of digital technology and which is commonly portrayed as a progressive journey towards greater levels of digital transformation. This implies the existence of stages within the continuum of digital maturity, as evidenced by various studies (Nambisan, Wright, & Feldman, 2019; Chanias & Hess, 2016; Kane, Palmer, Phillips, Kiron, & Buckley, 2017). The literature emphasizes the diverse and evolving nature of digital maturity, underscoring its multidimensional character. Consequently, digital maturity serves as a pivotal indicator of an organization's progress in attaining optimal digital transformation. However, due to the relative novelty of this research stream, there is currently a considerable debate and controversy surrounding the categorization of digital maturity levels (Thordsen, Murawski, & Bick, 2020). An overview of the current digital maturity models is presented in Table 2.3 and Table 2.4 which differ in their approaches, levels of maturity, and details of descriptions. These models are critical in understanding the progress of a company's digital transformation journey and offer guidance for their next steps.

Table 2.3: Overview of Digital Maturity Models I/III

Maturity Model	Source	No. Levels	Level	Characteristics/Description
The Digital Maturity Model (DMM)	Berghaus and Back (2016)	5	Promote & Support	Strategic Prioritization, Flexible Work, Management Support, Basic Digital Services, Customer Experience, Internal IT Infrastructure
			Create & Build	Digital Innovation, Strategic Importance, Internal Communication, Service Process Improvement, Digital Competencies, Collaboration, Resource Allocation
			Commit to Transform	Culture & Expertise, Organization Transformation, Proactive Error Management, Risk Willingness, Process Responsibilities, Strategic Planning
			User-Centered & Elaborated Processes	User-Centeredness, Customer Involvement, Personalization, Digital Innovation, Digital Ambidexterity, KPI Monitoring
			Data-Driven Enterprise	Advanced Data Analytics, Expenditure Planning, Customer Data Integration, Real-Time Analysis, Decision Support, Internal Expertise, Infrastructure, Data Governance
The Digital Maturity Model	Kane et al. (2017)	3	Early stage	Minimal adaptation to digital technologies and capabilities. Limited improvement in processes and engagement of talent
			Developing stage	Some implementation of digital technologies. Progress in improving processes and engaging talent, but not core to the business strategy
			Maturing stage	Comprehensive adaptation to digital technologies. Alignment of company's strategy, workforce, culture, and structure. Continuous adaptation to changing digital landscape and driving of new value-generating business models
Digital Maturity Framework	Remane et al. (2017)	5	Less Affected	Firms weakly affected by digital transformation, often smaller, stem from health or electronics industry, small IT budget, low ICT skills
			Unprepared	Firms significantly affected by digital transformation but unprepared, often smaller, stem from automobile industry, low ICT skills
			Average Preparedness	Firms strongly affected by digital transformation, prepared comparatively well, similar to average firm but with fewer employees having high ICT skills
			High Preparedness	Firms strongly affected by digital transformation, prepared well, similar to average firm but with many employees having high ICT skills
			Fully Prepared	Firms very strongly affected, prepared accordingly, more profitable, lower revenues, high IT budget, very high ICT skills

Source: Own Illustration

Table 2.4: Overview of Digital Maturity Models II/III

Maturity Model	Source	No. Levels	Level	Characteristics/Description
Digital Maturity Model for Telecommunications Service Providers	Valdez-de Leon (2016)	6	Not started	Organization has not taken any steps to transform
			Initiating	Organization has decided to move toward a digital business and is taking initial steps in that direction
			Enabling	Implementation of initiatives that will form the foundation of the digital business
			Integrating	Initiatives are being integrated across the organization to support end-to-end capabilities
			Optimizing	Digital initiatives are being fine-tuned to further increase overall performance
			Pioneering	Organization is breaking new ground and advancing the state of the practice within the dimension
The Digital Maturity Model 4.0	VanBoskirk and Gill (2016)	4	Skeptics	Just beginning the digital journey. Prompt a willing attitude
			Adopters	Invest in skills and infrastructure. Prioritize customer relationships over production
			Collaborators	Break down traditional silos. Use digital to create competitive advantage
			Differentiators	Leverage data to drive customer obsession. Blend the digital and physical worlds
The 4 Levels of Digital Maturity	Westerman, Bonnet, and McAfee (2011)	4	Digital Beginners	Limited use of digital capabilities, unaware of opportunities, tentative investments without effective management
			Digital Fashionistas	Experimentation with various digital applications, lack of synergy, change driven without maximizing business benefits, lack of enterprise-level governance
			Digital Conservatives	Prudence over innovation, strong vision and governance, skepticism towards new digital trends, risk of missing opportunities
			Digirati	Excellent understanding of digital transformation value, transformative vision, effective governance and engagement, strategic investments in new opportunities, continuous advancement of digital competitive advantage

Source: Own Illustration

The digital maturity models by Berghaus and Back (2016) and Kane et al. (2017) both recognize the necessity for a strategic approach to digital transformation, emphasizing the importance of alignment between the company's strategy, workforce, culture, and structure. However, Berghaus's model offers more depth with five levels of maturity compared to Kane's three levels, thus providing a more granular perspective of digital transformation progress. The Digital Maturity Framework by Remane et al. (2017) is a comprehensive model considering a firm's preparation level and its industry context. It suggests that the maturity of digital transformation can vary widely based on the specific industry and its digital demands. Valdez-de Leon (2016) model, built for Telecommunications Service Providers, focuses on the stages of implementation, from initial steps towards digital transformation to pioneering new ground, thereby providing a more action-oriented perspective. The Digital Maturity Model 4.0 by VanBoskirk and Gill (2016) and the 4 Levels of Digital Maturity by Westerman et al. (2011) both offer four stages of digital maturity. They provide a comprehensive view of digital transformation, emphasizing not just the technical aspects but also organizational culture, mindset, and customer-centric approaches.

In this dissertation, drawing on the first study (Title: Dynamics of Digital Change – Measuring the Digital Transformation and its Impacts on the Innovation Activities of SMEs), four distinct levels of digital maturity were identified: Early-digital (Level 0), Lagging (Level 1), Experimental (Level 2), and Advanced SMEs (Level 3). A more detailed discussion of digital maturity and corresponding models can be found in section 3, more specifically in 3.2.1, 3.2.2 and 3.3.2.

The second dimension of digital transformation central to this dissertation is **digital orientation**. As presented by Kindermann et al. (2021), digital orientation can be construed as an organization's guiding principle to actively pursue digital technology-enabled opportunities aiming for a competitive edge. This perspective essentially embeds a strategic mindset and organizational culture which underscores the relevance of digital technologies, coupled with innovation and adaptability, in realizing business objectives and steering digital transformation (Remane et al., 2017; De Carolis et al., 2017; Valdez-de Leon, 2016).

There are different ways to understand digital orientation. Some scholars see it simply as adding digital technologies to existing organizational strategies (Sawy, Amsinck, Kræmmergaard, & Vinther, 2016). Others believe it's more central, suggesting it should be at the heart of an organization's strategy (Bharadwaj et al., 2013; Kane, Palmer, Nguyen, Kiron, & Buckley, 2015). This evolving realization reinforces the importance of digital orientation, making it not just an add-on but a key driver that enables organizations to harness the latent potential of digital technologies in pursuit of strategic goals (Saunila, Nasiri, Ukko, & Rantala, 2021).

In evaluating these diverse interpretations, the definition by Kindermann et al. (2021) proves to be particularly robust. It holistically summarizes both the technological and strategic facets of digital orientation. Moreover, it fits well with the modern transformation that emphasizes digital technologies as central strategic components rather than peripheral elements. This definition not only aligns technological integration, but also highlights strategic depth and ensures that digital orientation is recognized as a fundamental strategic orientation in its own right (Cavallo, Ghezzi, Dell'Era, & Pellizzoni, 2019; Kane et al., 2015; Kindermann et al., 2021; Saunila et al., 2021).

Finally, in this dissertation, the term **technology adoption** stands as a cornerstone. At its core, technology adoption underlies a common understanding, as highlighted by (Rogers, 2003), and pertains to the structured process where organizations integrate new technologies into their operations. This encompasses not only the initial acceptance (Davis, 1989) but also its assimilation and effective application. Factors such as organizational preparedness, user receptiveness based on perceived usefulness and ease of use, necessary training, and infrastructure prerequisites (Venkatesh, Morris, Davis, & Davis, 2003), are crucial in determining the success of technology adoption. This understanding of technology adoption aligns with research accentuating its paramount importance in the digital transformation continuum (Stich, Zeller, Hicking, & Kraut, 2020; Nambisan et al., 2019). Notably, the extent and depth to which organizations embrace and implement digital technologies serve as a barometer for their advancement in the digital transformation journey.

Many technologies come into play during the digital transformation process. Some of these include big data analytics, the internet of things (IoT), cloud computing, augmented and virtual reality, artificial intelligence, cyber-physical systems, and mobile platforms (Urbinati, Chiaroni, Chiesa, & Frattini, 2018; Fitzgerald et al., 2014). For the scope of this dissertation, the following technologies are specifically considered:

- Digital interconnection within production/services
- Interconnection between production/service provision and logistics
- Digital outreach to customers
- Networking with suppliers
- Teleworking modalities
- Software-driven communication, like Skype
- Intranet platforms, such as Wikis
- E-commerce avenues
- Social media platforms, including Facebook and Twitter
- Cloud-based computing and applications
- Big data processing and analytics

The rationale for focusing on these technologies is multifaceted. These technologies encompass a spectrum of digital touchpoints that influence both internal operations and external engagements. Their integration into organizational ecosystems offers avenues for efficiency, innovation, and enhanced customer and partner relations. Furthermore, they have been recognized as drivers of competitive advantage and are fundamental in reflecting the diverse facets of digital transformation, from internal communication to customer interactions.

2.1.3 Crisis Terminology

Understanding crises necessitates the investigation of their triggers. **Exogenous shocks**, as highlighted by (Miklian & Hoelscher, 2022), encompass events beyond our control, such as wars, natural disasters, and disease outbreaks, which frequently result in significant economic disruptions (International Monetary Fund, 2003). Contrarily, **endogenous**

shocks emerge from internal sources like managerial missteps or operational breakdowns (Pearson & Clair, 1998). While both types of shocks can instigate crises, they do so from different origins and might require distinct management strategies. The recognition of these shocks, especially exogenous ones, is crucial as they can precipitate widespread crises that ripple across sectors and borders.

Building on this foundation, a **crisis** can be understood as the aftermath of these shocks (Miklian & Hoelscher, 2022). As described by (Crandall, Parnell, & Spillan, 2007), a crisis signifies an event or series of events disrupting regular operations, presenting threats beyond the mundane. These disruptions can manifest in various forms, such as financial downturns, reputational damages, operational halts, or cyber security incidents. Crises, thus, aren't merely immediate disturbances but have enduring consequences for organizations, affecting their survival and performance (T. Morgan et al., 2020).

Focusing on **crises in SMEs**, the landscape of crisis management further diversifies. Due to their inherent limitations in resources and scale, SMEs face unique challenges during crises (Ayyagari, Beck, & Demirgüç-Kunt, 2007; Storey, 1994). A situation that might merely dent a larger corporation's reputation could potentially cripple an SME (Agarwal & Audretsch, 2001). Their relative lack of resources, be it financial, manpower, or infrastructural, which is also referred to as the liability of smallness (Aldrich & Auster, 1986) makes them more vulnerable to both exogenous and endogenous shocks. Hence, understanding how crises affect SMEs is paramount, especially when formulating strategies tailored to their context. A more detailed examination of this relationship can be found in 2.3.2 within the theoretical framework of this dissertation.

An example of an exogenous shock in recent times is the **Covid-19 pandemic** caused by the outbreak of the novel coronavirus disease (COVID-19) rooted in the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Beyond being a health crisis, the Covid-19 pandemic dramatically reshaped economies, education systems, and daily routines. This pandemic serves as a contemporary illustration of how an exogenous shock can evolve into a global crisis. It showcases the intricate web of challenges organizations, especially SMEs, faced, and the adaptive strategies they employed. (Fauci, Lane, & Redfield, 2020)

In an unpredictable business landscape, the importance of **resilience** has come to the forefront. The essence of resilience can be seen as the capacity of individuals, communities, systems, or organizations to adapt, recover, and bounce back from adversity, challenges, or significant disruptions (Masten, 2001). This includes not only the ability to bounce back to a pre-existing state after facing disruptions, but also to grow, evolve, and adapt, subsequently resulting in an enhanced post-disruption state (Folke, 2006). This resilience, in all its facets, encompasses the capacity to endure shocks, maintain functionality, and even potentially thrive when facing adversities or stressors.

From an organizational perspective, resilience transcends just overcoming challenges. As Weick (1993) highlights, it emphasizes an organization's capacity to sustain its primary purpose and character in the face of external pressures. This demands not just robustness but adaptability. It's the holistic ability of an organization to foresee potential challenges, manage them efficiently when they arise, and adapt its procedures based on derived insights. This may involve strategies like diversifying resources, empowering staff to embrace multiple roles, creating redundant supply chain sources, or fostering a culture of continuous improvement and learning (Tukamuhabwa, Stevenson, Busby, & Zorzini, 2015). Moreover, specific to businesses, resilience ensures that the organization can persistently deliver its core functions, services, and values, even when faced with disruptions. This involves not just coping with challenges but actively anticipating, absorbing, adapting, and rapidly recovering from them, thereby safeguarding the organization's reputation and performance (Coombs, 2019; Lengnick-Hall & Beck, 2009).

2.2 Higher Order Theories

2.2.1 Disruption Theory

Disruption theory, introduced by Christensen (1997), is an essential concept for understanding the ever-evolving dynamics within industries. It is based on observing historical patterns and trajectories of innovation and offers insights into the nature and consequences of disruptions that unfold over time. The theory holds that there are innovations that

emerge, gradually mature, and eventually eclipse established products, services, or processes. These innovations, while initially inferior in some respects to the prevailing market offering, manage to penetrate new or underserved market segments. As they gain traction and evolve, they begin to match or even surpass established offerings, resulting in market leaders being dethroned or industry paradigms being recalibrated. This disruption cycle, subtle in its beginnings but with profound implications, is important to understanding the ever-changing industrial topography. (Christensen, 1997)

At the heart of the disruption theory lies its broad relevance for SMEs, offering insights into how they can strategically employ disruptive innovations to challenge established market norms. Transitioning into the realm of digital transformation, this theory becomes even more pertinent. In alignment with the principles of disruptive innovation, digital transformation underscores the transformative power of novel technologies in revolutionizing markets and industries (Giones et al., 2020; Zott & Amit, 2017). It's not merely a reaction to disruptive changes but a comprehensive and proactive strategy that enables organizations to harness the potential of digital technologies. This alignment illuminates the broader theoretical connection between digital transformation and the disruption theory, bridging the gap between technological potential and real business value (Seetharaman, 2020). By leveraging digital technologies, SMEs can foster new business models that disrupt traditional industry dynamics, positioning them not merely as participants but as driving forces of change (Kindermann et al., 2021; Nambisan et al., 2017; Quinton, Canhoto, Molinillo, Pera, & Budhathoki, 2018). The unique perspective of the disruption theory enables an enriched exploration of how SMEs can navigate the complex web of market opportunities, risks, and transformations brought about by disruptions such as the digital transformation (Christensen, 1997).

The choice of disruption theory as one of the key higher order theories to structure this dissertation is based on its comprehensive and multi-layered nature. It bridges the worlds of SMEs, digital transformation, and broader shifts within industries and research paradigms. Its application to digital transformation not only provides rich insights, but also enables a nuanced understanding of the numerous ways in which digitalization is

transforming the business landscape. Given the core nature of digital transformation – which is inherently disruptive, transformative, and paradigm-shifting – a theoretical lens was needed that reflected these qualities and provided a comprehensive view of its profound impact. Disruption theory, with its focus on radical change and the upheaval of established norms, is an almost symbiotic fit with digital transformation issues. Other higher-order theories may offer insights into certain aspects of change, but none captures the scale and depth of change initiated by digitalization as aptly as disruption theory. Accordingly, the exploration and roots of digital transformation are rooted in disruption theory, which consequently is one of the main overarching theories in this dissertation.

However, even beyond that, one can argue that digital transformation exemplifies the disruption theory in the deepest sense and transcends disruption of industries and reaches into the very core of scientific research, reshaping methodologies, expanding possibilities, and introducing new challenges (George, Haas, & Pentland, 2014; Gandomi & Haider, 2015). It signifies a paradigm that could evolve into a higher-order theory itself in the coming decades, providing a unifying framework for understanding the pervasive digitalization process (Bughin, Catlin, Hirt, & Willmott, 2018). Much like how the RBV and strategic alignment theory have shaped our understanding of resources and strategy, digital transformation stands as a potential leading theoretical lens for the digital age (Hitt, Bierman, Shimizu, & Kochhar, 2001; Chesbrough, 2020).

2.2.2 Resource-Based View

Transitioning from the theory of disruption to the RBV, our attention shifts from the overarching market and technological dynamics to the very essence of what powers organizations internally: their unique resources and capabilities. The RBV offers a foundational framework that suggests organizations, much like organisms in an ecosystem, possess a blend of resources, both tangible and intangible (Wernerfelt, 1984; Barney, 1991). These resources, when rare, valuable, inimitable, and non-substitutable, endow organizations with a competitive advantage, fostering sustained success in marketplaces (Barney, 1991).

For SMEs, the RBV takes on even greater relevance. Given the inherent constraints of size, scale, and often, financial muscle, SMEs do not always compete on the same parameters as larger enterprises. Instead, they navigate market terrains by leveraging their distinct capabilities and resources, be it agility, niche market knowledge, close customer relationships, or unique internal competencies (Aldrich & Auster, 1986). These capabilities and resources act as their defensive moats, enabling them to differentiate from competitors, respond more adeptly to market changes, and carve sustainable paths even in challenging business landscapes.

As the global business ecosystem witnesses the surge of digitalization, the traditional assets and capabilities emphasized by the RBV take on newer, digital dimensions. Digital capabilities, skills, and notably, an organization's degree of digital maturity, become central to their resource arsenal and form the crux of digital transformation (Nambisan et al., 2017). In this digital era, transformation becomes more than just the adoption of technology, it represents a strategic resource in itself. An organization's success in the digital age hinges on the strategic alignment, management, and utilization of these digital resources and their digital maturity level (Stich et al., 2020; Berghaus & Back, 2016). This perspective is further enriched when considering innovation. Organizations with advanced digital maturity can exploit digital technologies, potentially leading to superior innovation in products or processes (Westerman et al., 2012). However, SMEs still in the infancy of their digital journey may find the road ahead challenging due to the nascent stage of developing requisite digital capabilities (Fabrizio, 2009).

Given the complex landscape of the digital age, the decision to incorporate RBV into this dissertation is an obvious one. Not only does it provide a robust theoretical framework for understanding internal organizational dynamics, particularly in SMEs, but it also combines traditional strategic insights with the narrative of digital transformation. RBV thus provides an invaluable lens for understanding how SMEs can navigate, adapt, and thrive in an ever-evolving digital landscape despite resource constraints (Nambisan et al., 2017; Tushman & O'Reilly, 1996; Barney, 1991). This synthesis of traditional resources and digital imperatives underscores the essential role of RBV in this dissertation, making

it not only a theoretical choice, but also a strategic choice for understanding SMEs in the context of this dissertation.

2.2.3 Strategic Alignment

The final higher order theory relevant to this dissertation is the theory of strategic alignment, anchored in the work of Henderson and Venkatraman (1993). At its core, strategic alignment theory elucidates the concept of ensuring that there is a coherent and seamless connection between an organization's strategic objectives and its operational resources and capabilities (Reich & Benbasat, 2000). This alignment implies that both digital technology strategies and business strategies should not just co-exist, but should be interwoven in a manner that optimizes business processes and outcomes (Luftman, 2000).

For SMEs, the concept of strategic alignment takes on added significance. Given their inherent constraints, such as limited resources, shorter reach, and potential vulnerability to market volatilities, SMEs need to ensure that every operational action mirrors strategic intent (Levy, Powell, & Yetton, 2003). This makes strategic alignment not just a theoretical concept, but a practical imperative for SMEs. Their inherent agility, often seen as a trait of smaller enterprises, becomes a potent weapon when it is guided by strategic alignment. This alignment aids SMEs in swiftly adapting to market changes, leveraging their core competencies, and ensuring that their limited resources are directed towards strategic priorities, thus enhancing their competitiveness and performance in the market (Cragg, Caldeira, & Ward, 2012).

Transitioning from the insights provided by the RBV – which emphasizes the intrinsic value of resources such as digital capabilities and maturity for SMEs (Wernerfelt, 1984; Barney, 1991; Nambisan et al., 2017) – the strategic alignment theory broadens our understanding. It posits that the true potential of these digital resources is realized not just by their acquisition, but more importantly, by their strategic alignment and management (Stich et al., 2020; Berghaus & Back, 2016). In the digital realm, it is crucial for SMEs to ensure their digital orientation resonates with their broader business strategy. This entails making strategic decisions concerning digital technology investments, ensuring

these investments are aligned with business objectives, and integrating them effectively into ongoing processes and operations (Nguyen, Newby, & Macaulay, 2015). The strategic alignment theory enriches this perspective, emphasizing the need for harmony between an organization's business strategy and its infrastructure (Kane et al., 2015), all while considering both internal capabilities and the external business environment (Eller et al., 2020).

In conclusion, the strategic alignment theory emerged as a higher order theory for its invaluable insights into understanding the interplay between resources and strategy, especially in the context of digital transformation. By emphasizing the need for strategic harmony in the midst of digital disruption, it provides a compelling narrative on how SMEs can leverage their innate agility and resources for optimal performance (Rupeika-Apoga, Nedovis, & Thalassinos, 2022). While the RBV accentuates the intrinsic power of resources within organizations, the strategic alignment theory magnifies the importance of strategic orchestration in harnessing these resources. Together, they present a comprehensive framework for deciphering the multi-layered nature of digital transformation in SMEs, which is rooted in disruption theory. Accordingly, the triad of disruption theory as the root of digital transformation combined with the RBV and the strategic alignment theory as embedding higher order theories is ideally suited to provide the framework for this dissertation and to explore the nature of digital transformation in SMEs.

2.3 Theoretical Framework

2.3.1 Digital Transformation, -Maturity, & -Orientation in SMEs

Referring to the definition according to Vial (2019) digital transformation can be described as a process of enhancing an organization through significant changes in its characteristics by adopting and leveraging digital technologies. Subsequently, digital transformation fundamentally changes the way organizations operate, compete, and deliver value (Bharadwaj et al., 2013). It occurs across multiple dimensions such as organizational processes, structures, and customer interactions (Hess et al., 2016). The ubiquity of digital

transformation in today's business world, backed by research evidencing a positive relationship with organizational performance (Guo & Xu, 2021; Yu, Wang, & Moon, 2022), underscores the universal significance of this transformative process.

This evolving landscape extends its reach across all sectors and scales of the business spectrum. Of particular interest in this regard are SMEs considering their unique role in contributing to change and innovation, particularly in the realm of digital transformation (Ardito, Raby, Albino, & Bertoldi, 2021; Rupeika-Apoga, Nedovis, & Thalassinos, 2022). Known for their distinct characteristics, such as agility, adaptability, and flexibility, SMEs present a unique context for studying digital transformation as these traits can either catalyze or hinder the process (Levy & Powell, 1998). In the digital age, SMEs confront distinct challenges primarily due to their size and resource limitations. The liability of smallness refers to the constraints that small organizations face due to their limited resources (Aldrich & Auster, 1986). These constraints can manifest in various forms, including financial limitations, inadequate human resources, and lack of technological infrastructure (Bajwa et al., 2008; Ahmad, Bosua, & Scheepers, 2014; Taylor & Murphy, 2004; Clohessy & Acton, 2019). These limitations often result in a higher level of risk aversion, particularly concerning the adoption of digital technologies, thereby potentially inhibiting SMEs from exploiting the full benefits of digitalization (Nguyen et al., 2015).

On the other hand, the small size of these enterprises also presents unique advantages. SMEs are inherently more flexible, which allows them to adapt swiftly to new trends and changes in their environment (Levy & Powell, 1998). In the context of digital transformation, this adaptability can become a significant competitive advantage, as the rapid adoption of new technologies and processes can lead to improved operational efficiencies and customer engagement (Aldrich & Auster, 1986; Zhu, Dong, Xu, & Kraemer, 2006). The process of digital transformation can profoundly impact SMEs, reshaping their operational processes, business models, and market interactions (Vial, 2019; Dong, 2019).

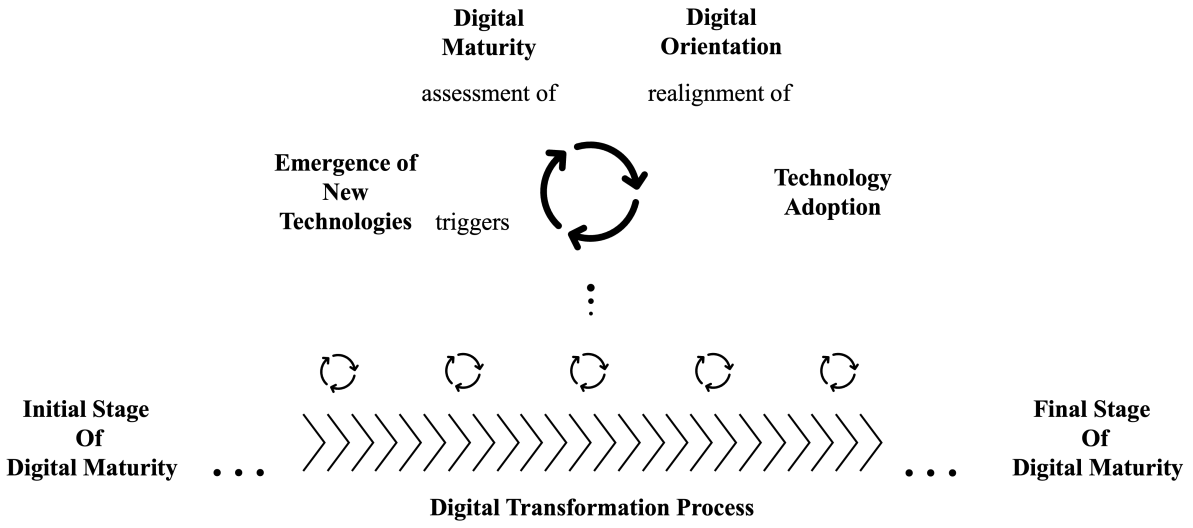
Regardless of the debate concerning whether SMEs are in a more favorable or less favorable position to benefit from digital transformation, empirical evidence suggests that SMEs frequently demonstrate a lower level of progress in their digital transformation journey

compared to their larger counterparts (Bajwa et al., 2008; Eller et al., 2020; OECD, 2021; Rupeika-Apoga, Nedovis, & Thalassinos, 2022). This observed deficiency tends to endorse the notion that SMEs face difficulties in the digital transformation process, potentially due to the liability of smallness (Aldrich & Auster, 1986). As a consequence SMEs might struggle with the required resources for the successful integration of resource-demanding digital technologies within an organization (Bajwa et al., 2008; Clohessy & Acton, 2019). With the crucial role SMEs play in the global economy, it becomes essential to delve deeper into how these enterprises can navigate the challenges inherent in their specific characteristics during the digital transformation process.

Digital transformation entails two further subdimensions – namely, digital maturity and digital orientation. A significant aspect of digital transformation is the establishment of a digital orientation, an organization's strategic response to pursue digital technology-enabled opportunities in order to achieve a competitive advantage (Kindermann et al., 2021). This implies a strategic shift towards continuous learning, experimentation, and agility (Kane et al., 2015). The other subdimension of digital transformation is digital maturity, which serves as an indicator of an organization's readiness to undergo digital transformation and its ability to extract value from such initiatives (Westerman, Bonnet, & McAfee, 2014). Precisely, digital maturity is delineated as a path towards higher degrees of digital transformation, with organizational maturity characterized by levels denoting a certain degree of an expected, desired, or logical maturity progression (J. Becker, Knackstedt, & Pöppelbuß, 2009; Gottschalk, 2009). The key elements of organizational maturity, which include infrastructures, technologies, and culture, encapsulate the multi-dimensionality of digital transformation (Mettler, 2011). Accordingly, the digital transformation process involves the iterative adoption of innovative digital technologies (technology adoption), a strategic response to the emergence of new technologies and related shifts (digital orientation), and the constant evaluation of the status quo concerning the digital transformation process (digital maturity) (Matt, Hess, & Benlian, 2015; Hess et al., 2016). Within a continuous framework as illustrated in Figure 2.2, this process initiates iteratively with the introduction of groundbreaking digital technologies. These

advancements act as catalysts for the strategic repositioning of an organization, which is initiated by an assessment of the organization's current digital maturity to ensure transparency, monitor progression, and establish benchmarks. Subsequently, the organization realigns its strategic orientation under consideration of the previously existing, or newly formulated digital orientation. This strategic response to the emergence of new technology, and the assessment of the current status of digital maturity then merges into a tangible incorporation of these new technologies. This incorporation further necessitates the alignment of the organization's infrastructure, procedures, and capabilities to seamlessly integrate with these novel technologies, before another iteration of assessment, alignment, and adoption reoccurs. Ultimately this process results in the improvement of organizational performance as proposed in Figure 2.3 (see end of this chapter).

Figure 2.2: Interrelation of Digital Maturity and Digital Orientation Within the Assessment, Alignment, and Adoption Cycle of the Digital Transformation Process (Source: Author's Illustration)



Source: Own Illustration

At the core of the strategic components of digital transformation lies digital orientation, a guiding principle encouraging organizations to leverage digital technology-enabled opportunities (Kindermann et al., 2021). As a reflection of the strategic alignment model, digital orientation outlines the extent of business strategy adaptation required to create value through digital alignment (Henderson & Venkatraman, 1999; Kindermann et al., 2021).

Accordingly, digital orientation serves as a significant catalyst, shaping an organization's characteristics through the integration and utilization of digital technologies (Vial, 2019; Dong, 2019). Digital orientation encompasses four subdimensions: architecture configuration, capabilities, ecosystem coordination, and technology scope (Kindermann et al., 2021). These subdimensions collectively signify the value creation, emergence of new skills, enhancement of existing skills, and the establishment of organizational prerequisites instigated by digital technologies. The strategic prominence of digital technologies in the modern era supports the assertion of digital orientation as a distinct strategic orientation (Sawy et al., 2016; Bharadwaj et al., 2013; Kane et al., 2015; Cavallo et al., 2019; Kindermann et al., 2021; Saunila et al., 2021).

While digital orientation is increasingly discussed in scientific discourse, the emphasis on SMEs within this conversation is relatively sparse (Ardito et al., 2021; Rupeika-Apoga, Nedovis, & Thalassinos, 2022; Saunila et al., 2021). The potential for SMEs to manage the changes implicated by digital transformation remains a contentious issue due to constraints such as their risk-averse nature and limited resources (Bajwa et al., 2008; Eller et al., 2020; Nguyen et al., 2015; Ahmad et al., 2014; Taylor & Murphy, 2004; Clohessy & Acton, 2019). Conversely, the inherent advantages of SMEs, such as flexibility, agility, and adaptability, may allow for swift adoption and adaptation of novel technologies (Levy & Powell, 1998; Aldrich & Auster, 1986; Zhu et al., 2006). Despite these strengths, SMEs are often observed to lag behind in their digital transformation journey (OECD, 2021; Rupeika-Apoga, Nedovis, & Thalassinos, 2022). As such, SMEs may potentially overcome their digital transformation challenges by cultivating a robust digital orientation. This strategic approach might lead to the successful integration of digital technologies, helping to offset the constraints of their limited resources and facilitate their journey towards digital maturity (Kindermann et al., 2021).

Within this context, the subdimension of digital transformation known as digital maturity emerges as a critical element. Considering the theoretical foundation of digital maturity, it's important to acknowledge the concept as a measure of digital transformation (Mettler, 2011). Therefore, for SMEs, the initial stride in their strategic response or approach

to digital transformation should be an introspective assessment, essentially evaluating their current level of digital maturity. In order to process such an evaluation various scholars have proposed multiple digital maturity models, each encompassing different characteristics of the dimensions at each stage of maturity (Thordsen et al., 2020). An overview of current maturity models is provided in Table 3.1.

Currently, there is no consensus regarding the quantity or traits associated with the various stages of digital maturity. Yet, despite the shared understanding among researchers that digital transformation is an ongoing process throughout an organization's existence, there is some agreement about the initial and final stage of digital maturity (W. Becker et al., 2018). The initial level of digital maturity is largely consistent across most models. Here, organizations possess a minimal digital technology budget, rudimentary internal Information Technology (IT) infrastructure, and technology adoption is often driven by peer and market pressure (Berghaus & Back, 2016; De Carolis et al., 2017). The application of digital technologies at this stage is typically characterized by the introduction of basic digital services in connection with production, service provision, and logistics (Westerman et al., 2012).

The literature presents a diverse number of middle levels of digital maturity depending on the specific model considered. In summary, organizations at these stages range from a variety of industries impacted by ongoing digitalization. These organizations may have either overlooked the significance of digitalization or are still experimenting (Remane et al., 2017). Further, the middle level is characterized by attempts to digitally enhance internal communication or service processes to counteract the lack of enabling technologies (Berghaus & Back, 2016; De Carolis et al., 2017).

High digital maturity, or the final stage, sees organizations focusing on user and customer involvement, with corresponding data playing a central role (W. Becker et al., 2018; Teece, 2010; Zott & Amit, 2017). Advanced data analytics for decision support or product development, along with employee skills in data utilization, advanced technological infrastructure, and data governance, all rely on a solid technology infrastructure and high IT budget (Berghaus & Back, 2016; De Carolis et al., 2017).

2.3.2 Digital Transformation in SMEs during Times of Crises

Exogenous shocks as events beyond control have significant negative impacts on the economy (International Monetary Fund, 2003). Precisely, the crisis as the aftermath of an exogenous shock (Miklian & Hoelscher, 2022) threatens the normal operations, reputation, or survival of organizations and can manifest in various forms, such as in the Covid-19 pandemic (Crandall et al., 2007). In this regard, Figure 2.3 illustrates the negative relationship between a crisis and SME performance, described as "Potentially Negative". Respectively, crisis prevention and management are crucial aspects of any organization, including those undergoing digital transformation. The theoretical frameworks in this area have evolved significantly with the advent of digital technologies. One of the most relevant theories for understanding crisis prevention in the context of digital transformation is the proactive crisis management theory (Coombs, 2019). This theory suggests that organizations should anticipate potential crises and take proactive steps to mitigate their impact. In the context of digital transformation, proactive crisis management might involve identifying potential risks associated with implementing new technologies, such as cybersecurity threats, data privacy concerns, or operational disruptions (Coombs, 2019).

However, while the digital transformation itself represents a disruption – in form of the digitalization paradigm – digital transformation can also benefit the crisis management of other exogenous shocks. While SMEs face unique challenges during crises, they have displayed remarkable resilience and adaptability, leveraging digital transformation as a strategic response to address these challenges (Bartik et al., 2020; Kindermann et al., 2021). Digital transformation enables SMEs to mitigate disruptions, enhance their competitiveness, and drive sustainability in an increasingly digitized landscape (Vial, 2019; Dong, 2019). SMEs, with their inherent agility and adaptability, can effectively leverage digital orientation to navigate through crisis periods, swiftly adapt and innovate, and enhance their competitiveness (Henderson & Venkatraman, 1999; Kindermann et al., 2021). The four subdimensions of digital orientation - architecture configuration, capabilities, ecosystem coordination, and technology scope - provide SMEs with a comprehensive

framework to strategize their digital transformation journey, especially during crisis periods (Kindermann et al., 2021). By strategically leveraging digital technologies, enhancing digital capabilities, fostering a conducive digital ecosystem, and broadening their technology scope, SMEs can mitigate the impacts of a crisis, ensure business continuity, and drive sustained value creation (Henderson & Venkatraman, 1999).

However, the strategic response to crises induced by exogenous shocks starts with an evaluation of the current status quo. In relation to this, digital maturity is a critical element in the effective crisis management of SMEs (Mettler, 2011). It measures an organization's progress in its digital transformation journey, providing a framework for evaluating characteristics at each stage of maturity (Thordsen et al., 2020). SMEs need to assess their current level of digital maturity as an initial step in their response to not only digital transformation but also in their response to exogenous shocks and inherent crisis such as the Covid-19 pandemic (W. Becker et al., 2018). Such an evaluation is required in order to identify the areas in the organization that can and should be evolved concerning their digital transformation status.

Organizations with higher digital maturity levels are better prepared to navigate through crises (Berghaus & Back, 2016; De Carolis et al., 2017). They have a solid technology infrastructure and advanced data analytics capabilities, enabling data-driven decision-making and innovative solutions in times of crisis (W. Becker et al., 2018; Teece, 2010; Zott & Amit, 2017). Moreover, they establish robust communication channels, both internally and externally, facilitating effective collaboration and information sharing during crisis events (Berghaus & Back, 2016; De Carolis et al., 2017). This is especially true for the advent of the Covid-19 pandemic which among other measures included the lockdowns and social distancing underlining the importance of online collaboration and communication. High digital maturity also enhances SMEs' agility and adaptability, allowing them to swiftly adjust operations, supply chains, and business models in response to changing market dynamics during a crisis (Remane et al., 2017). Consequently, by advancing their digital maturity, SMEs strengthen their crisis management capabilities (W. Becker et al., 2018; Teece, 2010; Zott & Amit, 2017). This involves investing in technology infras-

tructure, developing digital skills, embracing data-driven decision-making, and fostering innovation and agility. With a focus on digital transformation, digital orientation, and digital maturity, SMEs can effectively respond to crises, mitigate their impact, and position themselves for long-term resilience and success in a rapidly changing digital landscape.

In summary, digital transformation plays a critical role in SMEs' response to crises. By adopting a proactive crisis management approach and embracing digital orientation, and digital maturity, SMEs can effectively navigate through turbulent times, enhance their competitiveness, drive sustainability, and ensure business continuity in the face of crises (Bartik et al., 2020; Kindermann et al., 2021). Accordingly, derived from literature the proposed relationship between digital transformation and performance in SMEs, amid times of crises, is shown in Figure 2.3 illustrated as "Potentially Positive".

2.3.3 Digital Transformation and the Business Model in Times of Crisis

The pursuit of digital transformation yields substantive changes within an organization, underscoring the need to examine business models and business model innovation within this context, particularly during crisis situations. Business models provide a theoretical representation of an organization's structure, business rationale, and governance methods (Amit & Zott, 2001). These have been earmarked as integral to the success of SMEs in times of crisis (Ritter & Pedersen, 2020). In the context of the Covid-19 crisis, business model innovation, fueled by digital transformation, has surfaced as a response to counter the crisis's negative impacts (Chesbrough, 2020; T. Morgan et al., 2020).

In order to analyze the business model the literature presents several models for business model classification, such as the Business Model Canvas (Osterwalder & Pigneur, 2010), the Magical Business Model Triangle (Gassmann et al., 2015), and the Strategic Triangle (Amit & Zott, 2001). However, this study employs the four-component business model — value proposition, value delivery, value creation, and value capture — as suggested by Günzel and Holm (2013). This compact yet comprehensive framework offers a thorough

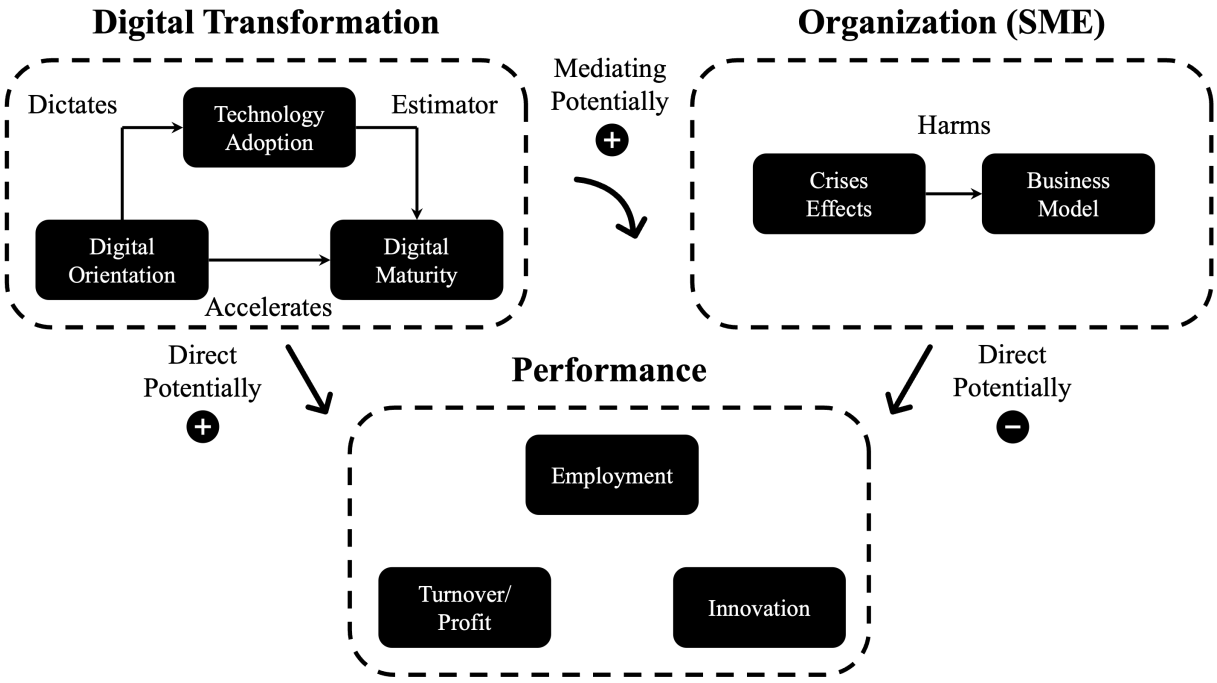
explanation of the crucial elements of a business model, shedding light on how digital transformation and technology adoption could present potential solutions to the issues raised by the Covid-19 crisis within SMEs.

The value proposition, a crucial component encapsulating an organization's array of products and services, has great influence on its success during and beyond a crisis (Remane et al., 2017; Altunbas, Manganelli, & Marques-Ibanez, 2011). For SMEs, this proposition is particularly critical for competitive positioning and customer engagement, given their generally limited resources compared to larger corporations (Aldrich & Auster, 1986). Swift adaptability of offerings to respond to fluctuating market demands becomes especially important during crises, with digital transformation acting as a catalyst for this adaptability, thereby aiding the survival and recovery of SMEs (T. Morgan et al., 2020). Moreover, digital transformation profoundly impacts value delivery, which encompasses the delivery of value propositions to customers via communication, distribution, and sales channels (Remane et al., 2017). Digital technologies pave the way for the reformation of value networks, allowing organizations to adjust their distribution and sales channels, especially during crises such as Covid-19, where goods and services need to be delivered with minimal physical contact and maximum safety (Andal-Ancion, Cartwright, & Yip, 2003; Hansen & Kien, 2015; Seetharaman, 2020). Digital transformation also has implications for value creation – the process through which the value proposition is realized (Remane et al., 2017). Data analytics for enhanced decision-making, along with the integration of automation and machine learning technologies, lead to improved efficiency and offer SMEs opportunities for substantial efficiency gains and competitive edges, essential for survival and growth during crises (Giones et al., 2020; Clohessy, Acton, & Morgan, 2017; Hess et al., 2016). Digital technologies also offer the potential to design new pricing strategies, such as subscription-based models or dynamic pricing, affording SMEs increased adaptability and flexibility in generating revenue, particularly essential in crisis-induced volatile markets (L. Tan, Zhang, Clarke, & Smucker, 2015a).

It is vital for organizations to understand that their business models are not fixed, but dynamic, requiring constant innovation using digital technologies (F. Li, 2020). This

is particularly pertinent in today's business climate, characterized by dynamism, uncertainty, and complexity, inclusive of the disruptive changes brought about by the Covid-19 pandemic (Leroi-Werelds, Verleye, Line, & Bove, 2021). Furthermore, the extent to which digital technologies are adopted and integrated into their business models could determine the influence of digital transformation on SMEs' crisis performance (Westerman et al., 2012). Thus, the level of digital transformation before the crisis may impact the performance during a crisis, as SMEs are better prepared to adapt their operations, alter their value propositions, and utilize new digital channels for value delivery and capture, thereby reducing the impacts of the crisis (Haddud, DeSouza, Khare, & Lee, 2017). Hence, a thorough comprehension of the interplay between business model change and digital transformation is essential to understand their combined impact on SME performance in times of crisis. Digital transformation drives business model innovation, with the resultant innovative business model directing the future trajectory of the organization's digital ventures. This cyclical interaction peaks in a symbiotic co-evolution of the business model and the organization's digital maturity, enhancing organizational resilience and performance during crises (Haddud et al., 2017). Respectively, the derived moderating relationship of digital transformation on the interaction between the business model and SME performance is shown in Figure 2.3 marked as "Potentially Positive".

Figure 2.3: Model of Assumed Interplay: Digital Transformation Dimensions, Organizational Context, and Multifaceted Performance Metrics in SMEs



Source: Own Illustration

Chapter 3

Dynamics of Digital Change – Measuring the Digital Transformation and its Impacts on the Innovation Activities of SMEs

Dynamics of Digital Change –

Measuring the Digital Transformation and its Impacts on the Innovation Activities of SMEs

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Abstract

Purpose *– Digital transformation has gained particular interest among academics and policymakers in recent years. However, the empirical quantification of digital transformation stages and their impact on innovation in SMEs remains understudied. Therefore, this study aims to investigate the impact of digital transformation stages on a differentiated measurement of innovation performance in SMEs.*

Design/methodology/approach *– We propose a simplified one-dimensional digital maturity path to estimate the stages of digital transformation in SMEs. We validate our approach with a cluster analysis and perform an ordered logistic regression to estimate the impact of digital transformation stages on SMEs' innovation performance.*

Findings *– Our results show that digital transformation in general has a positive impact on SMEs' innovation performance. More precisely, we find that the early stage of digital transformation has a detrimental effect on innovation performance, while significant and positive effects can be expected from the experimental stage onward. Furthermore, the advanced stage of digital transformation significantly increases the probability of producing radical innovations.*

Originality *– This study contributes to the ongoing discussion about the relationship between digital transformation and innovation in SMEs by presenting an approach to quantify digital transformation stages in SMEs. Additionally, this study provides new insights into the specific dynamics of the relationship between different stages of digital transformation and their impact on a differentiated measurement of innovation performance, including technological, non-technological, and radical innovation.*

Keywords: Innovation – Digital Transformation – Technology Adoption – Digital Maturity – SMEs

3.1 Introduction

Digital transformation in the context of organizations can be understood as a strategic business transition induced by the integration of digital technologies that fundamentally changes the way organizations create value (Stolterman & Fors, 2004). Digital transformation is of particular importance for small and medium-sized enterprises (SMEs), as they can mitigate their liability of smallness (Aldrich & Auster, 1986) by integrating digital technologies. This process is based on SME's agility, flexibility and adaptability in dynamic environments which facilitates such transformations (Hassan et al., 2020).

Similar to other strategic resources in organizations, digital transformation is seen as a new antecedent of innovation (Yoo, Boland, Lyytinen, & Majchrzak, 2012). However, the related debate is still inconclusive. While some studies underscore a positive relationship between digital transformation and innovation generation (Kastelli, Dimas, Stamopoulos, & Tsakanikas, 2022; Scuotto, Del Giudice, & Carayannis, 2017), others do not identify digital transformation as a new source of innovation (Usai et al., 2021). The related investigations in SMEs are largely underexplored (Appio et al., 2021; Chen & Kim, 2023), albeit some notable exceptions (Hempell & Zwick, 2008; Koellinger, 2008; Morikawa, 2004). Most of the existing research on the relationship between digital transformation and innovation focuses on qualitative investigations among SMEs, whereas the emerging contribution of digital transformation toward the restructuring of existing business processes warrants in-depth quantitative analyses (Nambisan et al., 2017). This underlines the importance to investigate the following research question: How can digital transformation be empirically measured in the context of quantitative analyses and what influence does the state of digital transformation of an SME exert on its innovation performance?

One of the central issues in this context is the operationalization of digital transformation in an empirical setting (Thordsen et al., 2020). As there is no common definition of digital transformation in the literature, it is challenging to empirically assess the extent of digital transformation in organizations and its subsequent impact on organizational performance (Vial, 2019). In this study, we underscore that the literature pertaining to

digital maturity provides reasonable foundation to empirically assess the degree of digital transformation in SMEs (Mettler, 2011). Digital maturity is proposed as an evolutionary process in which organizations digitalize over time through learning and implementing a set of digital technologies (Remane et al., 2017). Digital maturity is generally proposed as a holistic, and often complex approach that includes several organizational dimensions (e.g., digital technologies, human capital) which often hinders the quantification of digital maturity for empirical purposes (Valdez-de Leon, 2016).

Existing research suggests that digital technologies are not only the initiator but also the main driver of the digitalization process in organizations (Vial, 2019). Therefore, in this study, we underscore that digital technology adoption should be the most important dimension of digital maturity and a viable estimator of the stage of digital transformation in an organization. Against this background, we first propose a one-dimensional digital maturity pathway (digital technology-centered) as an estimator of digital transformation. In order to account for the complexity of digital transformation and to counteract the previous exclusive focus of research on internet-based digital technologies, this study considers the usage and the intensity of usage of a number of overarching digital technologies. Subsequently, we carry out a cluster analysis to quantify the digital transformation on a sample of 1,077 German SMEs between the years 2016 and 2019. We then use this measure to empirically examine the relationship between digital transformation and a differentiated assessment of innovation performance for technological, non-technological and radical innovations in SMEs.

This study advances our understanding of digital transformation and its impact on SME innovation performance with four key contributions. Firstly, it proposes a one-dimensional digital maturity pathway, emphasizing digital technology adoption as the primary dimension, addressing a significant gap in the literature. This focused approach allows for better decision-making and resource allocation in digitalization processes. Secondly, by considering a wider range of digital technologies, the study acknowledges the complexity and diversity of digital transformation, allowing for more accurate assessments of digital maturity and guiding organizations in identifying key areas for investment. Thirdly, the

application of cluster analysis to quantify digital transformation in 1,077 German SMEs provides valuable empirical evidence, revealing patterns and relationships between digital technology adoption and innovation performance, which can inform SMEs, policymakers, and industry stakeholders. Lastly, the study examines the relationship between digital transformation and various aspects of innovation performance, capturing a differentiated assessment of technological, non-technological, and radical innovations. This insight helps organizations strategically adopt digital technologies to enhance innovation capabilities and remain competitive in the evolving digital landscape.

3.2 Theoretical Framework

Digital transformation centers on two key aspects: the strategic adoption of technology within organizations and the consequential organizational shifts (Gobble, 2018; Yoo, Boland, Lyytinen, & Majchrzak, 2012). Existing literature indicates that by adeptly leveraging digital technologies, organizations can experience structural alterations (Gobble, 2018). Organizations are not only able to operate with technologies that are well connected and interwoven throughout the organization but are also able to efficiently access multiple data-driven sources (Hassan et al., 2020). Subsequently, this creates opportunities for organizations to exploit their digitalization-driven competitive advantage (Koch & Windsperger, 2017; Scuotto et al., 2017; Westerman et al., 2012).

Incorporating digital technologies into business operations has reshaped traditional views on how organizations strategically allocate their resources, especially in the sphere of innovation (Cardona, Kretschmer, & Strobel, 2013; Yunis, Tarhini, & Kassar, 2018). As a result, the act of embedding and using digital technologies has emerged as a notable precursor to innovation (Nambisan et al., 2017; Yoo, Boland, Lyytinen, & Majchrzak, 2012). However, there's a noticeable gap in research linking digital transformation to innovation (Appio et al., 2021; Chen & Kim, 2023; Higón, 2012). A challenge in this area is the difficulty of quantifying digital transformation. Yet, examining the concept of digital maturity from information systems research may offer insights into evaluating

digital transformation.

3.2.1 Digital Maturity as a Measure of Digital Transformation

Digital maturity represents a progressive journey towards more advanced stages of digital transformation (Mettler, 2011). In this regard, the overarching concept of organizational maturity is delineated by stages, each signifying a distinct degree of progression on a logical or anticipated path to maturity (J. Becker et al., 2009; Gottschalk, 2009). The foundational elements of organizational maturity encompass infrastructure, technologies, and culture (Mettler, 2011). When evaluating digital maturity, the goal is to assess the comprehensive current state of an organization's digital transformation and provide a structured roadmap to subsequent maturity phases. In essence, a dimension signifies a distinct, quantifiable, and standalone facet that encapsulates a core aspect of maturity, such as internal business procedures, external collaborations, customer relations, or the introduction of new business models and technologies (Thordsen et al., 2020). Numerous digital maturity models have been proposed by scholars, with each model exhibiting unique attributes across the various maturity stages (Thordsen et al., 2020). The following delineation of digital maturity levels is based on a comprehensive literature review of digital maturity frameworks. A synopsis of these models can be found in Table 3.1.

The basic level of digital maturity is quite consistent in many digital maturity models. At this stage, companies typically allocate a modest budget to digital technologies and have an internal IT infrastructure that is in place but neither mature nor fit for purpose (Berghaus & Back, 2016). Decisions to adopt or deploy digital technologies are often influenced by competitor and market dynamics (Egan, Clancy, & O'Toole, 2003). The adoption of digital technologies is evident in the introduction of elementary digital services in manufacturing, service delivery, and logistics (Berghaus & Back, 2016; Valdez-de Leon, 2016; VanBoskirk & Gill, 2016; Westerman et al., 2012). Organizations in this stage may also come from sectors that are only marginally affected by the digitalization (Koellinger, 2008; Remane et al., 2017; VanBoskirk & Gill, 2016).

Subsequent stages, often referred to as intermediate levels of digital maturity, vary sig-

nificantly across models. Essentially, these stages encompass organizations from different sectors that are affected by digitalization. These organizations may either understate the importance of digitalization or remain in the exploratory stage (Remane et al., 2017). Typically, prevailing production methods, governance, and organizational culture are prioritized over emerging competitors, customer relationships, or general technological advances (Avlonitis, Papastathopoulou, & Gounaris, 2001; VanBoskirk & Gill, 2016; Westerman et al., 2012). A characteristic feature of this stage is the pursuit of digital improvements in internal communications or service procedures to compensate for technological shortcomings and maintain competitiveness by testing emerging technologies (Berghaus & Back, 2016). While these organizations allocate more resources, time, and budget to new digital technologies, their deployment remains neither holistic nor intensive (Berghaus & Back, 2016; Valdez-de Leon, 2016; VanBoskirk & Gill, 2016).

The peak of digital maturity – often referred to as high digital maturity – is widely agreed upon in the existing literature. At the heart of these data-driven or digitally transformed organizations is a preoccupation with an emphasis on users and customers and the data associated with them (Teece, 2010). Proficient data analytics focused on decision making or product development, combined with employee data literacy, state-of-the-art technical infrastructure, and sound data governance, is anchored on a solid technological foundation and a substantial IT budget (Berghaus & Back, 2016). Integrated technologies promote connectivity and compatibility across the enterprise (Remane et al., 2017; Valdez-de Leon, 2016; Westerman et al., 2012). This deep technological immersion catalyzes numerous innovation opportunities, culminating in increased innovation capabilities (Casadesus-Masanell & Zhu, 2013).

Digital maturity assessment is an essential component of the digital transformation of enterprises, particularly SMEs, which is underscored by the emphasis on the importance of digital maturity assessment for effective support and transformation in SMEs (Kljajić Borštnar & Pucihar, 2021; Williams, Schallmo, & Scornavacca, 2022). However, the holistic digital maturity models present in the theoretical landscape are marred by issues related to generalizability, consistency, and precise measurement (Thordsen et

al., 2020). As highlighted in Table 3.1, the comprehensive notion of digital maturity is multidimensional, including several intermediary stages, thereby adding layers of complexity (Valdez-de Leon, 2016). This intricacy impedes the application of these models in empirical research, especially for SMEs, which necessitate more streamlined and flexible frameworks (Williams et al., 2022). In view of these considerations, we assume that the complexity of these models must be reduced in order to gain empirically sound and usable insights for SMEs. The dimension of digital technology integration can serve as a prime indicator to gauge an organization's digital transformation progress (Westerman et al., 2014). This rationale stems from the understanding that digital technologies are pivotal to the transformation journey, as not just the usage, but also the intensity of this usage can offer implicit insights into the organization's transformative steps (Nambisan et al., 2019). Accordingly, digital maturity denotes an organization's current status in digital technology adoption and its usage intensity, representing a crucial phase in its methodical digital transformation journey. Put differently, an organization can only harness specific digital technologies to a particular extent if it has already acquired the requisite capabilities and resources (Müller, Buliga, & Voigt, 2018). Adopting this perspective facilitates a sharper, more actionable method to evaluate digital maturity, amplifying the utility of digital maturity models in empirical research.

3.2.2 Hypothesis Development

In the realm of digital transformation, the integration of digital technologies stands as a pivotal point. These technologies, characterized by their programmability, openness, and data homogenization, are more and more being incorporated into organizational frameworks, leading to refined internal operations and a more adept capability to counter external challenges and gauge market dynamics (Autio et al., 2018; Nambisan et al., 2017). The momentum of this digital shift is especially evident among SMEs, where the promise of competitive advantage has spurred their engagement in this transformative journey (Abebe, 2014; Eller et al., 2020; Ghobakhloo & Ching, 2019).

Yet not all enterprises share the same transformative story. While some studies have

Table 3.1: Overview of Digital Maturity Models

Level	Industry Context	Priority Focus	Technology Adoption	Resource Allocation	Key Characteristics	Sources
Initial	Barely affected by digitalization	Existing production, governance, and culture	Introduction of basic digital services	Limited digital technology budget	Small budget, limited IT infrastructure, basic digital services	Berghaus & Back, 2016; De Carolis et al., 2017; Westerman et al., 2012
Middle (1)	Experimenting with digitalization	Internal communication or service processes	Emerging technology experimentation	Additional resources, time, and budget allocated	Variety of industries, overlooking digitalization, prioritizing existing production and governance	Berghaus & Back, 2016; De Carolis et al., 2017; Remane et al., 2017
Middle (2)	Affected by digitalization	Customer relations, general technological progress	Digital improvement of internal processes	Additional resources, time, and budget allocated	Variety of industries, experimenting, prioritizing existing corporate culture	Avlonitis et al., 2001; Lynch et al., 2010; Westerman et al., 2012
Middle (3)	Gradual digital transformation	Building digital capabilities	Systematic digital innovation	Growing investment in digital initiatives	Developing digital capabilities, building foundations for digital transformation	Teece, 2010; Zott & Amit, 2017; Williams, Schallmo & Lang, 2019
Middle (4)	Early stage of digitalization	Enhancing customer experience	Customer-centric digital initiatives	Moderate IT budget	Improved customer interactions, focus on customer satisfaction	Ochoa-Urrego & Peña, 2021; Teichert, 2019; Van-Boskirk & Gill, 2016
Middle (5)	Integrating digital processes	Operational efficiency and innovation	Integration of digital technologies in core processes	Increased budget for digital technologies	Process optimization, data-driven decision making	Valdez-de-Leon, 2016; Casadesus-Masanell & Zhu, 2013; Thordsen et al., 2020
Final	Data-driven, digitally transformed organizations	Users and customers, data utilization	Advanced data analytics, solid technology infrastructure	High IT budget	Advanced analytics, skilled employees, data governance, high innovativeness	Becker et al., 2018; De Carolis et al., 2017; Westerman et al., 2012

discussed the adoption of distinct digital technologies, a broader, more comprehensive analysis, particularly regarding SMEs, has been somewhat overlooked (Abebe, 2014; Eller et al., 2020; Ghobakhloo & Ching, 2019). Larger organizations, with expansive resource pools, often find themselves at the forefront of adopting sophisticated digital solutions (Bajwa et al., 2008; Clohessy & Acton, 2019; Saldanha & Krishnan, 2012). In contrast, SMEs, despite their agility and adaptability, seem to take a more conservative stance, often attributed to their resource limitations (Aldrich & Auster, 1986; Hausman, 2005). Delving deeper into literature, Yoo, Boland, Lyytinen, and Majchrzak (2012) highlighted the transformative potential of digital technologies when integrated effectively, emphasizing the role of organizational learning. Organizations, even when equipped with similar digital tools, manifest differential performance based on their learning capacities and experiences (Yoo, Boland, Lyytinen, & Majchrzak, 2012). This perspective underscores the importance of an organization's position on the digital maturity spectrum and its relation to innovation. Bearing this backdrop in mind, and to provide a more nuanced understanding, we hypothesize the following:

H_1 *Digital transformation is positively associated with the propensity for innovation within SMEs.*

While the above hypothesis captures the general innovation propensity within SMEs through digital transformation, it's equally crucial to zoom into the nature of such innovations. Specifically, the capacity for SMEs to engage in radical innovation, which implies not just incremental adjustments but profound market-shifting changes (OECD & Eurostat, 2018). In the field of innovation research, an organization's push towards establishing and retaining a competitive edge is often achieved by adopting avant-garde operational methodologies (Coccia, 2017). In this context, radical innovations often emerge as a byproduct of integrating new technologies and reconfiguring existing resources (Autio et al., 2018).

SMEs, with their innate agility, have shown the capability to merge their technological resources with external innovations, giving birth to unique value propositions (Ato Sarsah,

Tian, Dogbe, Bamfo, & Pomegbe, 2020). At the heart of this innovation drive is the notion of digital affordances. As outlined by Autio et al. (2018), digital affordances are rooted in the technical architecture of digital infrastructures, enabling a broad restructuring of value creation, delivery, and capture processes across the economy. These emerge from mature digital transformation stages, allowing organizations to redefine and innovate across various value dimensions building digital capabilities (Autio et al., 2018; Bohnsack, Kurtz, & Hanelt, 2021). Distinctly, two core characteristics define digital capabilities: convergence and generativity (Yoo, Boland, Lyytinen, & Majchrzak, 2012). Convergence allows for a blend of digital and analog resources, while generativity paves the way for integrating new digital assets, potentially leading to market disruptions and radical innovations for SMEs deeply engaged in the digital transformation process (Qin, van der Rhee, Venkataraman, & Ahmadi, 2021; Yoo, Boland, Lyytinen, & Majchrzak, 2012).

Drawing from this, it's evident that SMEs undergoing advanced digital transformation are poised to usher in market revolutions by fully leveraging the advantages of digital technologies (Kroh, Luetjen, Globocnik, & Schultz, 2018). Thus, given the potential of digital affordances and the agility of SMEs, we hypothesize:

H_2 *Advanced stages of digital transformation in SMEs amplify the propensity for radical innovation.*

3.3 Data and Methodology

3.3.1 Conceptual Framework

At the core of our research lies the relationship between digital transformation and innovation output in SMEs. Digital maturity, conceptualized through the adoption and intensity of digital technology usage, serves as an estimator of digital transformation progress, and acts as our primary independent variable. Innovation output, categorized into product, process, market, and organizational innovations, serves as the dependent variable. Interplaying with these are several control variables, including factors like absorptive capacity

and internationalization, which are known to influence innovation. The overarching aim is to unravel the intricate interconnections between digital transformation and innovative activities in SMEs.

3.3.2 Sample

We empirically test our hypotheses by using a firm-level dataset. The data for this study originates from the Mannheim Innovation Panel (MIP) of the Leibniz Centre for European Economic Research (ZEW). The panel is composed of an annual survey (stratified sampling design method) of the innovation behaviors of German organizations, similar to other, widely used community innovation surveys (Aschhoff et al., 2013). The stratified sampling design was chosen as it allows for better representation across various categories of organizations, ensuring that specific sub-groups within the population are adequately represented in the sample. We extract our sample from the two waves of the survey (2016 and 2019), as the information about the adoption of digital technologies in organizations was only available in the survey of 2016. We use the SME definition of the European Union (European Commission, 2003) to structure our sample. We obtain a sample of 1,077 SMEs after removing inconsistent, incomplete, and missing observations.

The sample contains both, industrial and geographically diverse SMEs. In terms of industry, most of the SMEs in our sample are from the manufacturing industry (60%), whereas around 40 percent are from the service industry. The distribution shows that our sample SMEs are active in 21 industrial sectors. We do not observe any extreme outliers regarding the industrial distribution. Most of the SMEs are from the industrial sectors of energy/water (8.45%), technical services/R&D services (8.36%), consulting/advertising (8.36%) and transport equipment/postal service (8.17%). The fewest of our sample SMEs are from the industrial sectors of retail/automobile (1.11%) and glass/ceramic (2.14%). In geographical terms, 64.71 percent of our sample SMEs (697 SMEs) originate in the former West Germany, whereas 35.28 percent (380 SMEs) are from the former East Germany. This geographical division is consistent with the historical aspect of the German economy, where former West-Germany dominates the economic activities in the country.

3.3.3 Variables

Dependent Variables

A complete list of variables, their measurements and types is provided in Table 3.2. Our dataset contains information about the product, process, organizational and market innovations in our sample SMEs in the reference periods.

A product innovation is defined as any new or significantly improved product (improved in terms of components, features, software etc.). A process innovation corresponds to a new or significantly improved business procedure, method or process that exerts a noticeable improvement in business processes (e.g., manufacturing, production, distribution, quality etc.). A market innovation is defined as any new marketing method (new to the organization) or strategy in an organization (e.g., new packaging, delivery mechanisms, promotion activities etc.). An organizational innovation refers to new strategic business practices (e.g., new workplace management/organization method, new information management method/strategy, new networking strategy etc.). In addition, our dataset includes information about the radical innovation activities of our sample SMEs. A radical innovation in our survey is defined as the introduction of radically new products to the market (market novelties) in the reference period.

Innovation performance: We use overall innovation output as an indicator of innovation performance in our dataset (hypothesis 1). The variable innovation output is a categorical indicator (0-4), where 0 corresponds to no innovation, whereas 4 indicates four types of innovations (product, process, market and organizational) in 2019. The choice of utilizing a composite score of innovation output is grounded in the literature that emphasizes capturing the holistic innovative performance of organizations rather than focusing on a singular dimension (Crossan & Apaydin, 2010). The distribution of our sample SMEs regarding their innovation output is presented in Table 3.3. Almost half of our sample SMEs (49.95%) did not report any innovation, whereas 82 (7.61%) are highly innovative. Further, 89 SMEs (8.26%) reported to have conducted radical innovation in the reference period.

Table 3.2: List of Variables

Variable	**Definition**	**Type**
Innovation Output	Indicator of innovation performance. Scale (0-4): 0: no innovation output, 4: 4 types of innovation (very high innovation output)	Categorical
Technological Innovation	Indicator of product and process innovation performance. Scale (0-2): 0: no innovation, 1. product or process innovation and, 2: both product and process innovations	Categorical
Non-Technological Innovation	Indicator of organizational and market innovation performance. Scale: 0: No innovation, 1. organizational or market innovation, and 2: both organizational and market innovations	Categorical
Radical Innovation	Indicator of market novelties introduced by an SME. Scale (0-1): 0: no and 1: yes	Binary
Digital Maturity	Indicator of the level of digital transformation of an SME. Scale (0-3): 0: Level 0, 1: Level 1, 2: Level 2 and 3: Level 3	Categorical
Level 0	Binary group variable. Scale: 1: firm belongs to level 0 (early-digital), 0: otherwise	Binary
Level 1	Binary group variable. Scale: 1: firm belongs to level 1 (lagging), 0: otherwise	Binary
Level 2	Binary group variable. Scale: 1: firm belongs to level 2 (experimental), 0: otherwise	Binary
Level 3	Binary group variable. Scale: 1: firm belongs to level 3 (advanced), 0: otherwise	Binary
R&D Intensity	Percentage share of R&D expenditures to total sales	Continuous
Quality of Human Capital	Share of average number of employees with a graduate degree	Continuous
Internationalization	Export intensity as export to sale ratio	Continuous
SME Size	Total number of employees	Continuous
Location	SME location in the former East or West Germany (1: West Germany, 0: East Germany)	Binary
Industry Dummies	Dummy variables for industrial sectors	Binary

Table 3.3: Innovation Output of the Sample SMEs

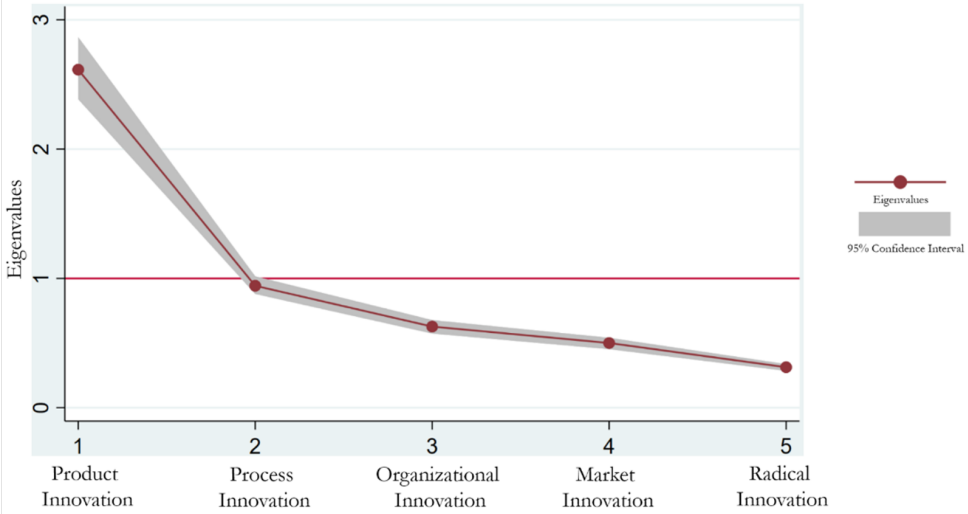
Innovation Output	**Frequency**	**Percentage**
No Innovation	538	49.95%
Low Innovation	150	13.93%
Medium Innovation	165	15.32%
High Innovation	142	13.18%
Very High Innovation	82	7.61%
Total	1,077	100%

The literature within innovation studies has predominantly emphasized technology-centric innovations, specifically product and process innovations. Contrastingly, market and organizational innovations have been relatively under-researched (Hagedoorn & Cloodt, 2003; Hipp & Grupp, 2005; Prajogo & Ahmed, 2006). Recognizing this, our study initiates a principal component analysis (PCA) encompassing all four types of innovations: product, process, market, and organizational. This comprehensive approach is portrayed in Figure 3.1, which showcases a Scree plot of the eigenvalues of principal components for these innovations. The PCA outcomes ($KMO : 0.7376, \alpha = 0.00$) underscore that product and process innovations account for the most substantial variance. Therefore, it is crucial for our subsequent analysis whether the influence of the digital maturity level differs between technological (product and process) and non-technological (market and organizational) innovations in order to enable a more differentiated analysis compared to the overarching variable of innovation output. For delineation, we employ two indicators: technological innovation, which encapsulates both product and process innovations on a scale from 0 (no innovations), 1 (product- or process innovation) and 2 (both, product- and process innovation), and non-technological innovation, which covers market and organizational innovations, also on a scale from 0 to 2. Additionally, we observe radical innovation as a binary measure of market novelties, to investigate our second hypothesis.

Explanatory Variables

Digital Maturity: Unlike previous studies, which focused only on internet and communication technologies our dataset includes information about the usage intensity of eleven types of digital technologies, presented in Table 3.4. The incorporation of a broader range

Figure 3.1: Scree Plot of the Eigenvalues of Principal Components



of digital technologies aims to capture a more comprehensive perspective on digital maturity, reflecting the evolving landscape of digitalization (Bharadwaj et al., 2013). In the dataset, each of the digital technology variables is a categorical variable that indicates the intensity of usage in a responding organization on a four-point scale: no usage (0) to very high usage (4). The information is also consistent and adequate for our analysis as the scale reliability coefficient (Cronbach's α) of 11 items of digital technologies is at 0.8942 and Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is at 0.885.

Table 3.4: Digital Technology Types in the Data

Technology	**Description**
T1	Digital interconnection within production / services
T2	Digital interconnection between production / service provision and logistics
T3	Digital interconnection with customers
T4	Digital interconnection with suppliers
T5	Teleworking
T6	Software-based communication (e.g., Skype)
T7	Intranet-based platforms (e.g., Wikis)
T8	E-Commerce
T9	Social media (e.g., Facebook, Twitter)
T10	Cloud computing / cloud applications
T11	Big data analysis

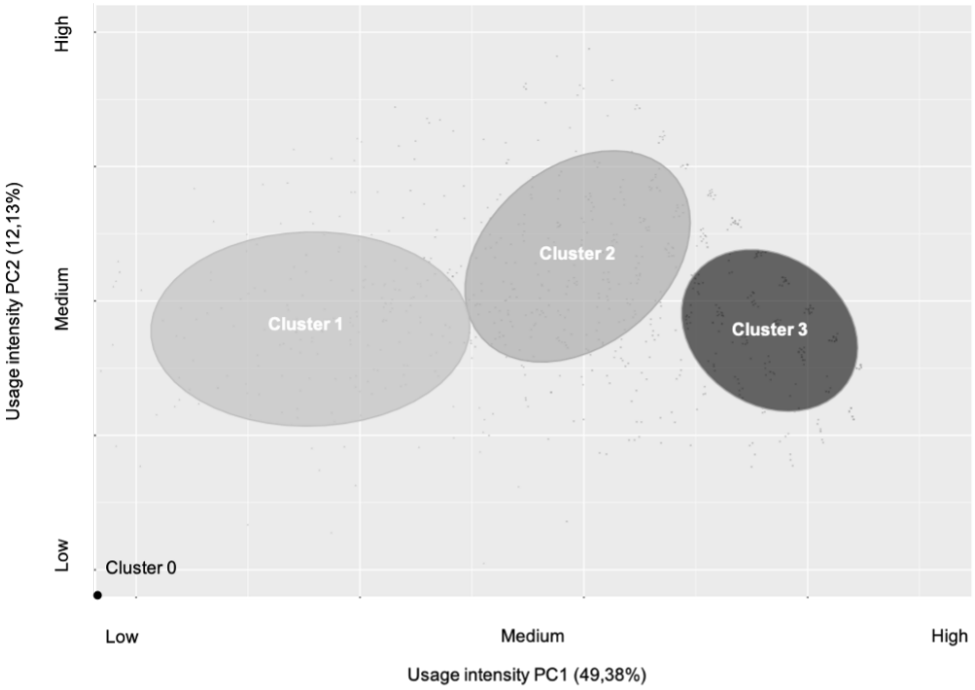
Using the dataset information pertaining to the usage intensity of digital technologies, we derive the digital maturity level of the sample SMEs and use it as an indicator of digital

transformation. The rationale behind the two-step process is to first identify distinct groups based on their digital technology adoption patterns and then categorize them into meaningful maturity levels. This variable is created in two steps. First, we perform a cluster analysis to identify the specific digital maturity stages in our sample. Following the results of the cluster analysis, we create a 4-level categorical indicator of digital maturity and group variables for each cluster.

A cluster analysis entails a set of techniques to identify groups of observations within a dataset. Clustering includes the grouping of observations with a maximum of similarity (high intra-class similarity) while holding the observations across different groups to a maximum of dissimilarity (low inter-class similarity) (Kaufman & Rousseeuw, 2005). Before conducting the analysis, we excluded SMEs that reported no usage of all eleven digital technologies from the subset. Those SMEs were assigned to level 0 of digital maturity serving as a base level in the further analysis of the whole dataset to mitigate the issue of sample selection bias.

We apply the k-means cluster technique to specify observations for each possible cluster. The idea behind the k-means method is to define clusters or groups under the condition that the total intra-cluster variation is minimized. To identify and obtain the optimal number of clusters, we conducted the Elbow method (Kodinariya & Makwana, 2013), Silhouette method (Kodinariya & Makwana, 2013) and Gap method (Tibshirani, Walther, & Hastie, 2001). Subsequently, we obtain three delineated clusters with increasing usage intensity and adoption of digital technologies. The results of our main cluster analysis are presented in Figure 3.2, whereas cluster classifications about individual digital technologies are provided in Figures 1A, 2A and 2B (in the Annex).

Figure 3.2: Cluster Analysis of Digital Technology Adoption and Usage Intensity for Eleven Digital Technologies in SMEs (Own Computation)



The results of the cluster analysis support the proposition that the one-dimensional consideration of digital maturity is comparable to holistic models and underlies a systematic path of digital maturity. By using cluster analysis, we identify 4 levels of digital maturity in our sample: 1) Early-digital - (Level 0), 2) Lagging - (Level 1), 3) Experimental - (Level 2), and 4) Advanced SMEs (Level 3) that are used as estimators for the degree of digital transformation in SMEs. Table 3.5 presents the sample distribution of our sample SMEs according to their digital maturity classification.

Table 3.5: Allocation of SMEs per Digital Maturity Level within the Sample

Cluster	**Digital Maturity Level**	**Frequency**	**Percentage**
Base Level	Level 0: Early-digital SMEs	142	13.18%
Cluster 1	Level 1: Lagging SMEs	354	32.87%
Cluster 2	Level 2: Experimental SMEs	373	34.63%
Cluster 3	Level 3: Advanced SMEs	208	19.31%
Total		1,077	100%

Control Variables

The literature has identified several factors that could otherwise influence the innovation performance of SMEs. We control for absorptive capacity (R&D intensity) (Scuotto et al., 2017), quality of human capital (Laursen, 2002) and the internationalization (Wolff & Pett, 2000) of our sample SMEs. The inclusion of these control variables is based on the established understanding that innovation is influenced by a myriad of internal and external factors (Cohen & Levinthal, 1990). Further, we control for, size, location, and industrial sector of the sample (refer to Table 3.2 for a detailed description of their proxies) (Rosenbusch, Brinckmann, & Bausch, 2011).

3.4 Results

3.4.1 Descriptive Statistics and Univariate Analysis

Summary statistics of our key dependent and independent variable are presented in Table 3.6. We further compute the variance inflation factor (VIF) to test for multicollinearity. The mean VIF value of 1.22 suggests that the model does not suffer with any serious multicollinearity issue (Agresti, 2007).

Table 3.6: Summary Statistics

Variable	N	Mean	Std. Deviation	Min.	Max.
Innovation Output	1,077	1.14577	1.358613	0	4
Radical Innovation	1,077	.082637	.2754606	0	1
Technological Innovation	1,077	.744661	.8241148	0	2
Non-Technological Innovation	1,077	.401114	.6753208	0	2
Digital Maturity	1,077	1.59981	.9428463	0	3
Level 0	1,077	.131847	.3384823	0	1
Level 1	1,077	.328690	.4699556	0	1
Level 2	1,077	.347260	.4763207	0	1
Level 3	1,077	.192200	.3942129	0	1
R&D Intensity	1,077	.010178	.0317448	0	.15
Quality of Human Capital (stand.)	1,077	.445979	.3417327	0.0	1.0
Internationalization (stand.)	1,077	.301564	.3754332	0.0	1.0
Size (stand.)	1,077	-.043128	.9300285	-0.766	4.196
Location	1,077	.352831	.4780730	0	1

Before running the main estimation models, a Chi-Square test for the goodness of fit between the key dependent and explanatory variables is conducted. The results are reported in Table 3.7. A significant p-value suggests that the sample data is consistent with our proposition and there is a statistically significant relationship between digital maturity and innovation.

Table 3.7: Univariate Analysis of the Relationship between Digital Maturity and Innovation Performance

Digital Maturity Levels	**Level 0**	**Level 1**	**Level 2**	**Level 3**
Innovation Performance	13.18%	32.87%	34.73%	19.22%
Chi-Square Test of Independence				
Pearson Chi2=125.32***, Likelihood-ratio Chi2=130.21***, Cramer's V(df:12)=0.1969***				
* p ¡ 0.1, ** p ¡ 0.05, *** p ¡ 0.01				

3.4.2 Estimation Results

Our initial effort sought to understand the impact of digital maturity, both on a holistic level and when broken down into individual maturity levels, on a trio of outcomes: innovation output, technological innovation, and non-technological innovation (as depicted in Models 1, 2, and 3). In a subsequent step, with an aim to elucidate the influence of the explanatory variables on radical innovation outcomes, we turned to the logit estimation technique (reflected in Model 4). The entirety of these results can be gleaned from Table 3.8.

Upon examining Model 1, it's clear that digital maturity, our primary explanatory variable, establishes a positive and significant stance ($\beta = 0.422, p < 0.001$). This evidence substantiates our first hypothesis (H1), reinforcing the notion that enhanced digital transformation – as reflected by advancements in stages of digital maturity – correlates with elevated innovation performance within SMEs. Further exploration into Models 2 and 3 reveals a consistent theme; digital maturity holds a positive and significant sway for both

technological and non-technological innovations.

Zooming into the individual maturity benchmarks, distinct patterns emerge. Early adopters, or Level 0 SMEs, register negative and significant coefficients across the first three models. In contrast, Level 1 SMEs, despite being behind the curve, display a modest influence, but this significance is confined to non-technological innovation. Moving up the maturity ladder, both Level 2 and Level 3 SMEs stand out with their pronounced positive impacts across all facets of innovation.

Pivoting to our second hypothesis (H2), our analysis reveals that digital maturity has a positive and robust relationship with radical innovation outcomes ($\beta = 0.529, p < 0.01$), validating the supposition that embracing digital transformation amplifies the propensity for groundbreaking innovations. Nonetheless, when dissected at the granularity of individual maturity levels, it's evident that only Level 3 or advanced SMEs have the prowess to create market novelties. Such insights accentuate the pitfalls of remaining non-digital or being in the nascent stages of digital adoption, particularly concerning innovation outcomes. Conversely, SMEs that are further along the digital maturity spectrum, especially those labeled as experimental or advanced, harness their digital acumen to its fullest, leading to significantly enriched innovation outputs. It's worth noting that this prowess is so profound among advanced SMEs that they emerge as the sole contenders for radical innovation. Contrary to initial expectations, our sample doesn't manifest any pronounced biases towards either form of innovation – technological or non-technological.

Finally, shifting focus to the control variables, a few patterns warrant mention. While R&D intensity emerges as a potent catalyst for innovation, SMEs with international footprints generally showcase an elevated inclination towards innovation, although this trend falters slightly in the non-technological segment. In a somewhat counter-intuitive observation, there appears to be an inverse relationship between the size of an SME and its propensity for radical innovations, hinting at the possibility that smaller enterprises possess a unique agility that empowers them to pioneer market novelties.

Table 3.8: Ordered Logit Estimation – Digital Maturity and SME Innovation Performance

	Model 1	Model 2	Model 3	Model 4
Dependent Variable	Innovation Output	Technological Innovation	Non-Tech. Innovation	Radical Innovation
Digital Maturity	0.422***	0.425***	0.398***	0.529**
	(0.0713)	(0.0744)	(0.0851)	(0.167)
Level 0	-0.747***	-0.680**	-0.937**	-0.741
(Early-digital (Base))	(0.207)	(0.210)	(0.291)	(0.632)
Level 1	0.405	0.341	0.626*	0.176
(Lagging SMEs)	(0.221)	(0.224)	(0.307)	(0.679)
Level 2	0.990***	0.921***	1.138***	0.934
(Experimental SMEs)	(0.222)	(0.226)	(0.304)	(0.648)
Level 3	1.199***	1.172***	1.294***	1.361*
(Advanced SMEs)	(0.245)	(0.254)	(0.325)	(0.667)
R&D	2.091***	2.703***	1.308***	2.927***
	(0.204)	(0.232)	(0.218)	(0.390)
Quality of Human Capital	0.0685	0.00351	0.260	-0.903
	(0.203)	(0.208)	(0.243)	(0.508)
Internationalization	0.374*	0.461*	0.290	0.898*
	(0.186)	(0.193)	(0.217)	(0.406)
Size	0.109	0.0400	0.138	-0.287*
	(0.0664)	(0.0709)	(0.0746)	(0.132)
Location	-0.245	-0.221	-0.202	0.0676
	(0.130)	(0.137)	(0.153)	(0.273)
Industry Dummies	-0.0907	-0.119	-0.0799	
	(0.135)	(0.140)	(0.161)	
N	1,077	1,077	1,077	1,077
Chi2	296.32***	345.53***	152.30***	168.24***
Prob¿ Chi2	0.000	0.000	0.000	0.000
Log Likelihood	-1329.764	-948.81	-784.034	-222.99
McFadden R2	0.1010	0.1543	0.0886	0.1003

Standard errors in parentheses, $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

3.5 Discussion

3.5.1 Theoretical Implications

Our research delves into the nexus between digital transformation and innovation performance within SMEs, using a dataset from German enterprises. Two primary contributions emerge: firstly, by employing cluster analysis, we offer a tangible metric for digital transformation, bridging a noted gap in empirical studies. Secondly, we empirically underscore the interplay between digital transformation and varied facets of innovation performance.

Our study provides a clear reflection of digital transformation within organizations through their digital maturity levels. By developing a quantitative measure of digital maturity, we provide a lens for understanding where an organization stands on its digital transformation journey, complementing the findings of Westerman et al. (2012). We propose a streamlined maturity path focused on digital technologies that harmonizes well with established holistic maturity models (Berghaus & Back, 2016; De Carolis et al., 2017; Remane et al., 2017; Valdez-de Leon, 2016; VanBoskirk & Gill, 2016; Westerman et al., 2012). By anchoring the adoption of digital technologies and their intensity of use, we provide a nuanced means to probe the depth of an organization's digital metamorphosis. This perspective simplifies the complex nature of digital transformation metrics, paves the way for new empirical research, and fills empirical gaps identified in Thordsen et al. (2020).

Leveraging a novel measure of digital transformation, our study delves into its correlation with SMEs' innovation performance. Empirically, we find that digital transformation significantly influences the innovation propensity of SMEs, even when accounting for traditional innovation sources (Casadesus-Masanell & Zhu, 2013; Hong, Oxley, McCann, & Le, 2016; Koellinger, 2008). This supports the notion that digital transformation can bolster innovation in SMEs (Morikawa, 2004; Nambisan et al., 2017; Yoo, Boland, Lyytinen, & Majchrzak, 2012). Moreover, our findings suggest that such transformation can be a competitive edge, with digitally advanced SMEs leaning more towards radical

innovations (Tushman & O'Reilly, 1996; Dooley, Subra, & Anderson, 2001; Westerman et al., 2012). This advantage stems from their adeptness at harnessing digital technologies to merge both internal and external information, fostering novel insights and products (Nambisan et al., 2017).

Interestingly, our results indicate a dichotomy in innovation outcomes based on the degree of digital transformation. SMEs with a robust digital presence are more likely to innovate, while those with minimal digital engagement face potential innovation setbacks. This underscores the urgency for SMEs to embrace digital maturity, especially given the disruptive digital landscape. It's worth noting that SMEs in the nascent stages of digital transformation often lack the infrastructure and know-how to fully exploit digital opportunities (Fabrizio, 2009; Kastelli et al., 2022; Kroh et al., 2018; Yoo, Boland, Lyytinen, & Majchrzak, 2012).

Furthermore, our empirical findings reveal that SMEs at the lagging level of digital transformation witness negligible effects on their innovation endeavors, with the exception of non-technological innovation. Such SMEs typically engage with just the essential digital technologies, either to maintain operations or due to external pressures (Egan et al., 2003). Their approach to digital technology doesn't seem strategic, often not leveraging it for novel value or knowledge creation. This aligns with literature that portrays early digital maturity stages as a period of digital enhancement without a clear focus on pivotal technologies (Avlonitis et al., 2001; Berghaus & Back, 2016; Westerman et al., 2012). Notably, while these SMEs might not see immediate returns in technological innovations, their digital efforts appear to favor non-technological innovations, particularly in market and organizational realms. This suggests that even basic digital engagements, such as digital interconnections across various business facets, can offer tangible benefits in non-technological domains.

SMEs at both the experimental and advanced stages of digital transformation tend to exhibit enhanced innovation performance across all metrics. The pivotal moment, where digital transformation begins to positively influence innovation, is discernible at the shift from the initial to the subsequent stage of digital transformation. Specifically, SMEs in

the experimental phase show a pronounced engagement in digital interconnections spanning production, logistics, customers, and suppliers compared to their lagging counterparts. Their adoption and utilization of information technologies, such as teleworking and software-based communication, surpass that of lagging SMEs. However, broader internet technologies like e-commerce and cloud computing see limited adoption at both stages.

The pronounced impact of digital transformation on SMEs' innovation performance at the advanced stage aligns with holistic digital maturity models. Intense technology usage is believed to catalyze innovation opportunities (Casadesus-Masanell & Zhu, 2013), thereby amplifying the likelihood of SMEs being innovative. Interestingly, our findings reveal no discernible difference between SMEs at the experimental and advanced stages in this context. This suggests that while basic engagement with technologies like teleworking and e-commerce might be essential, a deeper integration of business process technologies, such as digital interconnections across production and logistics, can significantly boost innovation performance. However, an overly intricate adoption of digital technologies might offer only incremental innovation benefits. This underscores that a strategic and efficient digital technology adoption is pivotal for SMEs aiming for elevated innovation outcomes.

A standout observation is that only SMEs at the pinnacle of digital transformation can foster radical innovations. These leading SMEs extensively integrate a spectrum of technologies, from teleworking to big data analysis, into their operations. While there's no marked difference between SMEs at the experimental and advanced stages in terms of general innovation output, achieving radical innovation appears contingent on reaching the zenith of digital maturity. Such SMEs, by adeptly leveraging digital technologies, position themselves as pioneers in introducing market innovations (Nambisan et al., 2017, 2019; Yoo, Boland, Lyytinen, & Majchrzak, 2012).

3.5.2 Practical Implications

Our research offers actionable insights for SMEs aiming to harness the power of digital transformation to bolster their innovation performance. Grounded in empirical evidence,

these insights provide a roadmap for SMEs to navigate the digital landscape effectively. One of the primary takeaways from our study is the pivotal role of digital transformation in enhancing innovation capabilities. SMEs, irrespective of their current digital maturity, should strategically prioritize digital transformation. Our findings underscore that even incremental advancements in technology adoption and usage intensity can significantly elevate innovation performance. This, in turn, equips SMEs with the tools to outpace competitors in dynamic markets, echoing the sentiments of Casadesus-Masanell and Zhu (2013).

Moreover, our research emphasizes that the depth of digital technology engagement trumps sheer breadth. Rather than indiscriminately adopting a plethora of digital tools, SMEs should aim for meaningful integration of select technologies. By evaluating their current digital maturity and setting sights on ascending to digitally advanced stages, SMEs can maximize returns on their digital investments. Specifically, reaching the experimental stage of digital transformation emerges as a critical milestone. Initial investments in foundational digital technologies, particularly those related to digital interconnections across various business facets, can set the stage for enhanced innovation outcomes. This perspective aligns with the insights of Westerman et al. (2012), highlighting the importance of strategic digital technology adoption.

For SMEs with ambitions of spearheading radical innovations, our study offers a clear directive: a deep-seated commitment to the digital transformation journey is non-negotiable. Technologies like cloud computing, big data, and social media stand out as catalysts for radical innovation (Nambisan et al., 2017). While progressing to the advanced stage of digital transformation demands substantial resource allocation and time, the potential rewards in terms of market leadership and innovation can be transformative. SMEs should, however, balance their aspirations with a pragmatic assessment of the associated costs and benefits. For those poised to champion radical innovation, a well-orchestrated strategy encompassing cloud computing, big data, and social media can carve out a distinct competitive edge.

3.6 Limitations and Future Research Implications

Our study, while offering a comprehensive exploration of digital transformation within SMEs in Germany, acknowledges certain limitations. The geographical focus on Germany might restrict the generalizability of our findings to other regions with distinct economic, legal, and cultural environments. However, this specific focus provides a detailed understanding of digital transformation in a well-defined context, serving as a benchmark for other regions given Germany's advanced digital infrastructure and SME ecosystem. Building on this foundation, future research could expand the geographical scope, comparing findings across different contexts (Westerman et al., 2012).

A further consideration is our use of a dataset that, in light of rapid technological advancements, may be viewed as less current. While technology's rapid evolution might make some data seem less current, capturing the essence of digital transformation at a specific point in time offers invaluable historical insights. This "snapshot" approach aids in understanding the trajectory of digital transformation in SMEs. As emphasized by Casadesus-Masanell and Zhu (2013) and Nambisan et al. (2017), future endeavors should leverage more recent datasets to capture the nuances of contemporary digital transformation trends.

Lastly, while our dataset provides a broad perspective on innovation practices in SMEs, it doesn't incorporate exhaustive measures of innovation performance, such as patent data. However, focusing on diverse innovation indicators beyond just patents offers a holistic understanding of innovation in SMEs (Yoo, Boland, Lyytinen, & Majchrzak, 2012). Future research could benefit from incorporating patent data alongside other innovation measures, ensuring a multi-faceted view of the digital transformation's impact on innovation (Kroh et al., 2018).

3.7 Conclusion

Our research delves deep into the intricate relationship between digital transformation and innovation within SMEs, addressing the previously identified gaps in the literature. One of the primary challenges in this domain has been the absence of a universally accepted definition of digital transformation and the intricacies of digital maturity models. Our study, by introducing a one-dimensional measure of digital maturity, offers a nuanced lens to gauge an organization's progress in its digital transformation journey. This measure, emphasizing both the quality and quantity of digital technology use, serves as a robust estimator, capturing the multifaceted nature of digital transformation. Utilizing cluster analysis techniques on a sample of 1,077 German SMEs, we compared the state of digital transformation against varied facets of SME innovation performance, offering insights into technological, non-technological, and radical innovation.

Our findings extend beyond the generic understanding of the digital transformation-innovation nexus. While we reaffirm the overarching sentiment that heightened digital transformation correlates with superior innovation performance, our study unravels the nuances within this relationship. Notably, SMEs that have reached an advanced stage of digital transformation exhibit a unique capability: they can spearhead radical innovations. This is attributed to their proficiency in synergizing both internal and external information streams, thereby fostering novel value and knowledge creation. Furthermore, our research underscores a pivotal insight: the depth of engagement with digital technologies is more consequential than the sheer breadth of technologies adopted. This revelation is instrumental for SMEs, guiding them to prioritize meaningful integration of digital tools over indiscriminate adoption.

In essence, our study not only bridges existing gaps in the literature but also offers tangible guidance for SMEs. By prioritizing and strategically navigating their digital transformation journey, SMEs can significantly bolster their innovation prowess, fortifying their competitive stance in today's volatile business landscape.

Chapter 4

Keeping Pace with the Digitalization – Exploring the U-Shaped Relationship between Digital Orientation and Performance in SMEs

Keeping Pace with the Digitalization – *Exploring the U-Shaped Relationship between Digital Orientation and Performance in SMEs*

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Abstract

In the digital era, organizations strategically embrace digital transformation to thrive amidst disruption. Particularly, they invest heavily in strategies rooted in their digital orientation. Yet, research scarcely delves into how digital orientation influences SME performance. This study illuminates this relationship by quantifying digital orientation and its facets using textual website data and assessing its impact on SME performance through quadratic regression. The results reveal a U-shaped relationship: while high performance is evident at both spectrum ends, an initial increase in digital orientation correlates with performance dips until a specific digital orientation level is reached, after which performance rises. This novel approach to gauging digital orientation in SMEs enhances our comprehension of its interplay with performance. Consequently, SMEs should adopt a holistic digital transformation perspective, anticipating short-term performance setbacks due to upfront investments.

Keywords: Digital Orientation – Performance – SMEs – CATA – U-Shape

4.1 Introduction

In the course of digitalization, the strategic orientation of an SME towards digital transformation is a decisive factor for long-term performance. Digital transformation is a superordinate construct that inherits multiple other constructs such as digital orientation, strategy, and technology adoption (Kindermann et al., 2021; Vial, 2019). In general, digital transformation can be understood as the various strategic postures concerning technology adoption and the resulting organizational changes (Gobble, 2018; Yoo, Boland, Lyytinen, & Majchrzak, 2012). The continued emergence of new digital technologies and the inherent disruptive organizational changes sparked academic interest in the relationship between digital transformation and organizational performance. There is growing evidence that digital transformation is increasingly important for an organization's competitive advantage (Guo & Xu, 2021; Añón Higón & Bonvin, 2023; Nambisan et al., 2017; Schiuma, Schettini, Santarsiero, & Carlucci, 2022). The impact on the competitive advantage of organizations is manifold as digital transformation can lead to increased financial performance, efficiency, customer satisfaction, and loyalty (Autio et al., 2018; Eller et al., 2020; Rachinger et al., 2019). Recently, the investigation of the subordinate constructs of digital transformation gained interest in research. In this regard the construct of digital orientation emerged as a nascent strategic orientation towards digital transformation. This new strategic orientation is rooted in the strategic alignment model (Henderson & Venkatraman, 1999) and represents the extent to which companies adapt their business strategy to digital aspects (Kindermann et al., 2021). The alignment is characterized by the synthesis of organizational processes and structures and the integration and usage of digital technologies (Leonardi, 2011).

However, insights on the role of digital orientation with regard to organizational performance are sparse and inconclusive. Currently, both no relation (Nasiri et al., 2022) and a positive relation (Kindermann et al., 2021) between digital orientation and organizational

performance have been found in academic research. SMEs, despite their national and global importance for the economy, are mostly not examined in this regard (L. Li, Su, Zhang, & Mao, 2018; Verhoef et al., 2021; Vial, 2019). Yet, studies show that within the process of digital transformation SMEs appear to be less advanced compared to their larger counterparts (Eller et al., 2020). Considering the continuous evolution of the digitalization paradigm, the identified lag of SMEs within the digital transformation process poses a potential threat, given the role of SMEs in national and global economies. Despite the potential challenges, digital orientation can offer significant benefits for SMEs. For instance, digital technologies can streamline operations, improve customer service, and open up new market opportunities, even for businesses involved in hands-on activities like SMEs (Bharadwaj et al., 2013; Mithas, Tafti, Bardhan, & Goh, 2012). Moreover, digital orientation can enable SMEs to adapt more quickly to changes in their business environment, enhancing their resilience and competitiveness (Bharadwaj et al., 2013; Hess et al., 2016; Nambisan et al., 2017). However, achieving these benefits often requires SMEs to overcome significant hurdles, such as the initial costs of digital transformation and the need to develop new skills and capabilities (Besson & Rowe, 2012; Hess et al., 2016; Ulas, 2019). These challenges can be particularly acute for smaller enterprises, which may lack the resources of their larger counterparts (Aldrich & Auster, 1986; Laforet, 2008; OECD, 2017). Therefore, understanding the relationship between digital orientation and SME performance, and identifying strategies to support SMEs in their digital transformation journey, is of utmost importance (Kindermann et al., 2021; Nasiri et al., 2022; Vial, 2019).

Consequently, the purpose of this paper is to shed light on the relationship between digital orientation and SME performance. Thereby, we aim to answer the research question whether digital orientation has an impact on SME performance. To adequately answer this question, we collected a dataset from 1,135 SMEs, which contains both quantitative (financial information) and qualitative (website-text data) information. This approach helps to avoid common data bias through the use of data triangulation (Jick, 1979). Our results show that digital orientation neither promotes nor reduces organizational performance linearly in the sample. However, we found that the impact of digital orientation

and certain subdimensions on SME performance follows a U-shaped relationship. This implies that the initial phase of digital orientation is accompanied by a decline in performance. In the subsequent phase, the trough of performance decline is reached, and the performance benefits start to exceed costs, resulting in a competitive advantage for SMEs. Consequently, this study contributes to the explanation of why some SMEs avoided or stopped the strategic initialization of the digital transformation process considering the initially negative effects on organizational performance. More specifically, this study suggests that SMEs need to pay more attention to the long-term prospects associated with digital orientation, as the initial negative effect is reversed after reaching a certain threshold, leading to superior organizational performance in the long-term.

In the following, we first present the theoretical framework for the relationship between digital transformation, digital orientation, SMEs, and organizational performance. Afterwards, the sample and the methodological approach are described, followed by the presentation of the empirical results. The subsequent discussion links the theoretical framework to the results, highlighting implications for both research and practice. The limitations of this study and implications for future research are then described before a conclusion is drawn.

4.2 Theoretical Framework

Digital transformation is generally defined as a process of organizational improvement via substantial change of the organization's characteristics through the implementation and utilization of digital technologies (Vial, 2019). Thus, digital transformation is based on the integration and adaptation of information-, computer-, communication-, and connectivity-technologies, i.e., digital technologies, within an organization (Dong, 2019; Vial, 2019). Following this process of transformation results in a competitive advantage which constitutes a valuable intangible capability that is difficult for others to imitate (Kindermann et al., 2021; Schweiger, Stettler, Baldauf, & Zamudio, 2019). In order to achieve competitive advantages through digital transformation, organizations can consider the construct from

a more differentiated perspective. Differentiating digital transformation reveals various subordinate constructs, with the emerging construct of digital orientation (Vial, 2019). Digital orientation, which is proposed as a new form of strategic alignment, forms the basis for organizations to derive a digital strategy and thus approach the digital transformation process in a more structured manner (Bharadwaj et al., 2013; Kindermann et al., 2021). Currently however, there is controversy about whether digital orientation really is a novel strategic orientation and can thus lead to a competitive advantage (Quinton et al., 2018). Albeit the integration and usage of digital technologies is often perceived as a subordinate addition to the general organizational strategy (Sawy et al., 2016), digital technologies and their implementation are nowadays increasingly moving into the strategic focus (Bharadwaj et al., 2013; Sahut, Iandoli, & Teulon, 2021). In this regard, digital orientation can be seen as an important strategic orientation as it allows organizations to leverage the potential of digital technologies to achieve their strategic goals (Saunila et al., 2021). This shift in strategic focus towards the integration and usage of digital technologies provides strong arguments that digital orientation indeed is a new strategic orientation (Cavallo et al., 2019; Kindermann et al., 2021; Saunila et al., 2021).

Although the scientific discourse on digital orientation has recently gained attention, SMEs as a contextual factor have mostly been neglected in previous studies (Ardito et al., 2021; Rupeika-Apoga, Petrovska, & Bule, 2022; Saunila et al., 2021). We observe this as a significant gap in the literature because the unique challenges and opportunities SMEs face in the digital age have critical implications. For instance, unlike large enterprises, SMEs often have resource constraints (Aldrich & Auster, 1986), which limits their capacity to fully engage with and exploit the benefits of digital technologies. This is especially concerning as SMEs represent one of the most important parts of many economies (Ardito et al., 2021; Rupeika-Apoga, Petrovska, & Bule, 2022). Specifically, SMEs contribute significantly to GDP (Ayyagari, Demirguc-Kunt, & Maksimovic, 2011), employment (Beck, Demirguc-Kunt, & Levine, 2005), and innovation (Audretsch & Keilbach, 2007). They are responsible for a significant portion of job creation (Ayyagari et al., 2011; Beck et al., 2005), fostering entrepreneurial spirit and innovation (Audretsch & Keilbach, 2007), and

often provide the foundation for the growth of new industries (Audretsch & Keilbach, 2007). Therefore, understanding the digital orientation of SMEs is not only important from an academic perspective, but also has significant practical implications in the course of digitalization for policymakers and practitioners seeking to stimulate economic growth and competitiveness.

Currently, SMEs are at the core of a controversial scientific debate about their ability to handle the changes implied by digital transformation. Central to the current discussion is the contested ability of SMEs to adopt and implement digital technologies (Bajwa et al., 2008; Eller et al., 2020; Nguyen et al., 2015), as SMEs are considered to be more risk averse, especially in terms of adopting digital technologies (Ahmad et al., 2014; Taylor & Murphy, 2004). Consequently, they frequently fail to grasp the opportunities associated with digital technologies (Nguyen et al., 2015). These characteristics can be attributed to the liability of smallness, which includes constraints on resources (e.g., financial and/or human) (Aldrich & Auster, 1986) that are often required to efficiently implement resource-intensive digital technologies (Bajwa et al., 2008; Clohessy & Acton, 2019; Meyer, 2011). As a result, SMEs often face significant hurdles within their digital transformation process. However, the challenges they face include not only the initial costs of investing in digital technologies, but also the ongoing costs of maintaining and upgrading these technologies, as well as the need to continuously develop and adapt their skills and capabilities to keep pace with technological change (Bharadwaj et al., 2013).

On the other hand, SMEs' smallness can be seen as one of their key advantages, because the size implies a certain flexibility and thereby fosters agility and adaptability to new trends and changes in their environment (Levy & Powell, 1998). This is especially beneficial in the current paradigm of digitalization, where the ability to quickly adopt new technologies and processes can be seen as a major competitive advantage. Indeed, previous research has shown that SMEs generally respond very quickly to external changes and are highly adaptable when it comes to digitalization (Aldrich & Auster, 1986; Zhu et al., 2006). In this context, digital orientation can play a crucial role in guiding SMEs' digital transformation efforts. By providing a strategic framework for the adoption and

use of digital technologies, digital orientation can help SMEs to navigate the complexities of the digital age, and to identify and seize the opportunities that digital technologies present (Quinton et al., 2018). However, achieving a successful digital orientation requires more than just the adoption of digital technologies. It also involves a fundamental shift in the organization's strategic focus, towards a more integrated and holistic approach to digital transformation (Kindermann et al., 2021). This transition, albeit demanding for SMEs, remains an integral stride towards harnessing the full capacity of digital technologies to amplify business enhancement and foster a competitive edge. However, in terms of the successful transition of digital transformation, SMEs in particular are lagging behind (OECD, 2021; Rupeika-Apoga, Petrovska, & Bule, 2022). Considering recent findings that emphasize the positive influence of digital transformation on organizational performance (Guo & Xu, 2021; Yu et al., 2022), these observations inevitably open a discourse on the standing of SMEs in the contemporary, disruptive business environment.

One part of this discourse are the strategic elements of digital transformation which can be examined by utilizing the concept of digital orientation (Kindermann et al., 2021). Digital orientation is considered a key element of the digital transformation and is also referred to as the fundament to create a strategy for the process of digital transformation. Specifically, digital orientation is defined as: "[...] an organization's guiding principle to pursue digital technology-enabled opportunities to achieve competitive advantage." (Kindermann et al., 2021, p. 649). Digital orientation is rooted in the strategic alignment model (Henderson & Venkatraman, 1999) and describes the extent to which organizations adjust their business strategy to create value through digital alignment (Kindermann et al., 2021). Therefore, digital orientation can be understood as an organization's fundamental perspective on the phenomenon from which the digital strategy is derived in order to successfully master the digital transformation (Kindermann et al., 2021; Vial, 2019). The construct of digital orientation can be categorized into four subdimensions, each of which describes different facets. The first subdimension "architecture configuration" entails the digital infrastructure and explains how organizations enable the digitalization of products and processes (Kindermann et al., 2021). The second subdimension

”capabilities” comprises human capacities, i.e., the skills and knowledge required in connection with an organization’s digitalization efforts (Henderson & Venkatraman, 1999; Kindermann et al., 2021). It includes both the application-specific characteristics and the management-related aspects necessary to implement such a process within the organization (Kindermann et al., 2021). The third subdimension ”ecosystem coordination” primarily describes aspects of digitalization in inter-organization relations and customer relations for the use of information access and network effects (Kindermann et al., 2021). The fourth and final subdimension, ”technology scope,” describes digitalization-related technological features, as well as competencies and functionalities that are specifically offered for the customer. The technology scope is characterized by a ”[...] set of digital technologies that allow the organization to realize strategic growth.” (Kindermann et al., 2021, p. 648). Together, these four subdimensions capture the digitalization-related value creation, the emergence of new skills and the advancement of existing skills and organizational prerequisites induced by digital technologies.

4.3 Hypotheses Development

The potential rewards of establishing and pursuing a digital orientation originate from the integration of digital technologies into a concrete business strategy and culture (Cavallo et al., 2019). Hence, digital orientation is accompanied by a change in resources and capabilities, which decisively influence the future direction and therefore also the performance of an organization (Bayo-Moriones, Billón, & Lera-López, 2013; Cavallo et al., 2019; Schiuma et al., 2022; H. Wang, Feng, Zhang, & Li, 2020). The rise of digital orientation as an increasingly important strategic orientation (Bharadwaj et al., 2013) follows recent insights that digital orientation can be considered a valuable, non-imitable resource (Schweiger et al., 2019) that can contribute to an organization’s competitive advantage (Kindermann et al., 2021; Schiuma et al., 2022).

Nevertheless, previous research on the effect of digital orientation on organizational performance is inconclusive. Nasiri et al. (2022) found, that for large organizations pursuing a

digital orientation does not have a significant effect on organizational performance. However, this argument is relativized by the fact that digital orientation has a positive impact on financial performance if there is a certain minimum level of digital maturity in the corresponding organization (Nasiri et al., 2022). This implies that the initial costs of starting the digital transformation process include investments that are negatively correlated with organizational performance. The initial negative impact of digital orientation may act as a barrier for SMEs to initiate the process of digital transformation, due to the constraints of the liability of smallness (Aldrich & Auster, 1986; OECD, 2017). As many SMEs start the digital transformation process from scratch, they need to invest heavily in new digital technologies, leading to short-term performance losses due to the high costs and potential disruptions associated with implementing these technologies (Besson & Rowe, 2012; Ulas, 2019). However, the negative effect reverses over time if the organization intensifies and proceeds the digital transformation process (Nasiri et al., 2022). Accordingly, the initial investments can lead to long-term performance gains as the SMEs become more efficient and competitive due to their digital orientation (Nasiri et al., 2022). The positive effects can be seen as a result of digital orientation, in particular the efficient use of digital technologies. Accordingly, the impact of digital orientation on performance is not linear but curvilinear, following a U-shaped pattern. This U-shaped relationship is the result of the dynamics involved in the process of digital transformation, which includes an initial investment phase, often associated with a decrease in performance, followed by a phase of growth and performance enhancement fostered via digital orientation. Therefore, we hypothesize:

H_1 *There is a curvilinear relationship between digital orientation and SME performance that follows a U-shape.*

Building upon the overarching construct of digital orientation, this study further delves into its subdimensions: architecture configuration, capabilities, ecosystem coordination, and technology scope. Each of these dimensions represents a unique aspect of an SME's digital orientation and can independently influence the organization's performance (Kindermann

et al., 2021). Investigating these dimensions separately allows for a more nuanced understanding of how different facets of digital orientation contribute to SME performance. This approach identifies specific areas where SMEs may need to focus their efforts during the digital transformation process, and how each of these areas can impact their performance over time. This granular analysis can provide valuable insights for both practitioners and researchers interested in the digital transformation of SMEs.

The first dimension considered is architecture configuration. The architecture configuration dimension of digital orientation refers to how an SME organizes its digital resources and capabilities. An effective architecture configuration can enable an SME to better leverage its digital resources, leading to improved performance (Kindermann et al., 2021). Nevertheless, the process of evolving and implementing an efficacious architecture configuration is not devoid of challenges. For instance, it has been established that the productivity benefits of information technology may be delayed due to the time required to reconfigure work processes and develop complementary skills (Dewan & Min, 1997). Consequently, a sufficient architecture configuration demands significant upfront investments in terms of capital, time, and human resources, which might initially lower organizational performance, resulting in a U-shaped relationship (Besson & Rowe, 2012; Ulas, 2019). Moreover, effective architecture configuration entails not only the technical aspects of integrating various digital technologies but also the alignment of these technologies with the business strategy, which may require organizational learning and adaptation (Sebastian et al., 2017). The complexity and effort involved in these processes potentially explain the initial decrease in performance. However, once the configuration is successfully implemented and aligned with the business strategy, the benefits begin to outweigh the costs, leading to improved performance. Therefore, in light of the aforementioned insights, we hypothesize:

H_2 *There is a curvilinear relationship between the dimension architecture configuration and SME performance that follows a U-shape.*

The capabilities dimension of digital orientation refers to the skills and competencies

that an SME has in using digital technologies. Developing these capabilities can enhance an SME's ability to utilize digital technologies for its competitive advantage, leading to improved performance (Kindermann et al., 2021). The capability to configure and reconfigure digital assets can provide a basis for a competitive advantage by allowing firms to respond rapidly and effectively to changes in the external environment (Teece, 2009). Furthermore, digital capabilities have been emphasized as instrumental in shaping the ability of SMEs to exploit digital technologies, to seize the strategic opportunities offered by digital technologies and mitigate potential threats, thereby fostering superior performance (L. Li et al., 2018). Simultaneously, a high level of digital capabilities can also result in complexity and increased coordination costs, particularly in the initial stages (Kane & Alavi, 2007). This complexity is due to the dynamic and rapidly changing nature of digital technologies, which necessitate continuous learning and adaptation. In this regard, the upskilling process can necessitate significant initial investment in training and development, potentially causing a decrease in immediate performance and leading to a U-shaped relationship with performance (Besson & Rowe, 2012; Ulas, 2019). Consequently, while the development of digital capabilities is advantageous for SMEs, it is imperative for them to manage this development carefully, considering the potential initial costs and risks. Therefore, we hypothesize:

H_3 There is a curvilinear relationship between the dimension capabilities and SME performance that follows a U-shape.

The ecosystem coordination dimension of digital orientation refers to how an SME coordinates its interactions with customers, suppliers, and other stakeholders, through digital technologies. Ecosystem coordination via digital channels can not only augment an SME's ability to swiftly respond to market changes, but also strengthen customer relationships and value creation within its supply chain, all of which can lead to improved performance (Cenamor, Parida, & Wincent, 2019; Nambisan et al., 2017). For example, the use of digital platforms enables firms to have a real-time connection with customers, capturing their feedback and preferences to better align products and services (Nambisan et al., 2017). Additionally, effective digital ecosystem coordination can facilitate knowledge sharing and

collaboration with suppliers, enhancing the overall value chain (Vargo & Seville, 2011). Despite the potential advantages, the establishment of effective digital ecosystem coordination is not straightforward. It often requires significant upfront investments in digital platforms and systems (Besson & Rowe, 2012; Ulas, 2019). Furthermore, the potential complexity and novelty associated with new digital ecosystems might require a period of learning and adjustment, leading to potential delays in realizing performance improvements (Chanias & Hess, 2016). These initial investments and adjustment periods could result in a U-shaped relationship with performance, where the benefits become noticeable only after a certain level of investment and utilization has been reached. Hence, the following hypothesis is proposed:

H_4 *There is a curvilinear relationship between the dimension ecosystem coordination and SME performance that follows a U-shape.*

The technology scope dimension of digital orientation refers to the range and diversity of digital technologies that an SME leverages. Once the digital technologies are integrated and utilized effectively, the SME can begin to see the benefits of a broader technology scope. For example, Kindermann et al. (2021) found that a wider range of digital capabilities can lead to improved performance as they provide more opportunities for process automation, data analysis, and customer engagement. Likewise, digital technologies can enable SMEs to develop new products and services, improve their operational efficiency, and enhance their competitive position (Ulas, 2019). Hence, a broad technology scope can enable an SME to utilize a wide range of digital capabilities, leading to improved performance (Kindermann et al., 2021). In the initial stages however, the investments in acquiring and implementing a range of digital technologies can strain an SME's resources, leading to a decrease in performance. Accordingly, investments in digital technologies can initially lead to a decline in firm performance due to the costs and challenges of implementation as the organization learns to leverage these technologies efficiently. However, the resulting performance benefits are expected to improve over time, proposing a U-shaped curve (Besson & Rowe, 2012; Kindermann et al., 2021; Ulas, 2019). Therefore, we hypothesize that an SME's performance might initially decline as it expands its technology

scope, but as the SME learns to leverage these technologies effectively, its performance will increase, resulting in a U-shaped relationship:

H_5 *There is a curvilinear relationship between the dimension technology scope and SME performance that follows a U-shape.*

4.4 Methodology

4.4.1 Sample and Data

In order to create a holistic and accurate picture of the current status of digital orientation, it is favorable to gather as much information about an organization as possible. Accordingly, to generate a representative sample, we collected qualitative and quantitative information on our sample of SMEs (see Table 4.1). First, we created a list of SMEs and exported it from Amadeus (Bureau van Dijk, 2023), a database containing a wide range of information for public and private organizations across Europe. Based on this list we created a sample of SMEs according to the European Commission definition of an SME by having an annual turnover equal to or below 50 m. € and a staff headcount below 250 (European Union, 2003). Further, only SMEs that had full available information on following indicators: URL, profit (last three years), turnover (last three years), number of employees (last three years), export, number of trademarks, industry, and organization age, were selected. The SMEs of our final sample are from different European countries and industries. After the first selection process our sample from the Amadeus database consists of 12,871 SMEs.

In the next step, we utilized web scraping techniques to capture the website texts for each of the URLs in the sample obtained from Amadeus. We initiated this process in late 2022. This allows us to collect qualitative data (text), including the text of up to the first 100 sub-pages of the considered SMEs' websites. Accordingly, we generate a second dataset, next to the quantitative Amadeus data (financial), that contains the qualitative text data of the website from each considered SME. The obtained text data

is diverse and includes everything an SME published on its website including company descriptions, mission statements, product descriptions, company news, and more. This bidimensional data base involving the combination of qualitative website-text data and quantitative data on SME performance, allows us to explore the relationship between an SME's digital orientation and its performance in a comprehensive and nuanced manner.

Following this, we started the operationalization process for both the Amadeus dataset (financial data) and the dataset with scraped website text. The operationalization process differs for the qualitative (website-text) and the quantitative (Amadeus financial information) data of our final sample. For the text data we started the operationalization by including only German- and English-language website-texts in our analysis, as we used both the original English language dictionary and a version translated into German. We also removed missing observations and dropped subpages, which are not of interest for our analysis or could potentially bias the results (e.g., information about cookies and privacy). We then followed standard data processing techniques and removed all non-textual elements, symbols, and punctuation from the collected website-texts and converted the text to lowercase to allow for case-sensitive comparability. In the next step, we tokenized the text of each website to perform analysis on a per-word basis. We also converted the website words into both lemmas and word-stems for comparability and standardization. Lemmatization and stemming are standard procedures in text-based analysis, that enable the identification and comparability of words regardless of their grammatical structure (Balakrishnan & Ethel, 2014; McKenny, Aguinis, Short, & Anglin, 2018). In order to measure digital orientation, we utilized the construct by Kindermann et al. (2021), which can be defined by a set of words called the digital orientation dictionary. We have translated this construct into German to be able to analyze the text data from German websites adequately. In order to match the words from the dictionary with the lemmatized/stemmed website text we also applied the same techniques (lemmatization and stemming) to all digital orientation words. After the cleaning process, which included dropping all observations where no text could be scraped and aggregating all website-related text, we obtained 1,652 SMEs in our final sample of qualitative text data.

For the quantitative data, we started the operationalization by dropping missing values and duplicates in the exported dataset. Additionally, we controlled for all unrealistic or falsely documented values. In the last step we match the quantitative Amadeus data of our sample SMEs with the website-text data gathered for each organization. After the merge 1,135 SMEs remain in our final sample including complete information on every organization's website-texts, profit (last three years), turnover (last three years), number of employees (last three years), export, number of trademarks, industry, and organization age.

Table 4.1: Sample Creation and Operationalization Process

Steps	**Description**	**N**
Step 1	Access Amadeus database and export a list of SMEs with information on: URL, turnover (last three years), profit (last three years), number of employees (last three years), industry, and organization age	12.871
Step 2	Collect the website text with up to 100 subpages of each SME based on the URLs obtained from Amadeus	12.871
Step 3	Start operationalization of the text dataset. Drop missing observations and subpages, which are not of interest for our analysis or pose a potential bias to the results (e.g., information about cookies and privacy)	1.652
Step 4	Remove all non-textual elements, symbols, punctuation, and exhibits from the collected website-texts and converted the text to lowercase	1.652
Step 5	Tokenization of the text of each website to perform analysis on a per-word basis. Based on the tokens per website we calculate the number of words per website	1.652
Step 6	Lemmatization and Stemming of the text of each website and the words of the dictionaries of digital orientation	1.652
Step 7	Start operationalization of the quantitative data from the database. Drop missing values and duplicates. Control for outliers and all non-realistic or falsely documented values	1,135

4.4.2 Measures

The current state of research on extracting the level of digital transformation, especially digital orientation, is rather scarce and subject to intensive criticism (Thordsen et al., 2020). We therefore apply a novel analysis in this context: the computer-aided text anal-

ysis (CATA) (Krippendorf, 2004), building on an established and validated dictionary representing the construct of digital orientation (Kindermann et al., 2021; McKenny, Short, & Payne, 2013; Short, Broberg, Cogliser, & Brigham, 2010). The dictionary consists of all relevant words that represent the phenomenon of digital orientation as a whole. Further the dictionary can be subdivided into four subdomains (architecture configuration, capabilities, ecosystem coordination and technology scope) where each sub dictionary is representative for the corresponding sub dimension.

For our study, we use the original English version of the validated digital orientation dictionary as well as a version translated to German, to also check websites that contain only German language. Previous research used text analysis mostly on a sample of annual reports (Boling, Pieper, & Covin, 2016) or letters to shareholders (Grühn, Strese, Flatten, Jaeger, & Brettel, 2017; Kindermann et al., 2021; Short et al., 2010). As we, however, focus on SMEs, annual reports or letters to shareholders are mostly not available. In contrast, nowadays almost every organization has a website. We build on this fact and use the existing information of the website texts to derive our set of independent variables (Esrock & Leichty, 2000).

The derivation of our independent variable, the digital orientation score of an SME, is rooted in two theoretical assumptions: The Sapir-Whorf hypothesis on one hand, which states that the frequency of occurrence of a word determines the direction and intensity of decision-makers' attention to a given topic (Abrahamson & Hambrick, 1997). On the other hand, digital orientation behavior is a result of decision makers' attention, so frequent usage of words related to strategic orientations is associated with more attention towards the phenomenon (Grühn et al., 2017; McKenny et al., 2018; Ocasio, 1997). Furthermore, in contrast to a concrete strategy, which may be hard to extract from a website unless it is not mentioned explicitly, the construct of strategic orientation, i.e., digital orientation, is a broader concept that reflects an organization's overall perspective and approach or principle to managing its resources, processes, and activities (Hakala, 2011). Hence, an orientation resembles an organization's general philosophy that guides its strategic decision-making (Lau & Bruton, 2011; R. E. Morgan & Strong, 2003) which, at least

partly, is inherent within the text provided on a website.

4.4.3 Dependent Variable

To investigate organizational performance, we test the explanatory variables against a composed growth indicator, as previous research showed that growth is a suitable predictor of SMEs' performance (Bhatti & Awan, 2014; Parmenter, 2010; Wiklund, 1999). We utilize this indicator to generate a differentiated picture of SME performance and to account for changes over time. As performance measurement systems in general should be designed to capture data over time, providing a more comprehensive view of an organization's performance (Neely, Gregory, & Platts, 2005), we have chosen to examine the growth rates for the number of employees, turnover, and profit over the last three available years (2019-2021) (Coad & Höllzl, 2012). This period was selected as it provides a more comprehensive picture of an organization's performance than a snapshot or single-year data. It allows us to capture any latent effects of strategic shifts or investments in digital orientation that may not immediately manifest in the same year. While in many studies, total sales or number of employees is used as an indicator of overall organizational performance, we use growth rates for the number of employees, turnover and profit (Coad & Höllzl, 2012). Since a one-sided consideration of growth variables can lead to distortions, we combine several variables in order to obtain a composed growth indicator as a representation of organizational performance (Weinzimmer, Nystrom, & Freeman, 1998). To achieve normal distribution all three development variables are individually categorized into 10 identical categories (see Table 4.2). Following, we establish an average development rate of annual turnover (= turnover growth rate), annual profit (= profit growth rate) and annual employees (= employee growth rate) from the last three observed years as an indicator of turnover, profit, and employee development (Richard, Devinney, Yip, & Johnson, 2009). By summing these three indicators and calculating the mean, we are able to construct an estimator of organizational performance that is in line with existing research on organizational performance measurement (Weinzimmer et al., 1998). An overview of all dependent and independent variables with the corresponding

descriptions can be found in Table 4.3.

Table 4.2: Dependent Variable Categories

Category	Description
1	-100 percent of sales / profit / employee development variable
2	-100 to -75 percent of sales / profit / employee development variable
3	-75 to -50 percent of sales / profit / employee development variable
4	-50 to -25 percent of sales / profit / employee development variable
5	-25 to 0 percent of sales / profit / employee development variable
6	0 to +25 percent of sales / profit / employee development variable
7	25 to +50 percent of sales / profit / employee development variable
8	50 to +75 percent of sales / profit / employee development variable
9	75 to +100 percent of sales / profit / employee development variable
10	> +100 percent of sales / profit / employee development variable

4.4.4 Explanatory Variables

To obtain our key independent variables for digital orientation, we followed the established four-dimensional operationalization of digital orientation. Accordingly, we create five independent variables, one for each of the subdimensions: Architecture Configuration, Capabilities, Ecosystem Coordination, and Technology Scope, and one for the overall superordinate construct of digital orientation. In line with previous research, we apply multiple steps to create our independent variable for digital orientation and its subdimensions (Grühn et al., 2017; Kindermann et al., 2021). First, we count the number of the respective subdimensions and dictionaries on each website-text, in order to obtain a score that reflects the overall digital orientation of an SME. We follow prior research by calculating one aggregated score for each variable (Short et al., 2010). Second, because of the varying length of text on the websites of our sample SMEs (see Table 4.4), we normalize the score to the base of 1,000 words to enable comparability. Finally, to minimize distortions we control for outliers. We check the consistency of our digital orientation measure following established rules of former CATA research through the computation of correlations (Covin & Wales, 2019; Short, McKenny, & Reid, 2018). Descriptive statistics of the variables are shown in Table 4.4.

With respect to prior research, we considered several other variables that may affect the relationship between digital orientation and organizational performance. We control for

the industry sector with a binary indicator of the manufacturing sector. Also, we control for organizational size and age, as previous studies indicated that both are affecting organizational performance due to the liability of smallness and liability of newness (Aldrich & Auster, 1986; Hite & Hesterly, 2001). Also, we control for the number of trademarks as an indicator for innovation activity (Mendonça, Pereira, & Godinho, 2004) and exports as an indicator of internationalization of an organization (Wolff & Pett, 2000; Añón Higón & Bonvin, 2023). The description and information of the control and other variables are shown in Table 4.3.

Table 4.3: List of Variables

Variable	**Description**	**Type**
Organizational Performance	Composite indicator of annual growth including turnover, profit and employee development rates	Count
Digital Orientation	Summed score of all matches from website words with all dictionary words. Represents the overall digital orientation in an SME	Count
Architecture Configuration	Summed score of all matches from website words with the architecture configuration dictionary words. Represents the digital orientation in an SME only in the subdimension architecture configuration	Count
Capabilities	Summed score of all matches from website words with the capabilities dictionary words. Represents the digital orientation in an SME only in the subdimension capabilities	Count
Ecosystem Coordination	Summed score of all matches from website words with the ecosystem coordination dictionary words. Represents the digital orientation in an SME only in the subdimension ecosystem coordination	Count
Technology Scope	Summed score of all matches from website words with the technology scope dictionary words. Represents the digital orientation in an SME only in the subdimension technology scope	Count
Organization Age	Years of existence since foundation	Count
Organization Size	Number of full-time employees in last year of observation	Count
Manufacturing Industry	Binary indicator of industry affiliation: 1 = Manufacturing Industry; 0 = else	Binary
Number of Trademarks	Total number of trademarks	Count
Export	Annual export revenue in M. €	Continuous

Table 4.4: Summary Statistics

	Min.	Max.	Mean	SD	N
Digital Orientation	0.0	151.6	45.7	37.9	1135
Architecture Configuration	0.0	127.2	8.1	13.6	1135
Capabilities	0.0	127.1	10.8	12.7	1135
Ecosystem Coordination	0.0	125.6	17.6	21.9	1135
Technology Scope	0.0	82.0	5.3	10.0	1135
Organizational Performance	2.3	9.3	5.5	1.2	1135
Organization Age	7.0	217.0	35.7	22.4	1135
Organization Size	0.0	249.0	63.9	55.8	1135
Manufacturing Industry	0.0	1.0	0.5	0.5	1135
Number of Trademarks	1.0	221.0	4.7	10.2	1135
Export	-0.0	45.8	5.0	6.8	1135
Word Count	2.0	525140.0	23065.5	32909.2	1135

4.5 Results

4.5.1 Descriptive Results

The correlations among all variables are displayed in Table 4.5. The correlation table shows relatively strong correlations among the individual subdimensions and the overall digital orientation variable, which is expected as all independent variables are based on one construct. Consequently, we estimate the dimensions in separated models each with all other explanatory variables. Overall, there is substantial independence among the control- and the independent variables which does not raise any multicollinearity concerns. Nevertheless, we tested the variance inflation factor (VIF) of all our independent variables in the separated models and found that none of them were close to the critical threshold of 2.5 (Johnston, Jones, & Manley, 2018).

Table 4.5: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Digital Orientation	1	0.538	0.548	0.734	0.477	-0.032	-0.082	-0.009	-0.095	-0.050	-0.045
(2) Architecture Configuration	0.538	1	0.177	0.083	0.264	-0.045	-0.067	-0.0003	-0.136	0.001	-0.038
(3) Capabilities	0.548	0.177	1	0.117	0.297	-0.043	-0.048	-0.044	-0.010	-0.071	-0.084
(4) Ecosystem Coordination	0.734	0.083	0.117	1	0.024	-0.018	-0.030	-0.008	-0.031	-0.047	-0.024
(5) Technology Scope	0.477	0.264	0.297	0.024	1	0.030	-0.111	-0.025	-0.098	-0.001	-0.001
(6) Organizational Performance	-0.032	-0.045	-0.043	-0.018	0.030	1	-0.086	0.019	0.015	-0.033	0.117
(7) Organization Age	-0.082	-0.067	-0.048	-0.030	-0.111	-0.086	1	0.224	0.209	0.064	0.143
(8) Organization Size	-0.009	-0.0003	-0.044	-0.008	-0.025	0.019	0.224	1	0.262	0.085	0.373
(9) Manufacturing Industry	-0.095	-0.136	-0.010	-0.031	-0.098	0.015	0.209	0.262	1	-0.014	0.174
(10) Number of Trademarks	-0.050	0.001	-0.071	-0.047	-0.001	-0.033	0.064	0.085	-0.014	1	0.148
(11) Export	-0.045	-0.038	-0.084	-0.024	-0.001	0.117	0.143	0.373	0.174	0.148	1

4.5.2 Estimation Results

Table 4.6 and Table 4.7 illustrate the results of the quadratic regression. We use six models to test our set of hypotheses. Model 1 illustrates the effect of digital orientation on SME growth without considering any control variables. We follow this procedure to initially estimate the unadjusted effect of digital orientation on SME performance. Afterwards we proceed with adjusted effects only, always considering all control variables. Model 2 contains the independent variable digital orientation in combination with the control variables. Model 3-6 show the independent variables: architecture configuration, capabilities, ecosystem coordination, and technology scope in combination with the control variables.

$H1$ predicts a U-shaped relationship between the overall construct of digital orientation of an SME and performance. This relationship is supported by Model 2, which shows significant estimates for both the linear term (β = -0.007; $p < 0.05$) and the squared term ($\beta = 0.00005$; $p < 0.05$). The relationship is illustrated in Figure 4.1.

$H2$-$H5$ propose a U-shaped relationship between the individual subdimensions (architecture configuration, capabilities, ecosystem coordination, and technology scope) of digital orientation and SME performance. We find support for $H2$ with significant effects for both the linear term (β = -0.020; $p < 0.01$) and the squared term ($\beta = 0.0002$; $p < 0.01$) of the architecture configuration subdimension in Model 3. $H3$ suggests the existence of a U-shaped relationship between the subdimension capabilities and organizational performance. The results show support for this hypothesis, as both the linear term (β =

-0.013; $p < 0.05$) and the squared term (β = 0.0002; $p < 0.1$) are significant. We find no support for the subdimension ecosystem coordination and therefore reject $H4$. $H5$ predicts a U-shaped relationship between technology scope and SME performance, which can be accepted as both the linear term (β = -0.016; $p < 0.1$) and the squared term (β = 0.0004; $p < 0.05$) are significant. All relationships of the subdimensions are illustrated in Figure 4.2.

To validate the presence of our hypothesized U-shaped relationships, we performed the robustness test proposed by Haans, Pieters, and He (2016) and Lind and Mehlum (2010), which involves testing the appropriate sign of β^2, controlling the cubic term model fit, and determining whether the inflection point of the U-shape lies within the data range using the 90% confidence interval. The U-shaped relationships for $H1$, $H2$, $H3$ and $H5$ are robust to all tests.

Figure 4.1: U-Shape Relationship between Digital Orientation and SME Performance

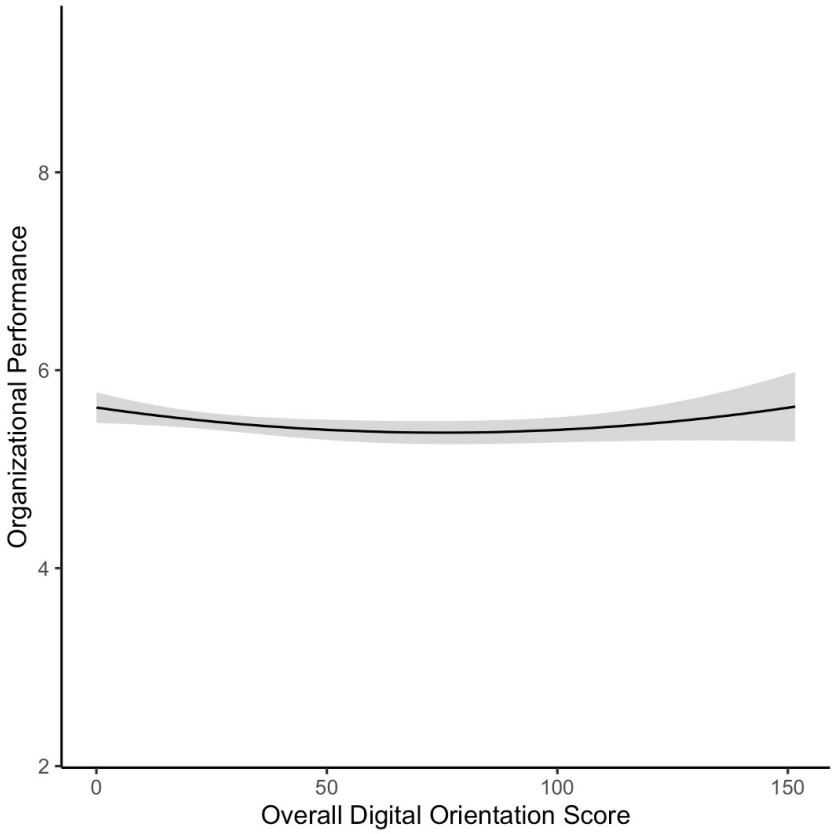

Table 4.6: Quadratic Regression - Digital Orientation and Organizational Performance

	Dependent Variable:	
	Organizational Performance	
	(1)	(2)
Digital Orientation	-0.007^{**}	-0.007^{**}
	(0.003)	(0.003)
Digital Orientation^2	0.00004^{*}	0.00005^{**}
	(0.00002)	(0.00002)
Organization Age		-0.006^{***}
		(0.002)
Organization Size		-0.0001
		(0.001)
Manufacturing Industry		0.028
		(0.077)
Number of Trademarks		-0.006^{*}
		(0.004)
Export		0.026^{***}
		(0.006)
Constant	5.623^{***}	5.739^{***}
	(0.079)	(0.105)
Observations	1,135	1,135
R^2	0.004	0.032
Adjusted R^2	0.002	0.026
Residual Std. Error	1.235 (df = 1132)	1.220 (df = 1127)
F Statistic	2.406^{*} (df = 2; 1132)	5.360^{***} (df = 7; 1127)
Note:		$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Figure 4.2: U-Shape Relationship between the Individual Dimensions of Digital Orientation and SME Performance

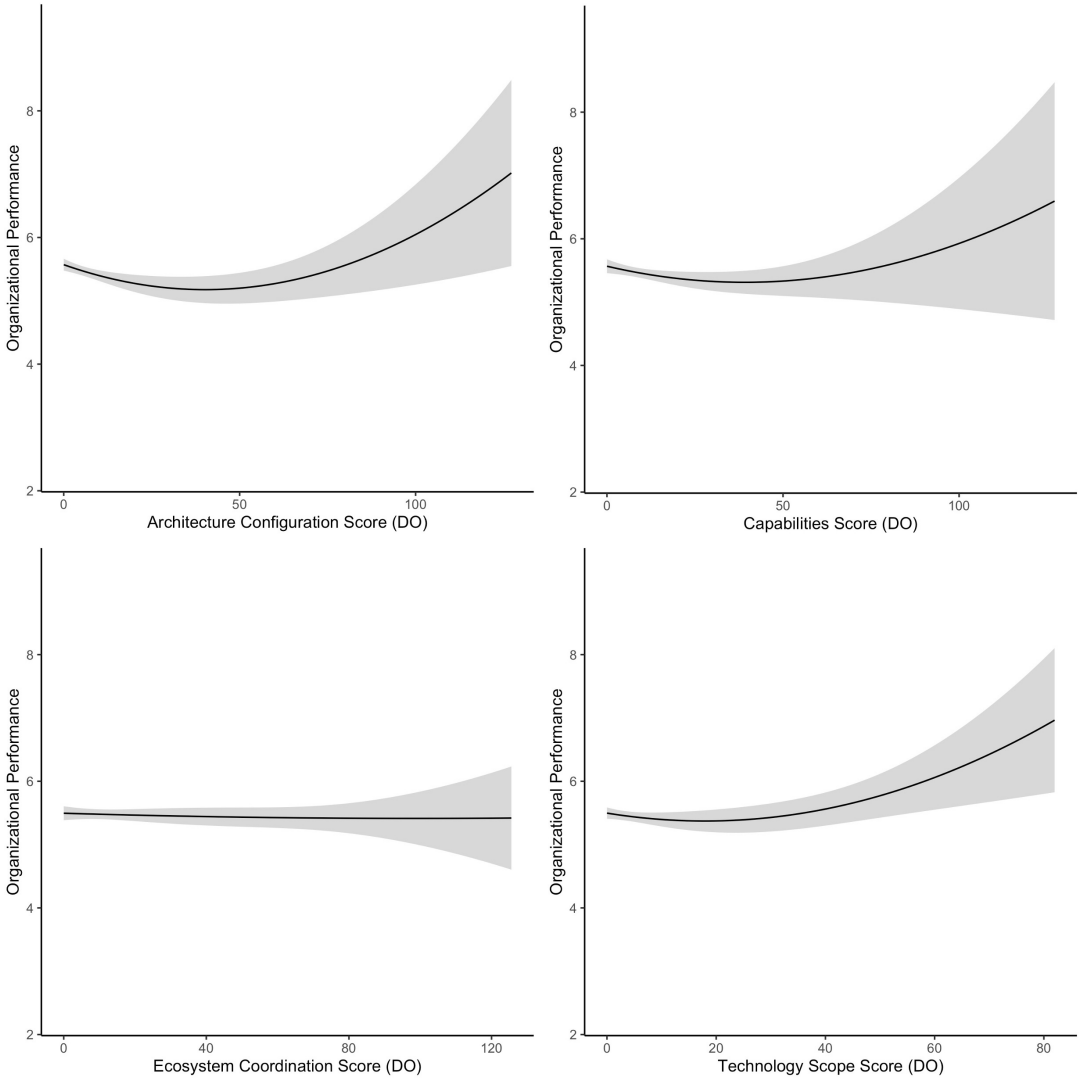

Table 4.7: Quadratic Regression - Digital Orientation Dimensions and Organizational Performance

	Dependent Variable:			
	Organizational Performance			
	(3)	(4)	(5)	(6)
Architecture Configuration	−0.020***			
	(0.006)			
Architecture Configuration^2	0.0002***			
	(0.0001)			
Capabilities		−0.013**		
		(0.006)		
Capabilities^2		0.0002*		
		(0.0001)		
Ecosystem Coordination			−0.003	
			(0.004)	
Ecosystem Coordination^2			0.00003	
			(0.0001)	
Technology Scope				−0.016*
				(0.008)
Technology Scope^2				0.0004**
				(0.0002)
Organization Age	−0.006***	−0.006***	−0.006***	−0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Organization Size	−0.00000	−0.0002	−0.0002	−0.0001
	(0.001)	(0.001)	(0.001)	(0.001)
Manufacturing Industry	0.006	0.041	0.033	0.026
	(0.077)	(0.076)	(0.077)	(0.077)
Number of Trademarks	−0.006	−0.006*	−0.006	−0.006
	(0.004)	(0.004)	(0.004)	(0.004)
Export	0.025***	0.025***	0.026***	0.025***
	(0.006)	(0.006)	(0.006)	(0.006)
Constant	5.676***	5.671***	5.608***	5.609***
	(0.085)	(0.090)	(0.089)	(0.085)
Observations	1,135	1,135	1,135	1,135
R^2	0.037	0.031	0.028	0.033
Adjusted R^2	0.031	0.025	0.022	0.027
Residual Std. Error (df = 1127)	1.217	1.221	1.223	1.220
F Statistic (df = 7; 1127)	6.156***	5.234***	4.574***	5.453***
Note:				*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

4.6 Discussion

4.6.1 Theoretical Implications

This article investigates the influence of digital orientation on SME performance. The study provides empirical evidence that the pursuit of a digital orientation in SMEs exhibits

a U-shaped curvilinear relationship. Accordingly, higher levels of performance can be achieved at both ends of the digital orientation spectrum. Moreover, the pursuit of a digital orientation will initially be accompanied by performance losses, which, while the orientation is intensified, turns into a positive effect on the performance of SMEs.

The results of this study tie in with the overarching academic discussion on the relationship between digital transformation and organizational performance, focusing on the subconstruct of digital orientation and SMEs. While confirming the findings about digital orientation being a valuable intangible capability (Kindermann et al., 2021; Schweiger et al., 2019; T. Wang, Malik, & Wales, 2021), our study contributes a novel aspect by revealing a non-linear but U-shaped relationship between digital orientation and organizational performance. While it is unclear, especially for SMEs, how they can drive digital transformation with limited resources (L. Li et al., 2018), the insights of this study empirically show that digital orientation indeed has a significant effect on organizational performance in SMEs. In contrast to previous findings, we observed that up to the trough of the U-shape, the intensification of the digital orientation initially leads to a decline in the performance of SMEs. However, after the minimum, the continuous increase of digital orientation leads to an improved performance of SMEs. Therefrom it can be deduced that digital orientation does not lead to an increase in organizational performance per se but has a significant effect on organizational performance at both ends of the spectrum. The divergence of insights from previous research may be due to the unique challenges and opportunities faced by SMEs in the digital transformation process, which can result in different patterns of performance compared to larger organizations. In the paradigm of digitalization, it initially seems contradictory to have significant effects on both ends of the spectrum, as one would assume that the renunciation of any digital orientation would have severe consequences for SMEs. In this regard, previous studies have found that SMEs indeed are lagging behind in the process of digital transformation (OECD, 2021; Rupeika-Apoga, Petrovska, & Bule, 2022). However, one possible explanation could be the focus of SMEs on local niche markets, which may put the urgency of increasing digital orientation into perspective (Camilleri, 2018).

Furthermore, our findings contribute to the existing literature by aligning with the perspective of researchers who recognize digital orientation as an emerging strategic orientation (Kindermann et al., 2021). By demonstrating that the pursuit of a digital orientation can be seen as a competitive advantage for organizations (Quinton et al., 2018), more specifically SMEs, we further fuel the scholarly discussion. Apart from the debate about whether digital orientation really is a new strategic orientation, there is another controversial discussion regarding the ability of SMEs to adopt and implement digital technologies (Eller et al., 2020; Nguyen et al., 2015). Previous research showed that SMEs might perform worse in the successful adoption and integration of digital technologies due to their risk aversion (Ahmad et al., 2014; Taylor & Murphy, 2004). In this regard our findings shed light on the concern of SMEs regarding the adoption and integration of digital technologies, confirming the short-term performance losses observed in prior research. However, our study extends this perspective by showing that long-term benefits can be realized once the trough of the U-shaped curve is passed. This could encourage a more risk-tolerant behavior in SMEs when it comes to digital orientation.

Finally, the results answer the posed research question by providing empirical evidence that digital orientation as a whole, as well as in its subdimensions - architecture configuration, capabilities, and technology scope - exhibit a significant U-shaped relationship with organizational performance in SMEs. In contrast to Nasiri et al. (2022), our results suggest that a medium level of digital orientation in the respective organization is not associated with higher financial performance. On the contrary, our data suggests that both very weak and very strong expressions of digital orientation lead to higher performance, while the organizations that are "stuck in the middle" suffer performance losses. Therefore, our results provide SMEs with a new perspective and novel insights to the ongoing discussion on whether digital orientation and subsequently digital transformation are drivers of organizational performance.

Apart from the empirical contribution to the explanation of the relationship between digital orientation and SME performance, we also add a new methodological approach in this research area by analyzing the effect via text-based content analysis based on

SMEs website-texts. This differs from many previous studies, which have relied on survey data or case studies to investigate digital transformation. The use of text-based content analysis allows for a more objective and scalable measurement of digital orientation, which could lead to new insights in this area and extend the scope of the current literature on digital orientation and SME performance. Accordingly, the utilization of CATA opens up innovative methodological avenues for entrepreneurship research (Obschonka, Lee, Rodríguez-Pose, Eichstaedt, & Ebert, 2020; von Bloh, Broekel, Özgun, & Sternberg, 2020). The presented approach of measuring website-text-based data through constructs in organizations in combination with web-scraping techniques allows the creation of large-scaled datasets. We therefore widen the ongoing discussion from a new perspective and thus are able to provide a more reliable picture of reality (Hossnofsky & Junge, 2019).

4.6.2 Practical Implications

The insights of this study have implications for both business management and policy. First, the study has shown that pursuing a digital orientation is essential when it comes to the successful development of SMEs in terms of organizational performance in the paradigm of digitalization. Consequently, SMEs should reflect on their own digital orientation and adapt to the prevailing trends, as this can ultimately lead to improved organizational performance. SMEs that get ”stuck in the middle” in the process of digital transformation, and thus in their digital orientation, do not show improved performance. On the contrary, these SMEs perform worst because the initial investments have already been made and the returns are still pending. In this situation, our findings underscore the importance of appropriate persistence with regard to the transformation process and the continuous intensification of digital orientation. Likewise, our results sensitize to the fact that the suitable degree of digital orientation depends on the respective context of the companies. However, it is also important for SMEs to invest in digital orientation depending on their industry and their current state of digital transformation. Although investing in digital orientation has the potential to improve organizational performance, it should be noted that not every investment in this area is necessary, and the benefits

may not be immediately reflected in performance. SMEs should therefore carefully assess the feasibility of pursuing digital orientation based on their specific contextual factors. Additionally, they should consider their willingness to undertake the necessary steps and investments required the successful implementation in the long-term.

Furthermore, the digital orientation of SMEs should be considered an essential prerequisite for building an ecosystem of competitive and sustainably viable SMEs within the digitalization paradigm. To improve the digital orientation of SMEs at the policy level, greater emphasis should be placed on promoting support programs that reflect the increasing importance of addressing the shortage of SMEs that have initiated and are persistently pursuing their digital transformation.

4.7 Limitations and Future Research Implications

This study is subject to limitations that open up opportunities for future investigations. One of the main limitations is the cross-sectional nature of our study, which can only provide a snapshot of the digital orientation of SMEs at a certain point in time. Although this approach offers valuable insights, it is unable to capture the dynamic and ongoing nature of digital transformation. Therefore, future research could benefit from a longitudinal design to fully investigate the temporal dynamics and potentially curvilinear relationships in the digital transformation process in SMEs. Such a design would allow for a more nuanced understanding of how changes in digital orientation over time relate to changes in organizational performance. Additionally, this study relies on a CATA-based measurement of digital orientation through the analysis of website-texts, which draws on existing research of strategic posture (Grühn et al., 2017; Kindermann et al., 2021; Short et al., 2018). Therefore, the variable creation results from the communicated degree of digital orientation based on the Sapir-Whorf hypothesis and the attention an SME devotes to the topic (Abrahamson & Hambrick, 1997). However, organizations may not always see the need to directly and sometimes also may not subtly communicate strategic orientation through external communication channels such as websites. Therefore, future

research could supplement secondary text data with primary data that directly captures the degree of digital orientation in an organization, to complement and complete the coverage of the degree of digital orientation.

We also note the limitation of our current set of growth indicators and the potential for their reevaluation or expansion to provide a more robust link between digital orientation and organizational growth. Furthermore, we focus exclusively on the organizational level. Future research should examine more closely how digital orientation interacts with the skills and characteristics of decision makers, i.e., individuals, or within teams. Since SME executives in particular tend to exert excessive influence on their organizations (Marcati, Guido, & Peluso, 2008), personal attitudes may have a major impact on the extent and rate of progress of digital orientation and digital transformation within SMEs and thus on organizational performance. Finally, although we control for the manufacturing industry, future research should take a more nuanced look at other industries and regional differences to examine the respective effects and consider industry and region-specific trends (Hossnofsky & Junge, 2019).

4.8 Conclusion

This study enriches the ongoing discourse on digital transformation and organizational performance by delving into the relationship between digital orientation and the performance of SMEs. Our findings reveal a curvilinear U-shaped relationship between digital orientation and SME performance. SMEs at both ends of the spectrum demonstrate increased performance. The initial negative impact of pursuing a digital orientation diminishes as the intensity of the orientation increases. These results bear substantial implications for SMEs navigating the disruptive landscape of the digitalization paradigm. Our study underscores that while the adoption of a digital orientation may present initial barriers, such as resource constraints, the long-term performance benefits for SMEs outweigh these initial challenges. Furthermore, our study emphasizes the necessity for SMEs to cultivate a strategic approach to digital transformation. Digital orientation only has a

beneficial impact on organizational performance if the transformation process has either taken place at a very low level or is being consistently intensified towards a high degree of digital orientation. In conclusion, our study offers novel perspectives on the relationship between digital orientation and organizational performance. It serves as a starting point for future research to further explore and develop this relationship in broader contexts and settings.

Chapter 5

Digital Transformation Amid Crisis – Navigating SME Growth and Business Model Disruption

Digital Transformation Amid Crisis –

Navigating SME Growth and Business Model Disruption

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Abstract

During the Covid-19 pandemic, the resilience of small and medium-sized enterprises (SMEs) faced unprecedented challenges, casting doubts over their crisis performance. Drawing on primary cross-sectional data from 868 German SMEs, this study investigates the interrelationship between the business model disruption from crisis, SME performance, and digital transformation's moderating role. Using ordinal logistic estimation, we found that SMEs with heavily disrupted business models experienced diminished performance. However, those that had embraced the digital transformation and reached a certain degree of digital maturity were better equipped to counteract these adverse effects. Further, our results illuminate effects on specific business model dimensions – value proposition, -delivery, -creation, and -capture. Digital transformation showed a significant moderation effect, especially on the disrupted business model dimensions value proposition, -delivery, and -creation. Accordingly, our research highlights digital transformation's key role as a buffer against business model disruptions, providing insights for academia and industry alike.

Keywords: Business Model – Digital Transformation – Covid-19 – SMEs – Quantitative

5.1 Introduction

The business model, which serves as the underlying principle of how an organization generates, delivers, and preserves value (Osterwalder & Pigneur, 2010), plays a critical role in determining an organization's ability to sustain performance during external shocks. Nowadays, organizations face unique challenges as they must simultaneously navigate both, the exogenous shock of the recent Covid-19 pandemic, and the ongoing digital transformation. The Covid-19 pandemic has particularly affected small and medium-sized enterprises (SMEs), as research has recently demonstrated the significance of an organization's size as a determinant of its performance during exogenous shocks (Miklian & Hoelscher, 2022). This implies that SMEs, due to their size and resource constraints which align with the liability of smallness (Aldrich & Auster, 1986), are more susceptible to

such shocks and their subsequent effects (Adian et al., 2020). In the context of the Covid-19 pandemic, SMEs have grappled with acute financial vulnerability (Klein & Todesco, 2021), struggling to survive or being forced to close down (Bretas & Alon, 2020). These circumstances have unveiled significant shortcomings within the existing business models of SMEs challenging their organizational resilience (Klyver & Nielsen, 2021).

In this context, digital transformation, captured through measures of the degree of digital maturity which indicates the depth and breadth of digital implementation across operations, has emerged as a pivotal factor influencing the performance of SMEs (Bettiola, Capestro, Di Maria, & Micelli, 2022; Kindermann et al., 2021; Plekhanov, Franke, & Netland, 2022). Digital transformation is defined as an organizational process induced by the digitalization that describes the substantial change of an organization's characteristics through the implementation and utilization of digital technologies (Vial, 2019). Despite the recognition of a direct positive correlation between digital transformation and SME performance (Autio et al., 2018; Eller et al., 2020; Rachinger et al., 2019), there exists a theoretical gap in understanding how the digital transformation of an SME interacts with its business model, especially during crises like the recent Covid-19 pandemic. (Seetharaman, 2020; Vrontis, Chaudhuri, & Chatterjee, 2022).

This unexplored area is even more pertinent, given the significant role SMEs play within most economies. In Germany, for example, SMEs account for more than 63 percent of total employment, while in the United States nearly 50 percent of all jobs are provided by SMEs (European Commission, 2019; Kobe, 2012). Consequently, the drivers of performance in coping with the consequences of external shocks are of key economic importance. Specifically, there is an urgent need to examine how the digital transformation can potentially redefine SMEs' business model disruptions amid a crisis, stabilizing their performance.

Against this backdrop the following research question arises: What is the impact of digital transformation on the relationship between business model disruption and crisis performance in SMEs? Thus, this study seeks to contribute to the scientific literature by examining how digital transformation, conceptualized through the lens of digital maturity, can

potentially redefine the relationship of disrupted business models and SME performance amid crisis. In an effort to answer the posed research question, we conducted a thorough primary data collection in 2021 using a systematic quantitative online survey. This method was employed to obtain a representative sample of German SMEs resulting in complete responses from 868 participants. Based on the collected data, we employed ordinal logistic estimations to derive empirical results. Specifically, this study investigates the relationship between the underlying business model disruptions and SMEs' performance amid a crisis and how this relationship is moderated by digital transformation. The key contribution of this study lies in the insights that the relationship between business model disruption – overall and in specific subdimensions – and crisis performance is moderated by the degree of digital transformation in SMEs. This suggests that digital transformation can play a crucial role in SMEs' ability to adapt, survive, and counteract the negative effects implied by the Covid-19 pandemic, and potentially future exogenous shocks.

In the subsequent sections of this study, we outline the prevailing literature and derive our set of hypotheses. We then delineate our sample selection and explain the research methodology utilized. This is followed by a detailed presentation and discussion of the study's findings. Finally, we derive the implications from the results, address the limitations, and draw a conclusion of the study.

5.2 Theoretical Framework

5.2.1 Exogenous Shocks and Crises in SMEs

Exogenous shocks, that include wars, economic crises, technological changes, natural disasters, and infectious disease outbreaks, like the recent Covid-19 pandemic (Miklian & Hoelscher, 2022), are events beyond control and have significant negative impacts on the economy (International Monetary Fund, 2003). The aftermath of such exogenous shocks impose ongoing stress and challenges for SMEs (T. Morgan et al., 2020). This aftermath is what we refer to as crisis while the exogenous shock is considered as the acute

event. The Covid-19 pandemic has proven to be one of the most destructive exogenous shocks in recent times causing a severe crisis for the economy. According to T. Morgan et al. (2020) the Covid-19 pandemic has resulted in disturbed supply chains, resource shortages, price volatility, and protective measures detrimental to organizations such as lockdowns. Hence, the Covid-19 pandemic was and remains an existential threat to many organizations (Giones et al., 2020).

While the disruptions emerging out of the crisis pose challenges for all organizations, the literature presents ambiguous insights for SMEs. On one hand, SMEs are generally more vulnerable to crises (Marshall, Niehm, Sydnor, & Schrank, 2015) and more likely to go bankrupt than Multi National Enterprises (MNEs) (Sydnor, Niehm, Lee, Marshall, & Schrank, 2017). This vulnerability stems from their unique characteristics, such as the liability of smallness and inherent resource constraints (Adian et al., 2020; Aldrich & Auster, 1986). These characteristics often restrict their ability to rapidly adapt to changing external conditions. For instance, limited financial reserves may impede the swift deployment of contingency plans, while the smaller size of SMEs often results in less influence over market conditions and a diminished capacity to absorb unexpected financial losses. Furthermore, the lack of diversity in SME's products, services, or markets may expose them to higher risks when disruptions occur in their primary business area (Cowling, Liu, & Ledger, 2012; Storey, 2016).

On the other hand, the literature underlines that SMEs display remarkable resilience to disruptions of the pandemic (Bartik et al., 2020). Resilience in an organizational context is understood not only as an organization's capacity to sustain its primary purpose and character in the face of external pressures (Lee, Vargo, & Seville, 2013), but also as its aptitude for situation awareness, addressing crucial vulnerabilities, and adapting within a multifaceted, ever-changing, and interlinked setting (McManus, 2008; Seville et al., 2008). In this regard, many SMEs leveraged the crisis as a catalyst to enhance their product or service quality (Musa & Aifuwa, 2020), subsequently leading to crucial transformations in their business models. These adaptations, born out of necessity, became instrumental for SMEs in seizing the emerging opportunities arising from the crisis (Chesbrough, 2020;

T. Morgan et al., 2020). In conclusion, SMEs, by their very nature, often have limited access to resources, which brands them especially vulnerable amid crises. Their inherent agility, however, can also become their strength. The dual nature of being both vulnerable and agile requires a deeper understanding of SMEs' performance during crises like the Covid-19 pandemic especially regarding the role of digital transformation, which may serve as a key determinant of their resilience.

5.2.2 Business Model and Digital Transformation Amid Crises

Given the macroeconomic importance of SMEs (OECD, 2010), it is critical to examine their potential vulnerability to crises. One potential solution to enhance SMEs' resilience amid crises may be the engagement in digital transformation, which is focused on the strategic aspects of digital technology adoption and subsequently organizational transformation (Ghobakhloo, 2018; Gobble, 2018; Yoo, Boland, Lyytinen, Majchrzak, Yoo, & Majchrzak, 2012). Digital transformation is characterized as harnessing digital technologies and auxiliary resources to construct a robust and innovative digital business model (Vial, 2019). Consequently, digital technologies lead to structural changes in organizations (Gobble, 2018) and can potentially secure a competitive edge (Hassan et al., 2020; Zott & Amit, 2017). Given the centrality of adopting digital technologies in the digital transformation process, an organization's integration of these technologies is indicative of its progress in digital transformation, particularly in the context of associated organizational changes (Matt et al., 2015). Building on this notion, the concept of digital maturity emerges in the literature, characterizing it as a phased journey where organizations methodically embrace and embed digital technologies, progressing towards a fully digitally transformed state (Remane et al., 2017). As organizations advance in their digital maturity, they amplify their resilience by bolstering flexibility, efficiency, and competitive edge, enabling them to effectively navigate crises triggered by exogenous shocks (Bharadwaj et al., 2013).

In conclusion, digital maturity, quantified by the extent of technology integration in SMEs, serves as an estimator for their technological proficiency. This metric further informs and

is abstracted into the overarching concept of digital transformation, which is characterized by a deliberate, incremental development process. While each stage of digital maturity embodies enhanced capability, adaptability, and strategic foresight, the intricate interplay of these elements becomes particularly critical when a crisis triggers business model disruptions.

The business model, which abstractly models the structures, logic, and governance of conducting business (Amit & Zott, 2001), has been identified as a factor that contributes to the performance of SMEs during crises (Ritter & Pedersen, 2020). More precisely, business model innovation, particularly within the context of digital transformation, has been proposed as a potential answer to the recent Covid-19 crisis for SMEs, aiming to counter the negative effects of the crisis through measures such as innovation, adaption, and pivoting of the business model (Chesbrough, 2020; T. Morgan et al., 2020). However, to effectively deploy such changes, it is vital to have a comprehensive understanding of the constituent elements of the business model. Various constructs of business model classification have been proposed in the literature, such as the Business Model Canvas (Osterwalder & Pigneur, 2010), the Four-Box Business Model (Johnson, Christensen, & Kagermann, 2008), and the Strategic Triangle (Amit & Zott, 2001). However, this study adopts the four subdimensions of a business model following Günzel and Holm (2013), which are namely: value proposition, value delivery, value creation and value capture. This offers a comprehensive yet concise framework that thoroughly delineates the key elements of a business model. By using this framework, this study aims to explore how the state of digital transformation in an SME could provide potential solutions to the disruption of specific business model dimensions of SMEs in addressing the challenges posed by crisis i.e., the recent Covid-19 pandemic.

The value proposition is understood as a comprehensive perspective on the collective suite of an organization's products and services (Remane et al., 2017). An organization's portfolio of value propositions can play a significant role in its performance during and after a crisis (Altunbas et al., 2011). For SMEs, the value proposition can be a critical determinant of competitive positioning and customer engagement, given their typically

limited resources compared to MNEs (Aldrich & Auster, 1986). Consequently, the ability to rapidly adapt offerings in response to changing market demands becomes particularly crucial. In crisis situations, such as the Covid-19 pandemic, this adaptability, facilitated by digital transformation, can be a key factor in the performance of SMEs (Añón Higón & Bonvin, 2023).

Considering the subdimension of value delivery, which involves delivering value propositions to customers through communication, distribution, and sales channels (Remane et al., 2017), digital transformation can enable the redefinition of value networks via strategies like disintermediation (Andal-Ancion et al., 2003). Amid the crisis, organizations needed to deliver products and services safely and with minimal physical contact, which was enabled by digital technologies that facilitated changes to distribution and sales channels (Seetharaman, 2020).

Digital transformation can also impact value creation, which pertains to the process of achieving the value proposition (Remane et al., 2017), through data analytics for improved decision-making (Giones et al., 2020) or incorporating automation and machine learning for increased efficiency and resource management (Clohessy et al., 2017; Hess et al., 2016; Plekhanov et al., 2022). For SMEs, these technologies can provide opportunities for significant efficiency gains and competitive advantages, essential for performance amid the crisis (Añón Higón & Bonvin, 2023; Mancuso, Petruzzelli, & Panniello, 2023).

Regarding value capture, defined as revenue streams resulting from successful value propositions (Remane et al., 2017), digital technologies can facilitate new pricing strategies, such as subscription-based models or dynamic pricing (B. Tan, Pan, Lu, & Huang, 2015). For SMEs, the adoption of such digitally driven pricing strategies could offer greater flexibility and adaptability in revenue generation, particularly crucial in a crisis-induced volatile market (Mancuso et al., 2023).

Consequently, it is important for SMEs to recognize that the elements of their business model are not static, but subject to change, and they are required to continuously reinvent their business model within the digital transformation process, progressing their digital maturity (F. Li, 2020). This is especially true in the current business environment, which

is characterized by dynamism, uncertainty, and complexity, including the disruptions caused by the Covid-19 pandemic (Leroi-Werelds et al., 2021).

5.2.3 Hypotheses Development

Digital transformation has been proposed as a potential solution to crises in SMEs (Nambisan et al., 2017). Precisely, an advanced digital maturity, resulting from the digital transformation process, bolsters SMEs agility, facilitating rapid adaptation to environmental changes (Vial, 2019). This can be realized through the optimization of business processes, the exploration of untapped market opportunities, and an increase in customer proximity (Hansen & Kien, 2015; Porter & Heppelmann, 2014). Additionally, digital technologies adopted in the process of becoming digital mature support the formation of value networks, enhancing collaboration and co-creation of values between SMEs and customers (Vial, 2019). Therefore, in light of digital transformation's ability to uphold performance amid crises, SMEs must proactively leverage the intertwined relationship between digital transformation and business model innovation (Priyono, Moin, & Putri, 2020). Accordingly, this involves organizational processes such as product redevelopment, identifying and working with new partners in an ecosystem, and strategic decision-making that creates value within dynamic environments by manipulating available resources into new value-creating strategies (Eisenhardt & Martin, 2000).

Since digital maturity serves as a metric for the state of digital transformation, it can be deduced that a higher level of digital maturity upholds SMEs' performance despite disruptions triggered by a crisis. This strengthening is achieved by improving flexibility, efficiency, and competitiveness through the strategic integration of key digital technologies, including but not limited to cloud computing, artificial intelligence (AI), data analytics and digital platforms. For instance, these technologies provide operational agility, enhanced decision-making capabilities, and expanded market access (Bharadwaj et al., 2013; L. Li et al., 2018). Cloud computing offers SMEs the flexibility to scale their infrastructure according to fluctuating demand, thereby providing cost efficiencies and improved business continuity during a crisis (Low, Chen, & Wu, 2011). Additionally, tech-

nologies such as artificial intelligence and machine learning enhance SMEs' operational efficiency by automating processes and bolstering decision-making through predictive analytics (Ransbotham, Kiron, Gerbert, & Reeves, 2017). Data analytics allow SMEs to harness large datasets for improved strategic decisions and customer interactions (Gupta & George, 2015). Moreover, digital platforms extend an SMEs' reach beyond geographical limitations, opening up new markets and customer bases (Parker, Van Alstyne, & Choudary, 2016). Overall, this enables SMEs to better navigate and respond to crises, potentially minimizing the negative impact. Consequently, SMEs that have achieved higher levels of digital maturity can leverage the implicit digital capabilities to adapt their business models and operations, allowing them to maintain or even improve performance during a crisis. Accordingly, we hypothesize that:

H_1 A higher degree of digital maturity is positively associated with a greater likelihood of superior crisis performance.

Apart from the mere utilization and integration of digital technologies, organizations must effectively manage the organizational and technological changes arising from digital transformation (Westerman et al., 2012). This implies that the impact of digital transformation on SMEs' crisis performance relies on how effectively they have already adopted and integrated digital technologies into their business models, ergo how digitally mature they are. Consequently, the degree to which an SME's business model is disrupted – that is the extent to which the crisis alters different elements of the business model – may depend on the SME's level of digital maturity. Accordingly, SMEs that have embedded digital technologies into their business models prior to a crisis may be better equipped to pivot their operations, modify their value propositions, and exploit new digital channels for value delivery and capture, thereby mitigating the impacts of the crisis (Haddud et al., 2017). Based on these insights, an in-depth understanding of the interrelationship between the business model and digital transformation is crucial in understanding their joint impact on SME performance in times of crisis. We can conceptualize this relationship as a dynamic, iterative process where digital transformation serves as the incentive for business model innovation, while the resulting transformed business model determines

the future course of the SME's digital transformation. This cyclical interaction results in a mutually reinforcing co-evolution of the business model and the SME's digital maturity, which enhances the SME's performance amid a crisis. Thus, the state of digital transformation, reflected via digital maturity, can not only enhance SMEs' performance amid a crisis directly, but also act as a moderating factor that strengthens the resilience of the reconfigured business model in amid a crisis. Subsequently, we hypothesize that:

H_2 The relationship between business model disruption and crisis performance in SMEs is moderated by the SME's degree of digital maturity.

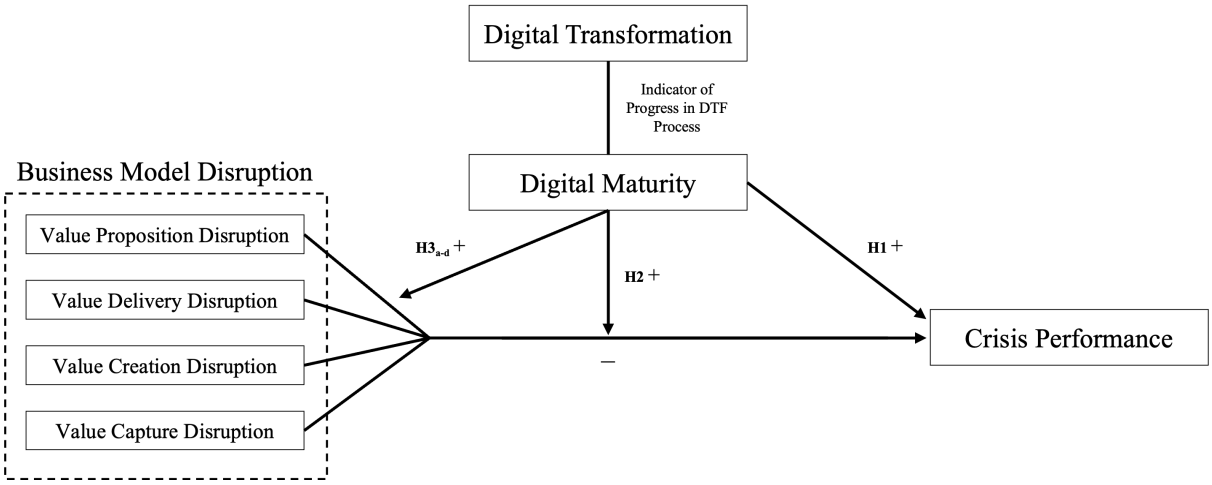
Further, the literature suggests that digital transformation can affect various dimensions of SMEs' business models. Specifically, digital technologies can facilitate the continuous reinvention of business model dimensions, allowing SMEs to remain relevant and successful in the amid crises (Nambisan et al., 2017). This transformative power of digital technologies manifests in various ways. It equips SMEs with the capacity to conceive innovative value propositions (Altunbas et al., 2011), fine-tune value delivery through digital channels (Hansen & Kien, 2015; Seetharaman, 2020), streamline value creation processes (Clohessy et al., 2017; Hess et al., 2016), and implement more efficient value capture mechanisms (B. Tan et al., 2015). Subsequently, as organizations become more digitally mature, they are better equipped to minimize the negative impact of crises on their business model dimensions. Drawing on the premise that digital maturity encapsulates the scope of digital transformation, it is postulated that digital transformation, when integrated into specific dimensions of a business model, can attenuate the adverse effects of crises on the performance of SMEs. Essentially, the digital transformation's influence serves as a moderating factor, cushioning the business model components vulnerable amid crises. Hence, we propose that the effect of the recent Covid-19 pandemic on the four primary subdimensions of the business model – value proposition, value delivery, value creation, and value capture – and the subsequent performance of SMEs is moderated by the SME's level of digital transformation. Based on this, we hypothesize that:

H_3 The relationship between value a) -proposition, b) -delivery, c) -creation and d) -capture disruption and crisis performance in SMEs is moderated by the SME's degree

of digital maturity.

In summary, we propose that the degree to which an SME's business model is disrupted by a crisis and its subsequent performance is intricately intertwined with its level of digital maturity. SMEs with a higher degree of digital maturity may exhibit greater resilience in adapting their business models amid crises, thereby potentially mitigating adverse impacts on their performance, resulting in a moderating effect of the digital transformation process. Figure 5.1 illustrates the proposed theoretical framework.

Figure 5.1: Proposed Theoretical Framework



5.3 Methodology

5.3.1 Sample Description

The primary cross-sectional data with time-lagged variables driving this study was derived from an online survey, conducted between June and July 2021 in Germany, encompassing both SMEs and larger enterprises. The survey was configured via KontiKat, a project aimed at addressing civil societal and corporate continuity through socio-technical networking amid crises (*Zivilgesellschaftliche und betriebliche Kontinuität durch sozio-technische Vernetzung in Katastrophenlagen*, 2023). A total of 2438 surveys were initiated, with 1660 (68.09 percent) being fully completed and 778 (31.91 percent) being incomplete.

This effort furnished a representative sample of 1,677 organizations, composed of a 61 percent representation of SMEs and a 39 percent segment of larger enterprises. Defined in adherence to the European Union (2003), SMEs are entities employing a maximum of 250 employees and attaining an utmost annual turnover of €50 million. It's noteworthy that while a key objective was to focus on SMEs, no direct exclusion criteria were set; thus, all enterprises in Germany were permitted to participate. Furthermore, SMEs (61 percent) were categorically differentiated, wherein 29 percent were recognized as micro-enterprises (hosting up to 9 employees and a maximum annual turnover of €2 million), 13 percent as small enterprises (up to 49 employees and no more than €10 million in annual turnover), and 19 percent as medium-sized enterprises (up to 249 employees and no more than €50 million in annual turnover).

Survey inquiries were discerningly constructed to probe into diverse facets pivotal to the study's primary objective, involving investigations into crisis management, the COVID-19 pandemic's impact, and the extent and repercussions of digital transformation within the organizations. We designed the survey and the order of questions so that respondents' answers would not be influenced by the researcher's assumptions (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The decision to focus on SMEs was guided by their significant role and inherent susceptibility to economic perturbations and crises, especially the disruptions culminated by the COVID-19 pandemic (Adian et al., 2020; Klein & Todesco, 2021; Klyver & Nielsen, 2021).

Through the application of a stratified sampling strategy, bolstered by an incentivization, a representative sample of 1677 organizations, straddling SMEs, and larger enterprises, was initially achieved. The stratification was designed to traverse multiple layers, such as enterprise size and industry type, securing a comprehensive and inclusive representation across 24 divergent sectors, embodying a mix of service and manufacturing industries. This offers a holistic lens through which the digital transformation implications, amid the Covid-19 pandemic, could be examined. After the empirical phase the data collection was followed by the data cleaning, in which large organizations, duplicates and inconsistent observations were removed, resulting in a final sample of 868 SMEs.

5.3.2 Dependent Variable

According to Hamann, Schiemann, Bellora, and Guenther (2013), when examining organizational performance, the four dimensions of organizational performance: profitability, liquidity, growth, and stock market performance, must be considered as a whole or in selected dimensions. As growth, despite the controversial debate about performance indicators, is generally considered as a valid performance indicator (Weinzimmer et al., 1998; Lee et al., 2013), we employ SME growth as our dependent variable. There is no single, ideal measure of organizational growth, which makes it beneficial to investigate a variety of growth metrics to gain a comprehensive understanding of an organization's performance (Donckels & Miettinen, 1997). Therefore, the current study proposes the creation of a composite growth index that combines employment and sales growth as a dependent indicator of organizational performance. Growth of sales and employment are most commonly employed in empirical growth research and labeled as reliable organizational performance indicators (Bhatti & Awan, 2014; Coad & Hölzl, 2011; Donckels & Miettinen, 1997; Parmenter, 2015). On the one hand, sales data is easily accessible, applicable to most organizations, less affected by capital intensity and integration, and considered suitable across various conceptualizations of organizations (Donckels & Miettinen, 1997). On the other hand, assessing growth through employment is advantageous for cross-industry and cross-country analyses. Moreover, when evaluating the growth of SMEs, considering employment data alongside financial indicators may be more reliable as reported sales and profits as single indicators, could be subject to misreporting (Coad & Hölzl, 2011).

We compose the growth index as the sum of changes in employees and in sales (Donckels & Miettinen, 1997) and calculate the changes (growth rates) for all cases based on the formula according to Weinzimmer et al. (1998, p. 253). To account for extreme volatility in terms of the relative growth in SMEs and especially in micro enterprises we constructed the dependent variable as a categorical indicator (Lee et al., 2013). Consequently, the dependent variable of crisis performance is an index of growth calculated by considering

the development of both employees and sales from 2019 (pre-crisis) to 2020 (during crisis). Both employment and sales growth rates are individually categorized into 5 identical categories: 1) −100 to −50 percent, 2) −50 to 0 percent, 3) 0 to 50 percent, 4) 50 to 100 percent, and 5) 100+ percent. Subsequently, the index of growth is calculated by taking the sum of the two categories, which can range from a minimum of 2 to a maximum of 10, with higher scores indicating greater growth. Each SME is uniquely assigned to a category. The calculation of the crisis performance resulted in a categorical variable with nine categories, the sample distribution is shown in Table 5.1. For the purpose of simplification names have been assigned to the categories: Existential Distress, Poor Performance, Below Average Performance, Average Performance, Above Average Performance, Good Performance, Very Good Performance, Excellent Performance, and Prospering.

Table 5.1: Sample Distribution Dependent Variable

Performance Category	**SMEs per Category**
0 = Existential Distress	4
1 = Poor Performance	29
2 = Below Average Performance	132
3 = Average Performance	249
4 = Above Average Performance	386
5 = Good Performance	38
6 = Very Good Performance	27
7 = Excellent Performance	2
8 = Prospering	1

5.3.3 Explanatory Variables

This study examines six explanatory variables that may impact the performance of SMEs amid the Covid-19 pandemic: the key explanatory variables are the degree of digital transformation in 2019 (pre-crisis) and business model disruption (during crisis), as well as the control variables skilled labor, age, size, and innovation output (during crisis). The degree of digital transformation in 2019 is measured via digital maturity by a principal component analysis of 12 binary items and reflects the extent to which a company has adopted digital technologies. Business model disruption is determined by a principal component analysis of 12 binary items and reflects the impact of the pandemic on various

aspects of an organization's business model.

Concerning the control variables, research has demonstrated that skilled labor is linked to crisis performance (Hitt et al., 2001) and the corresponding variable represents the share of employees with a graduate degree. The influence of age, an influencing factor recognized in organizational science studies (Carroll & Hannan, 2004; Stinchcombe, 2000), represents the duration of an organization's existence since its legal inception. The size of an organization is an essential determinant of crisis performance, with prior research suggesting smaller firms are typically more flexible, adaptive, and capable of dealing with rapid changes (Acs & Audretsch, 1988). To account for this, we include a categorical size variable in our study, classifying companies as micro, small, or medium, with size increasing correspondingly with the value assigned. Another key factor influencing performance is innovation (Schumpeter, 1934). This idea has been explored further in recent years showing that a firm's ability to innovate can significantly influence its performance during times of crisis (Filippetti & Archibugi, 2011). The innovation output is also measured via a principal component analysis of four binary items and reflects the extent to which a company has introduced product, process, market, or organizational innovations. A complete overview of all variables can be found in Table 5.2.

5.3.4 Data Analysis

Given the ordinal nature of our dependent variable, which captures varying levels of SME growth, we opted to use ordinal logistic regression. This method allows us to model the probability of an observation falling into a specific category of the dependent variable based on a set of predictors. Specifically, ordinal logistic regression is suitable for our dataset as it provides a way to model the relationship between the ordinal outcome (SME growth) and our explanatory variables. This approach enables us to understand how each unit change in an explanatory variable affects the log odds of the dependent variable falling in a higher category.

To ensure the robustness of our study amidst potential statistical biases, we subjected our models to validation tests. Particularly, a major concern in survey-based research is

Table 5.2: List of Variables

Variable	**Description**	**Type**
Crisis Performance	Index of annual growth as the sum of categorical employee and sales development from 2019 (pre-crisis) to 2020 (during crisis)	Categorical
Digital Maturity	Principal component of 12 items reflecting the adoption and usage intensity of digital technologies in different areas (Digital networking within production / services, Digital networking of production / service provision and logistics, Digital networking with customers, Digital networking with suppliers, Teleworking, Software-based communication, Intranet-based platforms, E-commerce, Social media, Cloud computing, Artificial Intelligence, Security-related technologies)	Continuous
Business Model Disruption	Principal component of 12 items reflecting the impact of the pandemic on all four subdimensions of an organization's business model (10 items form the subdimensions, 2 overarching items)	Continuous
Value Proposition Disruption	Average of 2 items reflecting the impact of the pandemic on an organization's value proposition	Continuous
Value Delivery Disruption	Principal component of 3 items reflecting the impact of the pandemic on an organization's value delivery	Continuous
Value Creation Disruption	Principal component of 3 items reflecting the impact of the pandemic on an organization's value creation	Continuous
Value Capture Disruption	Average of 2 items reflecting the impact of the pandemic on an organization's value capture	Continuous
Skilled Labor	Categorical variable indicating the share of graduates in 9 categories (1-5%, 6-10%, 11-15%, 16-20%, 21-30%, 31-50%, 51-75%, and 76-100%)	Binary
Age	Existence in years as the span of time that a company has been in operation since its legal founding	Count
Size	Organizational size classified as micro (=1), small (=2) or medium (=3) sized organization	Categorical
Innovation Output	Principal component of the introduction of product, process, market, or organizational innovations of an organization	Count

the potential for Common Method Variance (CMV) to confound the results, arising when predictor and criterion variables are collected through the same method (Podsakoff et al., 2003).

In our pursuit to mitigate and assess CMV, Harman's Single Factor Test was administered through exploratory factor analysis, evaluating different model specifications (Harman, 1976; Podsakoff et al., 2003). Crucially, across all scrutinized models, the variance elucidated by the first factor did not transcend the critical 50 percent threshold, a widely accepted criterion for asserting that CMV is not a dominant issue in the data (Podsakoff et al., 2003). Concretely, the total variance explained by the first factor varied between 15 percent and 41 percent across the models, substantiating that our constructs are not influenced by a single common factor. Furthermore, factor loading values did not exhibit a uniformly high loading on the first factor across models, which further supports the non-dominance of a single factor that might indicate pervasive CMV (Podsakoff et al., 2003). Thus, while a degree of CMV may exist, it does not significantly bias the associations identified amongst the studied variables, fortifying confidence that the observed relationships are not merely artifacts of method variance. Our comprehensive analysis, therefore, offers a reliable and rigorous exploration of the data, providing a solid foundation upon which to build our findings and discussions.

5.4 Results

5.4.1 Descriptive Results

The following subsection provides a comprehensive analysis of the business model dimensions by exploring their correlations and addressing potential multicollinearity issues through a Variance Inflation Factor (VIF) analysis. For the analysis of the subdimensions, the correlation matrix shows that there is a strong positive correlation among all business model dimensions (between 0.72 and 0.77). Accordingly, it is important to examine each of the subdimensions in separate models to avoid multicollinearity issues. To mitigate any multicollinearity concerns within the model with the overarching business model variable

we employed a VIF analysis. The results of the VIF analysis are presented in Table 5.3. The Digital Maturity variable has a VIF of 1.064, the Business Model Disruption variable a VIF of 1.077, which suggests that there are no multicollinearity concerns. The other variables also have relatively low VIF values, with Innovation having the highest VIF of 1.359. Hence, the results of the VIF analysis suggest that there is no multicollinearity present in the model considering a cutoff level of 2.5 (Johnston et al., 2018).

Table 5.3: VIF Analysis

Variable	**Variance Inflation Factor**
Digital Maturity	1.064412
Business Model Disruption	1.077384
Skilled Labor	1.180934
Age	1.190400
Size	1.291302
Innovation Output	1.359119

5.4.2 Estimation Results

The ordinal logistic regression, depicted in Table 5.4, uses a composed growth indicator as an estimator for crisis performance (pre-crisis to during crisis) as the dependent variable and incorporates several independent variables including the pre-crisis degree of digital transformation in 2019 estimated via the Digital Maturity variable, and during crisis variables for Business Model Disruption, Skilled Labor, Age, Size, and Innovation Output. The moderation variable is the interaction between the Digital Maturity and Business Model Disruption variables (labeled as DM—BM). The results of model (1) indicate that the pre-crisis digital maturity has a statistically significant positive relationship with crisis performance, with a coefficient of +0.046 ($p < 0.1$). This suggests that a higher degree of pre-crisis digital maturity increases the likelihood of a better crisis performance. Accordingly, we can accept $H1$, albeit considering the weak significance. The Business Model Disruption variable in model (2) has a highly significant negative relationship with the dependent variable, with a coefficient of -0.15 ($p < 0.01$). This suggests that a higher level of business model disruption increases the likelihood of a worse crisis performance. In terms of the moderation variable in model (3) the results show that the relationship

between Business Model Disruption and Crisis Performance is moderated by the level of Digital Maturity of an SME, with high significance and a coefficient of +0.028 ($p < 0.01$). This suggests that the effect of Business Model Disruption on Crisis Performance is dependent on the degree of Digital Maturity in an SME providing support for $H2$.

In summary, the results show that the effect of both Digital Maturity and Business Model Disruption within the ordinal logistic estimation are consistent and statistically significant across all three models. Both effects are most pronounced in the model where both are included (Digital Maturity: $\beta = +0.108,\ p < 0.01$, Business Model Disruption: $\beta = -0.212,\ p < 0.01$). Among the control variables, Skilled Labor is statistically significant and positively related to Crisis Performance across all three models ($\beta_{model1} = +0.103,\ p < 0.1$; $\beta_{model2} = +0.204,\ p < 0.05$; $\beta_{model3} = +0.135,\ p < 0.1$). This suggests that employing skilled labor has a positive impact on an SMEs' ability to perform well during a crisis. Furthermore, Age has a statistically significant negative relationship with Crisis Performance across all three models ($\beta_{model1} = -0.091,\ p < 0.1$; $\beta_{model2} = -0.118,\ p < 0.05$; $\beta_{model3} = -0.083,\ p < 0.1$). This suggests that older organizations may be less resilient and encounter more obstacles when adapting to crisis situations compared to younger organizations. Additionally, Size is statistically significant and positively related to Crisis Performance in model (2) ($\beta = +0.148,\ p < 0.05$). This suggests that larger organizations may have an advantage in performing well during a crisis, possibly due to their greater resources and capacity for response. However, the lack of relationship in models (1) and (3) may indicate that other factors included in these models may be more influential in determining crisis performance.

Table 5.4: Ordinal Logistic Regression

	Dependent Variable:		
	Crisis Performance		
	(1)	(2)	(3)
Digital Maturity	0.046*		0.108***
	(0.027)		(0.029)
Business Model Disruption		−0.150***	−0.212***
		(0.027)	(0.030)
Skilled Labor	0.043*	0.056**	0.043*
	(0.023)	(0.023)	(0.023)
Age	−0.150*	−0.195**	−0.138*
	(0.083)	(0.082)	(0.083)
Size	0.032	0.182*	0.080
	(0.107)	(0.103)	(0.107)
Innovation Output	−0.019	0.022	0.022
	(0.041)	(0.041)	(0.042)
Moderation: DM—BM			0.028***
			(0.009)
Observations	868	868	868
Note:			*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table 5.5 suggests that the disruption of the subdimensions of the overarching business model construct - value proposition, value delivery, value creation, and value capture - have a negative and statistically significant effect on the crisis performance. Specifically, companies with higher disruption in these areas were more likely to show worse crisis performance during the Covid-19 pandemic. Value Proposition Disruption has a negative and statistically significant effect on Crisis Performance ($\beta = -0.402,\ p < 0.01$). The effect of Value Delivery Disruption on Crisis Performance is also negative and statistically significant ($\beta = -0.341,\ p < 0.01$). The same applies to the effect of Value Creation Disruption ($\beta = -0.275,\ p < 0.01$) and the effect of Value Capture Disruption ($\beta = -0.379,\ p < 0.01$) on Crisis Performance.

Additionally, our findings indicate a moderating effect of Digital Maturity on the relationship between the subdimensions of the overarching Business Model Disruption and Crisis Performance in SMEs. Specifically, the moderating effect of Digital Maturity was statistically significant for the dimension Value Proposition Disruption ($\beta = +0.05,\ p < 0.05$), thus supporting hypothesis $H3_a$. Similarly, hypothesis $H3_b$, pertaining to Value Delivery Disruption ($\beta = +0.047,\ p < 0.01$), and $H3_c$ relating to Value Creation Disruption ($\beta = +0.035,\ p < 0.05$) were substantiated by the empirical data. However, the effect of Digital Maturity on the relationship between Value Capture Disruption and Crisis Performance was not significant ($\beta = +0.027,\ p > 0.1$). Therefore, we do not find support for hypothesis $H3_d$.

Among the control variables, some statistically significant effects on Crisis Performance are observable. Specifically, Skilled Labor has a positive effect on Crisis Performance across several models ($\beta_{model1} = +0.040,\ p < 0.1;\ \beta_{model2} = +0.054,\ p < 0.05;\ \beta_{model4} = +0.043,\ p < 0.1$). This suggests that employing skilled labor is an important factor in determining an organization's ability to perform well during a crisis. Additionally, Age also shows a significant relationship with Crisis Performance in model (1) ($\beta = -0.145,\ p < 0.1$) and model (3) ($\beta = -0.155,\ p < 0.1$). The statistically significant negative relationship between age and crisis performance in these models suggests that older organizations may be at a disadvantage in dealing with crises compared to younger organizations. However, the significance of the effects is not consistent across all models which suggests that these variables might not be strong predictors of crisis performance considering this analysis.

Table 5.5: Ordinal Logistic Regression

	Dependent Variable:			
	Crisis Performance			
	(1)	(2)	(3)	(4)
Value Proposition Disruption	-0.402^{***}			
	(0.072)			
Value Delivery Disruption		-0.341^{***}		
		(0.049)		
Value Creation Disruption			-0.275^{***}	
			(0.047)	
Value Capture Disruption				-0.379^{***}
				(0.067)
Digital Maturity	-0.002	0.095^{***}	0.093^{***}	0.034
	(0.052)	(0.028)	(0.028)	(0.055)
Skilled Labor	0.040^{*}	0.054^{**}	0.036	0.043^{*}
	(0.023)	(0.023)	(0.023)	(0.023)
Age	-0.145^{*}	-0.128	-0.155^{*}	-0.131
	(0.083)	(0.083)	(0.083)	(0.083)
Size	0.050	0.045	0.084	0.080
	(0.107)	(0.107)	(0.107)	(0.107)
Innovation Output	0.003	0.030	0.003	0.012
	(0.042)	(0.042)	(0.042)	(0.042)
Moderation: DM—VP	0.050^{**}			
	(0.023)			
Moderation: DM—VD		0.047^{***}		
		(0.016)		
Moderation: DM—VCr			0.035^{**}	
			(0.015)	
Moderation: DM—VCa				0.027
				(0.022)
Observations	868	868	868	868

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

5.5 Discussion

5.5.1 Theoretical Implications

Existing literature denotes SMEs as notably susceptible to the effects of exogenous shocks such as economic crises, attributed to their inherent liability of smallness (Adian et al., 2020; Aldrich & Auster, 1986). Scholars have highlighted that digital transformation holds potential to augment an SME's resilience during crises, principally by fostering increased flexibility, efficiency, and competitiveness (Hassan et al., 2020; Zott & Amit, 2017). However, the initiation, integration, and application of digital technologies present certain challenges for SMEs, mainly due to their limited resources and expertise. Conversely, our findings demonstrate that the pre-crisis degree of digital transformation, represented by digital maturity, positively correlates with crisis performance, thereby aligning with previous research (Hassan et al., 2020; Bettiola et al., 2022). In essence, SMEs with a higher pre-crisis degree of digital maturity were more likely to yield superior crisis performance. This insight echoes the notion that the integration and adoption of digital technologies can support SMEs in swiftly transitioning to new markets or products, optimizing their supply chains, and enhancing communication with customers and stakeholders (Hassan et al., 2020; Kindermann et al., 2021; Zott & Amit, 2017). Moreover, this advantageous effect was observed to persist during the Covid-19 pandemic, a crisis characterized by its unique challenges.

One of the key contribution of our findings is the critical role digital transformation plays as a moderating variable between business model disruption and crisis performance in SMEs. This somewhat contradicts the conventional narrative of digital transformation as a direct performance enhancer (Chesbrough, 2020; T. Morgan et al., 2020), at least amid the Covid-19 pandemic. Picking up on the weak significance of the direct effect of digital maturity on the crisis performance of SMEs, we could show that the path of the effect rather follows the relationship of a moderation. Subsequently, we demonstrate that digital maturity, which mirrors the progress of the digital transformation process in

an organization, acts as a protective shield, mitigating the negative impact of external shocks on SMEs, particularly those heavily disrupted by crises. This insight prompts a re-evaluation of the prevalent understanding of digital transformation in crisis management, emphasizing its strategic role in buffering adverse impacts rather than being merely an operational lever.

Prior studies acknowledge the transformative power of digital technology and its role in innovating the business model dimensions of value proposition, -delivery, -creation, and -capture, specifically within crises contexts (Altunbas et al., 2011; Günther, Rezazade Mehrizi, Huysman, & Feldberg, 2017; Hansen & Kien, 2015; Seetharaman, 2020). We enrich current literature by a detailed understanding of how varying degrees of digital transformation can moderate the interplay between business model dimensions and SMEs' crisis performance. Our research revealed that digital maturity has a significant moderating effect on the relationship between crisis performance and value proposition, -delivery, and -creation dimensions. This aligns with previous works emphasizing the potential of integrating and adopting digital technologies in enhancing the value proposition (Remane et al., 2017), optimizing value delivery (Andal-Ancion et al., 2003; Hansen & Kien, 2015; Seetharaman, 2020), and bolstering value creation processes (Giones et al., 2020; Hess et al., 2016). Subsequently, digital transformation enables SMEs to adapt swiftly to changing market dynamics, a critical factor for survival and recovery during crises (Aldrich & Auster, 1986; Altunbas et al., 2011).

However, in contrast to the existing literature which suggests that the integration and adoption of digital technologies can pave the way for innovative pricing strategies and enhanced revenue streams (B. Tan et al., 2015), we observed no impact of digital maturity within this business model dimension on the crisis performance of SMEs. This unexpected finding suggests that while digital transformation can augment revenue models under normal conditions, its effect may be reduced during crises, possibly due to SMEs prioritizing immediate survival strategies over strategic revenue model transformations.

While the direct and moderating effects of digital maturity constituted our primary analysis, insights gained from the control variables warrant discussion. Our models reveal that

skilled labor has a consistently positive effect on crisis performance, reinforcing the idea that human capital is a crucial asset, especially during crises (Hitt et al., 2001). This might allow SMEs to utilize digital technologies, innovate, and adapt to crisis-induced changes. On the other hand, organizational age exhibits a significant negative relationship with crisis performance in some models. This aligns with previous insights and suggests that older organizations might face challenges in swiftly adapting to rapidly changing environments, perhaps due to established routines and structures that might resist change (Carroll & Hannan, 2004; Stinchcombe, 2000). While the effects observed across all models exhibit nuanced significance and consistency, this opens up avenues for deeper exploration, particularly within the realms of control variables and varying organizational contexts. Such exploration would further illuminate the findings proposed by Adian et al. (2020), Aldrich and Auster (1986), and Zott and Amit (2017), thereby providing a richer understanding of the phenomenon in various scenarios.

In conclusion, this study affirms the significant role of digital transformation in mitigating the negative impacts of crises on SMEs, echoing the sentiments of prior research. Yet, it also underlines the need for a more nuanced understanding of this relationship, one that considers the moderating effect of digital maturity on various business model dimensions. This revelation invites future research to delve deeper into the specific ways in which digital transformation can bolster SMEs' performance during crises and provides a useful foundation for SMEs to strategize their digital transformation journeys effectively.

5.5.2 Practical Implications

This study's findings offer valuable practical implications for SMEs. Primarily, the results imply that SMEs that achieved a higher degree of digital transformation, estimated via their digital maturity, prior to a crisis tend to perform better during a crisis. This underscores the relevance of investing in the integration and adoption of digital technologies to enhance SMEs' competitiveness in amid crises. Moreover, the results show that digital maturity moderates the impact of business model disruption on crisis performance. This suggests that SMEs with advanced digital maturity can mitigate the adverse effect of

business model disruption on crisis performance. Therefore, SMEs should periodically review their business models, especially considering their digital transformation, and assess their vulnerability to crises.

In terms of control variables, the study found no significant effect for size and innovation output on crisis performance. However, organizational age was negatively correlated with crisis performance, implying older SMEs are more crisis-vulnerable and require particular support. Younger SMEs may enjoy a competitive advantage during crises due to their innovativeness and agility, which could be leveraged to disrupt markets or exert more pressure on competitors. In sum, SMEs should prioritize digital transformation under consideration of their business models and evaluate the potential impact of external shocks to enhance their crisis resilience and competitiveness.

5.6 Limitations and Future Research Implications

While this study covers novel pathways in understanding the multifaceted impact of digital transformation amid crisis, certain limitations ought to be considered which, in turn, burgeon promising avenues for future research. Notably, the essence of this research lies in its exploration of the interplay between digital transformation and SMEs' crisis performance through the lens of business model disruptions, offering a rich, empirical investigation into an area that has been sparsely explored.

First, our insights are drawn from a geographically confined sample of 868 German SMEs, circumscribing the generalizability of the findings. This geographical specificity, however, allows for a deep, contextual understanding of the German SME landscape during the Covid-19 crisis. Therefore, allowing a rare empirical glimpse into business model adaptations amid digital transformation in this context. Future explorations might valuably extend this research to SMEs across varying countries and regions, enabling a comparative analysis of digital transformation amid diverse socio-economic environments.

Second, our utilization of a growth index as a performance metric, although multivariate, might not fully encapsulate all performance dimensions. It is critical to acknowledge

the innovative approach in adopting a multivariate growth index, providing a holistic yet quantitatively rigorous examination of performance in a crisis context. Nevertheless, to build upon this foundation, future studies might incorporate additional performance indicators such as market share or profitability ratios to further diversify the understanding of SME performance amid digital transformations and crises.

Third, although we deliberately included the digital maturity variable with a time lag in the survey (we actively asked about the use of digital technologies before the crisis), our primary data is a cross-sectional study. Future studies can build on the results of this study and generate further insights by conducting a panel survey.

Fourth, in terms of measuring digital transformation, our approach, centering on digital maturity, while methodologically robust, may not exhaustively capture an SME's digital transformation panorama completely. Nonetheless, this research innovatively synthesizes empirical data regarding digital maturity and business model responses to crisis, offering novel insights into the operationalization of digital transformation amid crises. For enhanced granularity in future research, refined or additional measures of digital transformation, such as strategic digital utilization or the alignment with organizational goals, might be investigated, shedding light on the nuanced dynamics between digital transformation and crisis performance in SMEs.

Lastly, this research delineates the moderating role of digital transformation in the business model-performance trajectory amid a crisis, providing a nuanced understanding of SME survival tactics. Future research is encouraged to explore other potential moderating or mediating variables, such as varying shock characteristics or the specificity of digital technologies implemented, to uncover diverse strategic implications and enhance the robustness of crisis management frameworks across varied SME contexts and crises.

5.7 Conclusion

In summary, this study offers relevant insights regarding the role of digital transformation in bolstering the ability of SMEs to effectively navigate crises, implied by exogenous

shocks. The results of this study suggest that a higher degree of digital transformation, estimated via digital maturity, is associated with better crisis performance. However, the main finding is that the relationship of business model disruption and crisis performance is moderated by the pre-crisis degree of digital transformation, which highlights the non-direct relation of digital maturity and organizational performance amid the Covid-19 pandemic. These findings have direct implications for practitioners seeking to support SMEs in times of crisis. Although digital transformation may be challenging for SMEs, particularly due to their limited resources and expertise, this study suggests that the benefits of digital transformation in terms of crisis performance outweigh the costs of implementing these technologies for SMEs. Future research should explicitly investigate the impact of digital transformation on SME performance under different types of crises. In addition, it is recommended to use a more comprehensive set of indicators to quantify the degree of digital transformation. This more comprehensive approach could provide additional evidence on the complex relationship between digital transformation, business model configurations and crisis performance in SMEs.

Chapter 6

Synthesis and Concluding Remarks

The subsequent chapter offers a critical consolidation of this dissertation's investigation into the digital transformation journey of SMEs, thereby revealing an overarching narrative that underscores the cumulative significance of this dissertation. It commences with a recapitulation of key findings and contributions (section 6.1), providing a snapshot of the main outcomes. Moving forward, this chapter delves into the overall synthesis of the key findings and contributions (section 6.2). This chapter is divided into the subsection 6.2.1, which bridges the gaps in extant literature presenting the theoretical implications. Following, the theoretical implications are illustrated and described in the subsection 6.2.2 (Illustrative Synthesis of Observed Dynamics). Subsequently, the pivotal findings and contributions are molded into a cohesive interpretation, emphasizing their overarching significance in a broader practice panorama (subsection 6.2.3). Section 6.3 acknowledges the limitations of the study and points towards potential avenues for future research. The section concludes by summarizing the overall journey (section 6.4), encapsulating the essence of this dissertation's exploration into digital transformation in SMEs.

6.1 Summary of the Key Findings and Contributions

The rapid progression of digital technologies has ushered in a new era for organizations worldwide. The importance of understanding how SMEs navigate the complexities of digital transformation cannot be understated considering their economic significance, and especially given the multifaceted implications on their operations, strategies, and overall performance. Through this dissertation, the aim is to provide a rigorous and comprehensive understanding of the stages, challenges, and outcomes associated with the digital transformation journey of SMEs. In the following the core essence of the three studies

associated with this dissertation will be outlined.

The primary objective of the first study ("Dynamics of Digital Change – Measuring the Digital Transformation and its Impacts on the Innovation Activities of SMEs") is to quantitatively assess the digital transformation of SMEs and explore its impact on their innovation performance. This study answers the question: How can digital transformation be empirically measured in the context of quantitative analyses and what influence does the state of digital transformation of an SME exert on its innovation performance?

The study shifts from a focus on the mere integration of digital technology to a more in-depth analysis of the extent to which SMEs engage with these tools. This perspective offers a more nuanced understanding of the adoption and application of digital technologies by SMEs, emphasizing the combination of quality and quantity of technology usage (Westerman et al., 2012). This approach, alongside empirical measurements of digital maturity, provides a robust method to monitor an organization's progress in its digital transformation journey (Berghaus & Back, 2016; De Carolis et al., 2017). A key finding of the study is the strong correlation between high levels of digital maturity and the propensity of SMEs to produce innovations, supporting the theoretical connection between digital transformation and enhanced innovation performance (Casadesus-Masanell & Zhu, 2013; Koellinger, 2008).

The study also outlines the different stages of digital maturity, ranging from basic usage to strategic application for value and knowledge creation. This comprehensive view enables SMEs at different stages of digital maturity to strategically plan and implement their digital transformation efforts (Fabrizio, 2009; Kroh et al., 2018). One significant conclusion of the study is that SMEs at the final stage of digital maturity are capable of producing radical innovations, complementing the extant literature with quantitative evidence (Nambisan et al., 2017). This suggests that advanced digital transformation allows SMEs to fully exploit the potential of digital technologies, leading to significant market innovations. This insight underscores the role of digital transformation in the success of SMEs and emphasizes the need for achieving higher levels of digital maturity (Yoo, Boland, Lyytinen, & Majchrzak, 2012).

In summary, the first study adds to the understanding of digital transformation within SMEs by introducing a new digital maturity metric and providing a detailed analysis of the transformation process and its impact on the innovation performance of SMEs.

Building on the findings of the first study, which highlights the intricacies of digital transformation in SMEs and its impact on innovation, there is a need to explore the broader aspects of digital orientation in more depth (Kindermann et al., 2021). A complementary understanding is required to comprehend digital transformation in its individual facets. The priority here is to find out how digital orientation, which encompasses the strategic alignment and inclination towards digital tools, can influence the performance of SMEs (Kindermann et al., 2021). Accordingly, the second study ("Keeping Pace with the Digitalization – Exploring the U-Shaped Relationship between Digital Orientation and Performance in SMEs") addresses this continuum by emphasizing the role of digital orientation and its implications for SMEs' overall performance, an area frequently overlooked in digital transformation research despite its substantial economic importance (Kindermann et al., 2021; Schweiger et al., 2019; T. Wang et al., 2021). By doing so, the study provides a more holistic view of the digital transformation journey of SMEs, ensuring that the nuances of maturity and orientation are seamlessly intertwined to present a comprehensive narrative of digital transformation in SMEs. This transition not only ties the two studies together but also accentuates the importance of viewing digital transformation as a multi-dimensional process with varying impacts at different stages, from mere technology adoption to strategic orientation. Specifically, the second study delves into the impact of digital orientation on SME performance, aiming to address the research question to what extent digital orientation has an impact on SME performance.

A primary contribution of this study is the introduction of a new method for measuring digital orientation, utilizing textual website data, diverging from traditional methodologies (Hossnofsky & Junge, 2019). This approach offers a unique means of quantifying digital orientation within SMEs, fostering a more comprehensive, data-driven understanding of how organizations adopt and adapt to digital trends. This change in methodology enables more precise, objective, and replicable measurements of digital orientation, marking

an important addition to the field and inviting new opportunities for future research. The study's central finding is the establishment of a U-shaped relationship between digital orientation and SME performance, indicating that SMEs may face initial performance dips during the early stages of digital transformation until a certain level of digital orientation is achieved (L. Li et al., 2018; OECD, 2021; Rupeika-Apoga, Nedovis, & Thalassinos, 2022). Beyond this point, the study found that digital orientation begins to positively influence performance, emphasizing the strategic role of digital transformation in enhancing SMEs' competitive position (Camilleri, 2018; Kane et al., 2015; Quinton et al., 2018).

The implications of this correlation between digital orientation and performance are noteworthy for both SMEs and the broader organizational community. The findings highlight the need for a carefully planned digital orientation and long-term vision when undertaking a digital transformation journey. The study also draws attention to the potential for initial performance losses due to investment efforts, a key factor for SMEs working towards digital maturity (Eller et al., 2020; Nguyen et al., 2015; Ahmad et al., 2014; Taylor & Murphy, 2004; Nasiri et al., 2022).

In summary, the second study substantially broadens our knowledge of digital orientation and its effect on SME performance. The innovative method for measuring digital orientation, together with its significant findings, imparts valuable knowledge to the field and provides strategic guidance for SMEs navigating the complexities of digital transformation.

Having delved into the intricate relationship between digital maturity, digital orientation and SME performance in the first two studies, it becomes imperative to explore how digital transformation is leveraged in times of unprecedented challenges (Miklian & Hoelscher, 2022). The global landscape of organizations experienced a shift with the onset of the Covid-19 pandemic, compelling SMEs to reevaluate their strategies and business models (Adian et al., 2020). Amid this backdrop, the third study ("Digital Transformation Amid Crisis – Navigating SME Growth and Business Model Disruption") emerges as a timely inquiry, pivoting the focus from the steady-state operations of SMEs to their adaptability and resilience in crisis scenarios. Building on the foundational insights from the first

two studies, the third study synthesizes the concepts of digital transformation, business models, and crisis context to offer a holistic view of SME performance. It underscores the idea that the benefits of digital transformation extend beyond mere performance enhancements in steady-state scenarios; they can also serve during turbulent times, enabling SMEs to pivot, adapt, and thrive. This seamless progression from understanding the nuances of digital transformation in SMEs to its application in crisis scenarios accentuates the multi-faceted role of digital transformation in the modern organizational landscape.

Accordingly, the third study presents an in-depth exploration of the role of digital transformation and its effect on SME performance in the context of the Covid-19 pandemic. Consequently, the study answers the question: What is the impact of digital transformation on the relationship between business model disruption and crisis performance in SMEs?

This study sheds light on the impact that external disruptions, such as global pandemics, can have on SMEs and identifies digital transformation as a strategic tool for performance uphold (Bughin et al., 2018; Hassan et al., 2020; Zott & Amit, 2017). It posits that digital transformation can function as a performance-enhancing factor for SMEs during a crisis. The research promotes a balanced view, acknowledging the challenges and threats that crises pose, while also identifying their potential to stimulate growth and transformation for SMEs equipped to adapt. A significant finding from the study is the moderating effect of the degree of an SME's digital transformation on the relationship between the overall business model (including its subdimensions) and crisis performance (Amit & Zott, 2001; Günther et al., 2017). This finding is notable because it implies that the level of digital transformation not only directly influences performance but can also temper the negative impacts of a crisis on various facets of the business model.

The study emphasizes the importance of considering both the business model and digital transformation when dealing with external shocks (Altunbas et al., 2011; Seetharaman, 2020). This combined perspective is a crucial insight, suggesting that digital transformation and the business model should not be managed separately, especially in a crisis. Instead, they should be considered as interdependent elements that together shape an

organization's ability to respond to and recover from crises. This study expands the existing literature by providing insights into how digital transformation can aid SMEs in mitigating the negative effects of the Covid-19 pandemic. It showcases how digital transformation can be utilized as a strategic tool for navigating challenging circumstances, offering valuable guidance for researchers, practitioners, and policymakers (Vial, 2019; Nambisan et al., 2017; Linnenluecke, 2017). In summary, the third study enhances our understanding of digital transformation in SMEs during a crisis, precisely the Covid-19 pandemic. It emphasizes the potential of digital transformation as a strategic asset for SMEs, equipping them to not only survive but also prosper in challenging conditions.

Throughout the trilogy of studies, a coherent narrative on the digital transformation journey of SMEs emerges, painting a comprehensive picture of its multifaceted impact. The first study explores the stages of digital transformation, illuminating its profound influence on innovation performance, and introduces a novel metric for digital maturity. This understanding sets the stage for the second study, which delves deeper into the strategic alignment of SMEs with digital tools, termed as their digital orientation. This orientation, as revealed, plays a pivotal role in influencing SME performance, highlighting the intricate balance SMEs must strike between technology adoption and strategic direction. However, the realm of digital transformation doesn't operate in isolation. The third study positions digital transformation as a beacon during turbulent times, showcasing how SMEs, fortified by their digital orientation, can navigate global crises like the Covid-19 pandemic. In essence, these studies collectively underscore the significance of digital transformation not merely as a tool for growth but as an essential compass for SMEs, guiding them through innovation, performance optimization, and crisis management in an increasingly digitalized organizational landscape.

6.2 Synthesis of the Key Findings and Contributions

6.2.1 Synthesis of Theoretical Implications

This dissertation undertakes on a journey to decipher the intricacies of digital transformation in SMEs, beginning with an empirical investigation of how digital maturity is assessed and quantified. Addressing this challenge in an empirical context, a quantitative measure of digital maturity is established that can be used to estimate an organization's current state of digital transformation. This measure corresponds to existing theoretical insights on the holistic maturity process (Berghaus & Back, 2016; De Carolis et al., 2017; Remane et al., 2017; Valdez-de Leon, 2016; VanBoskirk & Gill, 2016; Westerman et al., 2012), resulting in a four level scale of digital maturity, mirroring the digital transformation progress in organizations. Table 6.1 illustrates how the proposed scale of digital maturity can be listed in the previous table format and how it aligns with existing maturity models with reference to Table 2.3 and Table 2.4.

Precisely, this dissertation contributes to research by using cluster analysis to identify four levels of digital maturity, namely: 1) Early-digital - (Level 0), 2) Lagging - (Level 1), 3) Experimental - (Level 2), and 4) Advanced SMEs (Level 3) that are used as estimators for the degree of digital transformation in organizations. Building on this, the quantitative metric offers a clear perspective on an organization's position in its digital transformation trajectory, augmenting the insights of Westerman et al. (2012). Accordingly, a refined technology-centric and quantitatively validated maturity pathway is introduced, aligning seamlessly with recognized comprehensive maturity frameworks (Berghaus & Back, 2016; De Carolis et al., 2017; Remane et al., 2017; Valdez-de Leon, 2016; VanBoskirk & Gill, 2016; Westerman et al., 2012). This methodology, emphasizing both the embracement and depth of digital technology utilization, delivers a detailed exploration into an organization's digital transformation journey. Such an approach unravels the layered metrics of digital transformation, setting the stage for future empirical investigations and addressing the empirical voids underlined by Thordsen et al. (2020).

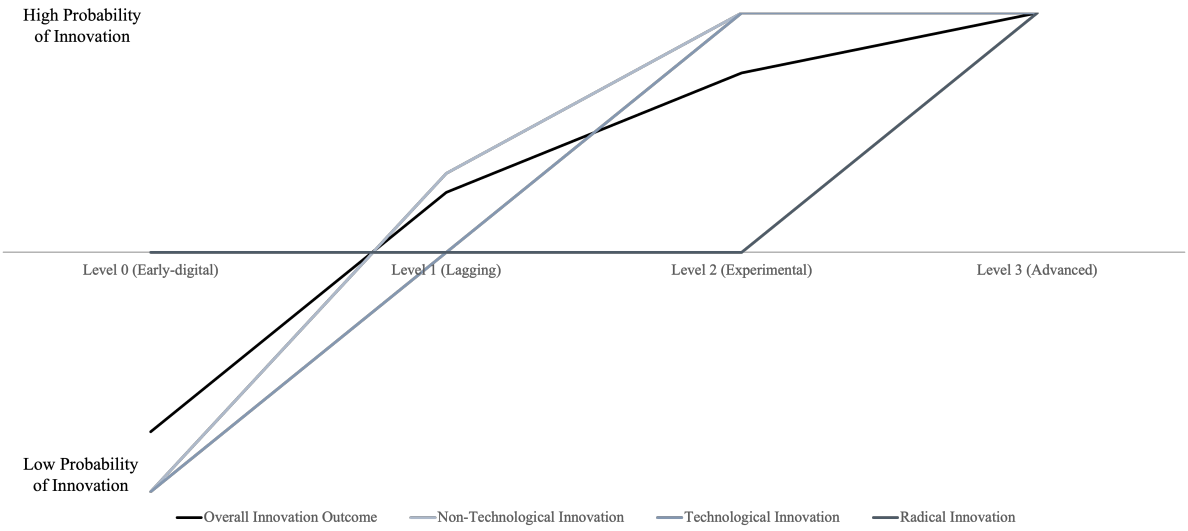
Table 6.1: Overview of Digital Maturity Models III/III

Maturity Model	**Source**	**No. Levels**	**Level**	**Characteristics/Description**
Quantitative Digital Maturity Assessment (4-Level-QDMA)	Escoz Barragan, Hassan, Meisner, and Bzhalava (2023)	4	Early-Digital	Base level SMEs with minimal adaptation to digital technologies; minimal engagement in most technology areas (see Figure 8.1, Figure 8.2, Figure 8.3); directly linked to limited technological and non-technological innovation outcome (see Table 3.8)
			Lagging	SMEs with basic digital engagements, mainly for operations or due to external pressures; initial steps in software-based communication, intranet platforms, and e-commerce (see Figure 8.1, Figure 8.2, Figure 8.3); directly linked to enhanced non-technological innovation outcome (see Table 3.8)
			Experimental	SMEs with pronounced digital interconnections, surpassing lagging SMEs in IT adoption; notably involved in e-commerce, social media, and cloud computing (see Figure 8.1, Figure 8.2, Figure 8.3); directly linked to enhanced technological and non-technological innovation outcome (see Table 3.8)
			Advanced	SMEs extensively integrating a range of technologies; high usage intensity across most technology areas (e-commerce, cloud computing, software-based communication, intranet-based platforms, and social media), specific focus on big data analytics (see Figure 8.1, Figure 8.2, Figure 8.3); directly linked to enhanced technological, non-technological and radical innovation outcome (see Table 3.8)

Source: Own Illustration based on Current Research (Escoz Barragan et al., 2023)

Building on the quantitative classification scale of digital maturity (4-Level-QDMA), the insights of this dissertation also confirm the assumption that digital transformation leads to improved innovation performance in SMEs. Figure 6.1 shows a simplified illustration of the underlying relationships uncovered within this dissertation.

Figure 6.1: Simplified Illustration of the Relationship between Innovation Performance and Digital Maturity in SMEs



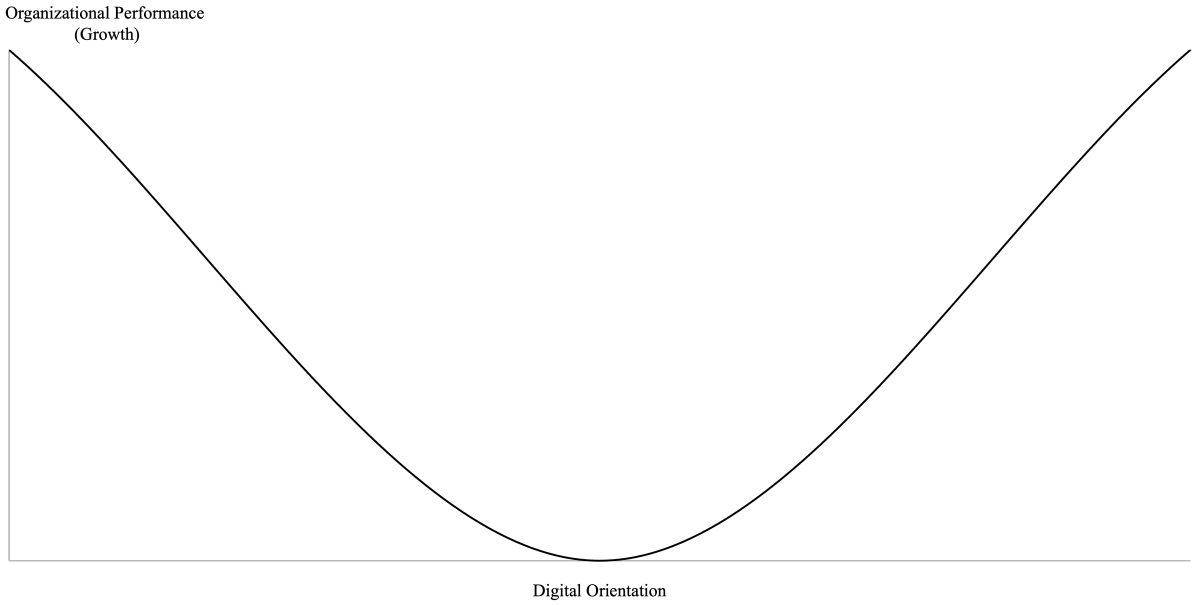
Source: Own Illustration (please note that this is a simplification of the underlying relationships)

Specifically, the results show that a high level of digital maturity enhances the propensity for innovation, while a low level can be detrimental to the innovation activities of SMEs (Casadesus-Masanell & Zhu, 2013; Hong et al., 2016; Morikawa, 2004; Nambisan et al., 2017). In the context of digital transformation, a notable addition to the extant literature emerges at the lagging level of digital maturity. Despite their limited engagement with digital technologies, SMEs at this level manifest a pronounced influence on their non-technological innovation outcome. This relationship has not been uncovered so far, as literature does not link early stages of the digital transformation process to performance gains in terms of innovation outcome (Avlonitis et al., 2001; Berghaus & Back, 2016; Westerman et al., 2012). Subsequently, the effects of digital transformation on an SMEs' innovation potential become evident from the second stage of digital maturity onward, increasing the propensity of both non-technological and technological innovation.

This underscores the premise that heightened technological engagement can pave the way for augmented innovation prospects (Casadesus-Masanell & Zhu, 2013). Contrary to the presumption that both experimental and advanced stages of digital transformation similarly impact radical innovation, empirical evidence from this dissertation suggests that such groundbreaking innovation is exclusive to SMEs in the terminal stage of their digital transformation journey (Nambisan et al., 2017, 2019; Yoo, Boland, Lyytinen, & Majchrzak, 2012).

Building on the foundation of quantified digital maturity and its intricate ties to innovation performance, it becomes imperative to broaden the lens to encompass the strategic dimension of digital transformation. This subsequent exploration not only complements the discourse but also underscores the multifaceted interplay inherent in the broader spectrum of digital transformation within SMEs. In this regard the dissertation provides evidence of a U-shaped curvilinear relationship between digital orientation and SME performance, meaning higher performance levels can be observed at both low and high ends of the digital orientation spectrum. Figure 6.2 shows a simplified illustration of the uncovered relationship.

Figure 6.2: Simplified Illustration of the Relationship between Organizational Performance (Growth) and Digital Orientation in SMEs



Source: Own Illustration (please note that this is a simplification of the underlying relationships)

This initially counter-intuitive result aligns with previous work that highlights digital orientation as a valuable capability for SMEs (Kindermann et al., 2021; Schweiger et al., 2019; T. Wang et al., 2021). Contrary to past studies, this research identifies a decline in performance of SMEs at the initial stages of digital orientation. It is only after passing the trough of the U-shaped curve that intensifying digital orientation starts to enhance SMEs' performance. This divergence may be attributed to the unique challenges SMEs face in the digital transformation process (OECD, 2021; Rupeika-Apoga, Petrovska, & Bule, 2022). Contradicting Nasiri et al. (2022), this study proposes that a medium level of digital orientation does not correspond with higher financial performance. Instead, it suggests that both very weak and very strong expressions of digital orientation are linked to superior performance, whereas organizations "stuck in the middle" tend to suffer performance losses. This offers fresh insights to SMEs in their strategic consideration of digital orientation. In agreement with researchers who view digital orientation as an emerging strategic orientation (Kane et al., 2015; Kindermann et al., 2021), the study emphasizes its role as a competitive advantage for organizations, particularly SMEs (Quinton et al.,

2018). Despite concerns about SMEs' ability to adopt and implement digital technologies due to risk aversion (Ahmad et al., 2014; Taylor & Murphy, 2004; Eller et al., 2020; Nguyen et al., 2015), this research offers an encouraging perspective, as it confirms that SMEs experience short-term performance losses before the trough of the U-shaped curve, but points out the long-term benefits that emerge once the trough of the U-shaped curve is passed.

Within the digital transformation process, it might initially appear paradoxical to witness pronounced impacts at both extremes of the spectrum. The general assumption might be that the lack of a digital orientation would detrimentally affect SMEs' performance. However, this perspective does not account for the strategic choices SMEs make. Many SMEs deliberately prioritize local niche markets, a move that can counterbalance the perceived urgency of an all-encompassing digital orientation (Camilleri, 2018). Such a targeted approach, rooted in understanding the unique needs of localized markets, might indeed deemphasize the immediate need for an intensification of the digital orientation, thereby offering an alternative pathway to sustained performance (Camilleri, 2018). Nevertheless, as digital transformation continues its pervasive trajectory, it is likely that most organizations will be necessitated to engage with this transition. Those that remain reluctant might ultimately face a competitive disadvantage in an evolving digital organizational environment.

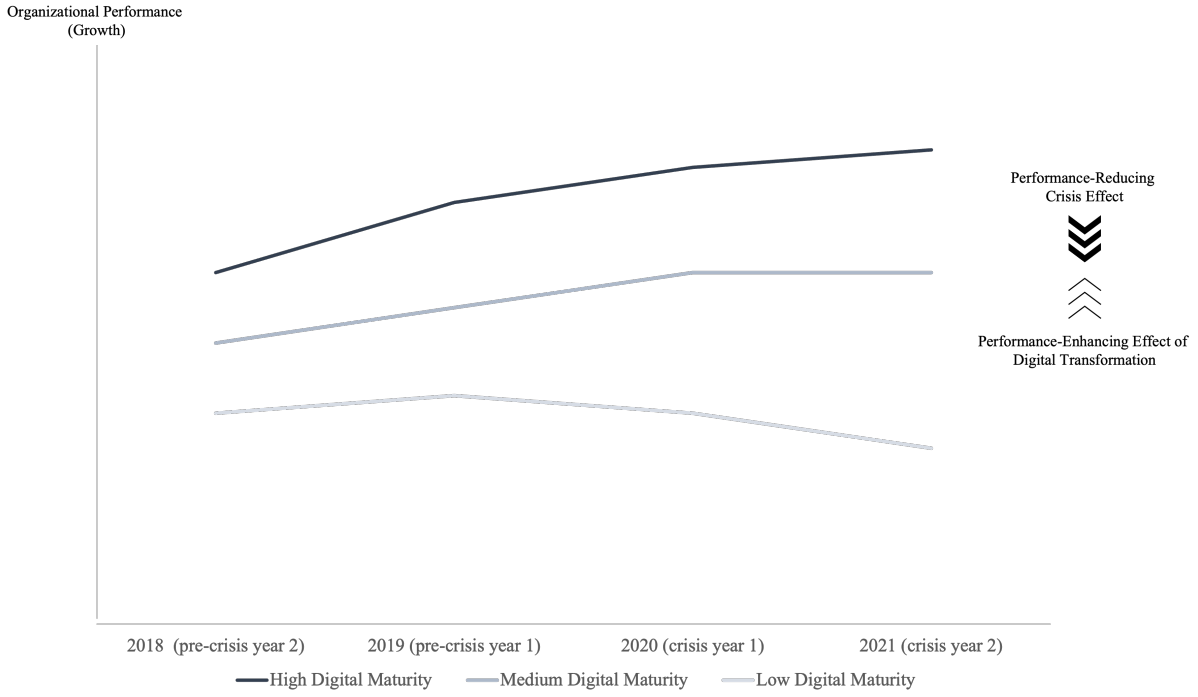
Methodologically, this study adds a new approach to the field by using text-based content analysis of SMEs' website texts, which deviates from traditional survey data or case studies. This allows for more objective and scalable measurement of digital orientation and opens up innovative research avenues. The study demonstrates how constructs can be measured in large-scaled data sets using web-scraping techniques, providing a more reliable picture of reality (Hossnofsky & Junge, 2019).

Having explored the dimensions and dynamics of digital maturity and digital orientation, as well as the quantifiable impact they have on organizational performance (innovation and growth) in SMEs, context factors that might affect the digital transformation journey of SMEs remain. Accordingly, this dissertation took a unique perspective on the role of

digital transformation amid crisis. Precisely, this dissertation sheds light on the role of digital transformation as a moderating variable in the relationship of business model disruption and crisis performance in SMEs. This perspective contradicts the traditional view of digital transformation as a direct performance enhancer (Chesbrough, 2020; T. Morgan et al., 2020). Figure 6.3 shows a simplified illustration of the underlying mechanisms.

The insights of this dissertation suggest that digital transformation acts as a protective shield, mitigating the negative impact of external shocks on SMEs. Accordingly, SMEs with a higher digital maturity are more likely to uphold performance amid crises, at least crises similar to the Covid-19 pandemic. This implies a shift in understanding digital transformation from being merely an operational lever to a strategic tool that buffers adverse impacts. Building on prior studies (Altunbas et al., 2011; Günther et al., 2017; Hansen & Kien, 2015; Seetharaman, 2020; L. Tan, Zhang, Clarke, & Smucker, 2015b), we offer a detailed understanding of how digital transformation can moderate the relationship between business model dimensions and SMEs' crisis performance. We observed significant moderating effects of digital transformation on the value proposition, delivery, and creation dimensions. These findings are in line with previous works (Remane et al., 2017; Andal-Ancion et al., 2003; Hansen & Kien, 2015; Seetharaman, 2020; Giones et al., 2020; Hess et al., 2016). Contrary to existing literature suggesting that digital technologies can enhance revenue streams (B. Tan et al., 2015), we found a less pronounced impact of digital transformation on the value capture dimension during crises. This suggests that while digital transformation may enhance revenue models under normal circumstances, its effect might be limited during crises as SMEs may prioritize survival strategies over strategic revenue model transformations.

Figure 6.3: Simplified Illustration of the Relationship between Organizational Performance (Growth) and Digital Transformation Amid Crisis in SMEs



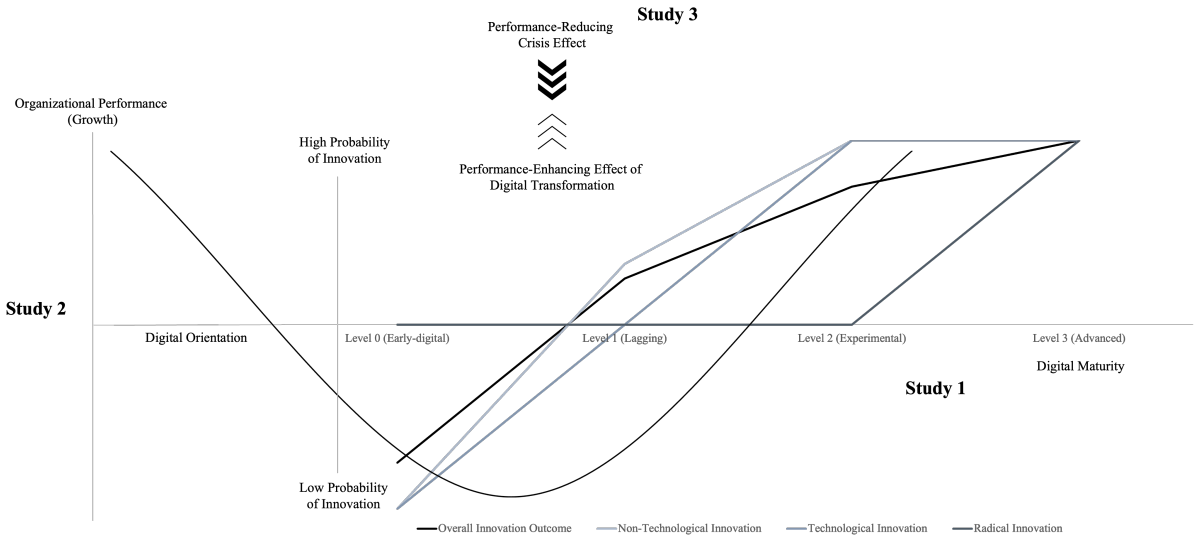
Source: Own Illustration (please note that this is a simplification of the underlying relationships)

Looking at these studies from a meta-perspective, it is evident that digital transformation impacts SMEs in diverse and multi-faceted ways, not always conforming to established theoretical expectations. This dissertation uncovered that the application of digital technologies and digital orientation is not a simple, linear process but entails complex dynamics that can have varying effects on different areas of an SME's operations, from innovation activities to crisis performance. Central to this understanding is the recognition of four distinct levels of digital maturity: Level 0 (Early-digital), Level 1 (Lagging), Level 2 (Experimental), and Level 3 (Advanced). As illustrated in Figure 6.4, the journey through these stages is not merely about implementing technologies but rather a strategic orchestration of aligning technology with organizational objectives. The benefits of a solid digital orientation often manifest with a time lag. This latency can be attributed to the strategic approach an organization adopts towards its digital maturity. In essence, while the seeds of a digital orientation are sown early on, the true fruits are reaped as the organization matures in its digital transformation process. Such a realiza-

tion is pivotal, especially when considering the investments made in the early stages of digital orientation. These investments may seem dormant initially, but they morph into tangible advantages as the organization progresses in its digital maturity. Additionally, the delineation between non-technological innovation, technological innovation, and radical innovation offers a granular perspective on a different performance dimension. While non-technological innovation demonstrates a consistent growth trajectory, technological innovation start being more likely for SMEs from Level 2 onward. Radical innovation, conversely, emerges prominently in Level 3, underscoring the transformative power of advanced digital integration.

In synthesizing these insights, this dissertation highlights the multiple dimensions of digital transformation, emphasizing the importance of strategic foresight, timely investments, and an unwavering commitment to evolving in a digital environment.

Figure 6.4: Simplified Illustration of the Relationship between Organizational Performance (Growth), Innovation Performance, Digital Orientation, and Digital Maturity in SMEs



Source: Own Illustration (please note that this is a simplification of the underlying relationships)

6.2.2 Illustrative Synthesis of Observed Dynamics

With reference to the initially established assumption of relationships as shown in Figure 2.3, the following synthesis of the final findings and contributions can be made: Collectively, the three studies of this dissertation provide a comprehensive and detailed interpretation of digital transformation, highlighting its multifaceted influence on SMEs. The overall relationships uncovered within this dissertation are illustrated in Figure 6.5. Each study, while furnishing its distinctive perspective, cumulatively constructs a detailed exposition on the strategic importance of digital transformation for SMEs, its progressive stages, the crucial role of digital orientation, and the significant influence of digital transformation on various indicators of SME performance during both stable and turbulent periods, exemplified by the Covid-19 pandemic.

An emergent, central theme across the studies is the understanding that digital transformation is more than mere technological adoption. It calls for a shift in digital orientation and a systematic overhaul of the business model. Consideration of not only the extent of technology adoption but also the intensity of technology usage offers an insightful view on an organization's digital transformation progress. As the depth of usage increases with knowledge, resources, and alignment towards the digital transformation, it inherently reflects the advancement of this transformation within the organization. The research acknowledges the possibility of performance declines during the initial stages of digital transformation. However, it robustly demonstrates that the long-term benefits of well-implemented digital transformation outweigh these initial hurdles. Another salient pattern across the studies is the strategic role of digital transformation in reinforcing innovation capabilities, enhancing performance, and improving crisis resilience. These insights hold significant implications for SMEs, suggesting that a strategic and comprehensive embrace of digital transformation is imperative for maintaining competitiveness in an increasingly digital organizational environment.

In addition to their theoretical contributions, these studies present notable methodological advancements in the digital transformation research stream. The innovative methods of

measuring digital transformation and digital orientation deliver a more complex and comprehensive picture of the digital transformation process within SMEs. Hence, the methods delve beyond quantifying digital technology adoption, offering insights into strategic orientation and engagement with digital technologies, as well as the intensity of digital technology usage. Utilizing a variety of data sources and techniques – from textual website data analysis to robust quantitative measures – the studies provide a multifaceted view of the profound impacts of digital transformation on SMEs. Consequently, these studies, when depicted as a cohesive narrative, offer a more holistic understanding, capturing the full spectrum of digital transformation, a feat traditional methods may have fallen short of.

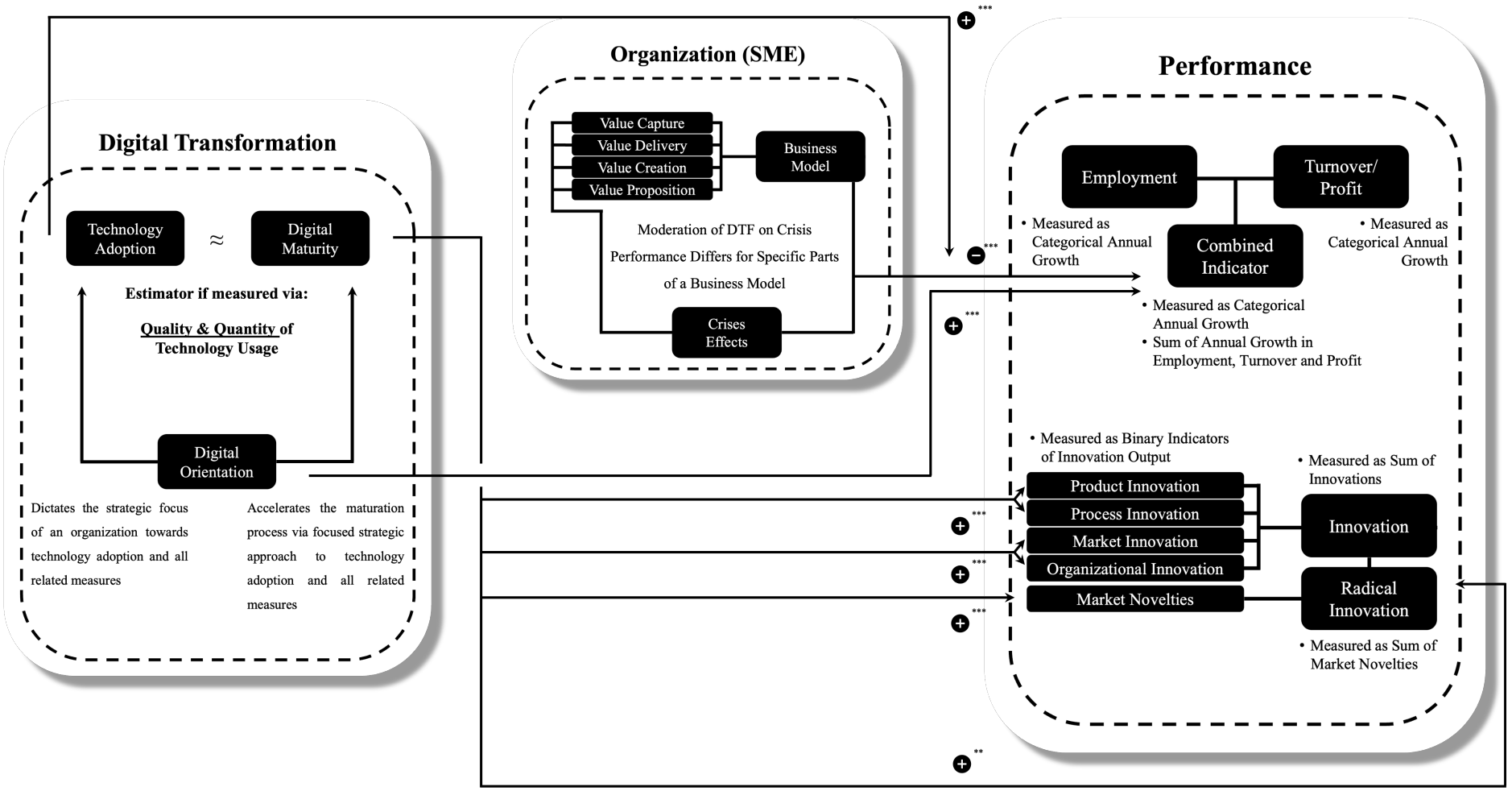


Figure 6.5: Observed Dynamics: How Digital Transformation, Organizational Context, and Performance Metrics Relate in SMEs
Source: Own Illustration

6.2.3 Synthesis of Practical Implications

At the outset of the digital transformation journey, for SMEs in diverse industries, especially those in the early stages of digital maturity (early digital, lagging), it is crucial to accurately capture and assess their current level of digital maturity. This initial assessment serves as a compass, guiding SMEs through the nuanced landscape of digital transformation and setting the stage for subsequent strategic planning and execution. The assessment can be estimated via the categorization suggested in the 4-Level-QDMA (see Table 6.1) based on the usage intensity of the technology groups listed in Table 3.4. Once an SME's digital maturity is assessed, prioritizing digital orientation becomes imperative to align their strategic direction with the ongoing digitalization of the economy, ensuring that their efforts are in harmony with their current level of maturity. Following this, the selection and adoption of technologies that best advance their digital maturity strategically is the next step, accompanied by implementing the necessary organizational changes. This structured approach to embracing digital transformation is visualized in Figure 2.2, which underscores the iterative nature of progressing through stages of digital maturity.

In more detail, the conclusions from this dissertation present pragmatic advantages for SMEs, providing resources and tools that help in gauging their existing level of digital maturity and digital orientation. This enables SMEs to make informed strategic decisions on their path of digital transformation. By identifying their strengths and potential areas for improvement, SMEs can strategically allocate resources, thereby enhancing the effectiveness of their digital transformation efforts. In particular, the findings imply that SMEs need to prioritize digital transformation to enhance their innovation capabilities and competitiveness, especially in dynamic environments. To this end, our findings suggest a targeted and deep integration of technologies, prioritizing impactful advancements over a broad but shallow technological base. Accordingly, SMEs should aim to reach certain digital transformation stages, such as the experimental stage, to fully exploit the potential of emerging digital technologies. They should also prioritize technologies such

as cloud computing, big data, and social media, if they pursue radical innovation as these technology groups have been identified as main drivers of radical innovation.

Moreover, the dissertation points out that SMEs must reflect on their digital orientation to improve organizational performance. Particularly, SMEs that stall mid-transformation should persist and intensify their digital orientation efforts, depending on the industry context and their current stage of digital maturity. SMEs should critically evaluate each potential digital investment, recognizing that not all investments yield immediate performance gains and should align with long-term strategic goals. In this context, it's crucial to engage and support SMEs that are at the nascent stages of digital orientation, even if they currently exhibit strong performance without having embraced digital maturity. These enterprises need encouragement and incentives to embark on the digital maturity journey, as failing to do so may risk their long-term viability and competitiveness in an increasingly digital-centric economy.

In the context of crisis resilience, the study emphasizes the importance of digital transformation investments. These should be directed towards digital infrastructure like cloud services, cyber security, and digital collaboration tools. By doing so, SMEs can efficiently manage remote working, maintain communication during crises, and enhance their crisis resilience and competitiveness. Our research further reveals that SMEs advanced in the digital transformation process can more effectively withstand the shocks of business model disruptions during crises. Consequently, a consistent reassessment of business models in light of ongoing digital advancements is essential for maintaining agility and crisis resilience.

Lastly, on a policy level, the dissertation suggests that promoting support programs addressing the shortage of SMEs pursuing digital transformation can help build a competitive and sustainable SME ecosystem. Therefore, policy measures should be designed to more effectively encourage and support SMEs to initiate and sustain their digital transformation. Particular attention should be paid to those who are in the early stages of digital maturity (early digital, lagging) and at the beginning of a more intensive digital orientation. Accordingly, a comprehensive assessment of digital maturity levels should

be the first step in any structured support program aimed at advancing SMEs' digital maturity. This initial assessment will ensure that the subsequent support and guidance, such as a new alignment of an SMEs' digital orientation, are tailored to each SME's specific stage of digital maturity, thereby fostering a sustained and cohesive advancement in digital proficiency across the entire SME landscape. These consolidated insights offer a comprehensive view of the practical implications of the dissertation for SMEs, guiding them on their digital transformation journey.

In conclusion, the consolidation of this dissertation's primary findings and contributions illuminates the multi-dimensional dynamics of digital transformation within SMEs. Additionally, the diverse and innovative methods employed across these studies considerably deepen our understanding of the digital transformation process. This comprehensive understanding offers invaluable insights to both researchers and practitioners, bridging theory and practice. The collective analysis presents a substantial progression in our understanding of digital transformation, its implications for SMEs, and highlights promising areas for future research.

6.3 Limitations and Future Research Implications

Reflecting on the limitations from a meta-perspective, the overall research encapsulated within this dissertation is bound by certain constraints that influence the interpretability and generalizability of its findings. These limitations offer avenues for future research, further enriching our understanding of digital transformation in SMEs.

Firstly, a recurring limitation is the geographical confinement to German SMEs. Focusing solely on Germany enabled a more granular understanding of a specific market, allowing for richer data collection and deeper insights. This constraint, although allowing an in-depth understanding of the specific context, might curtail the application of these findings to SMEs in other regions or countries with distinct economic, legal, and cultural environments. Future research should consider diverse geographical and cultural settings for a globally representative understanding of digital transformation in SMEs.

Secondly, the methodological approaches utilized in this research, while pioneering in many respects, inherently come with certain restrictions. The decision to use data sets that some might view as outdated stems from the rapid pace of technological progress. When the research commenced, these data sets were among the most comprehensive and recent available, allowing for a robust analysis of digital transformation trends at that time. The rapidly evolving nature of technology means that data becomes less contemporary swiftly. However, using this dataset offered a snapshot of digital transformation during a crucial phase of technological expansion. Recognizing the dynamic technological environment, it is acknowledged that more recent data sets would present a current picture, thereby enhancing the relevancy of our findings. The reliance on a cross-sectional design in multiple studies, while providing a detailed view of a particular moment in time, limits the ability to trace changes and developments over extended periods. Cross-sectional designs are beneficial for capturing a broad spectrum of data in a shorter time frame, making them ideal for studies with temporal or budgetary constraints. Nevertheless, the insights derived are limited to the specific time of the study, potentially missing out on the evolution of trends.

Furthermore, the use of text-based analysis, particularly CATA, in measuring digital orientation is both innovative and limiting. Using website text data as a basis for CATA is grounded in the idea that a company's digital footprint, particularly its online content, is reflective of its digital orientation. While this approach captures an organization's public digital persona, it might not encapsulate all aspects of a company's internal digital operations or strategies. This is comparable to judging a book by its cover – informative, but perhaps not entirely comprehensive. However, in the absence of direct internal metrics, the public-facing content of an organization provides a reasonable and accessible proxy for understanding its digital orientation.

Given these methodological limitations, there's a pronounced need for future research endeavors to consider adopting longitudinal study designs to track the progression of digital transformation over time. Moreover, integrating more recent data sets, applying a combination of quantitative and qualitative methods (mixed-method approaches), and

potentially gathering primary data that captures an organization's digital orientation more directly would substantially augment the depth and breadth of our understanding.

Thirdly, the performance metrics and measures used, including growth indices, might not provide a comprehensive representation of all performance dimensions. However, these metrics were selected for their widespread acceptance and applicability in the industry, making the findings more immediately relevant to practitioners. Future research can diversify the understanding of SME performance by incorporating metrics like market share, profitability ratios, and patent data.

Fourthly, the singular focus on the organizational level might overlook the influence of individual characteristics, decision-makers, and inter-team dynamics on digital transformation. This focus allowed for a clearer, more controlled study of organizational strategies without individual variance. The role and impact of personal attitudes, especially in SMEs where executives have significant influence, might be crucial in shaping an organization's digital transformation process. Future studies can delve into these aspects, examining how individual traits or team interactions affect digital orientation and its subsequent impact on performance.

Lastly, while the findings offer insights into specific contexts such as the Covid-19 pandemic and select industries, the applicability to other crises, varied industry types, or non-crisis situations remains uncertain. Yet, this specificity helped derive insights relevant for businesses navigating the unique challenges posed by the pandemic. Future research can explore digital transformation's role across different crises, industries, and typical operational periods, considering industry and region-specific trends.

In summary, the limitations present fertile ground for future inquiries, potentially expanding, validating, and refining our findings. These prospective directions could lead to a more comprehensive and globally applicable understanding of digital transformation in SMEs.

6.4 Conclusion

This dissertation embarked on an explorative journey into the nuanced role of digital transformation in SMEs, a vital yet often resource-constrained and risk-averse sector of the economy. Through an integrated trilogy of studies, it unveiled the multifaceted dynamics of digital transformation, illuminating its impact on innovation performance, financial health, and crisis resilience.

In synthesizing the insights across the studies, this dissertation illuminates the interconnected nature of digital maturity, orientation, and resilience in SMEs. The journey begins with the foundational concept of digital maturity, where the first study established a quantitative measure correlating digital maturity with innovation performance. It revealed that different stages of digital maturity yield varying impacts on innovation, providing a nuanced view of the transformative journey. This measure, emphasizing both the quality and quantity of digital technology use, serves as a robust estimator for capturing the multifaceted nature of digital transformation. Building on this, the dissertation transitions to the strategic implications of digital orientation in SMEs. The second study's surprising discovery of a U-shaped relationship between digital orientation and SME performance adds depth to our understanding, highlighting the strategic importance of digital orientation at both low and high levels. This finding offers SMEs fresh perspectives for formulating their digital strategies, indicating that initial challenges in digital transformation are overshadowed by long-term performance benefits. Further, the third study shifts focus to the role of digital transformation as a strategic buffer during crises, particularly exemplified by the Covid-19 pandemic. It reframes digital transformation as a moderator rather than just a direct performance enhancer, underscoring its protective role in times of adversity. This study suggests that the benefits of digital transformation in terms of crisis performance outweigh the costs of implementing these technologies for SMEs. This thematic integration of the studies underscores the complexity and layered impacts of digital transformation, moving beyond the view of it as a homogeneous, direct performance enhancer. The findings portray digital transformation as a journey with

stages, each holding distinct implications for SMEs.

The dissertation's focus on German SMEs, along with methodological and scope limitations, point to future research directions. These include broadening geographical scope, employing dynamic methodologies, considering individual-level influences, and applying these findings across various industry types and crisis contexts. In conclusion, this dissertation significantly advances our understanding of digital transformation in SMEs. It opens new avenues for future research and offers SMEs insights to navigate the complexities of the digital era. Concluding with the timeless wisdom of Heraclitus, his words echo profoundly in our rapidly evolving digital society:

"The only thing that is constant is change." – Heraclitus

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Chapter 8

Appendix

8.1 Appendix Article I/III

Title – Dynamics of Digital Change – Measuring the Digital Transformation and its Impacts on the Innovation Activities of SMEs

Figure 8.1: Digital Usage Intensity per Type of Technology (T1 – T5) & Average Cluster Usage Intensity

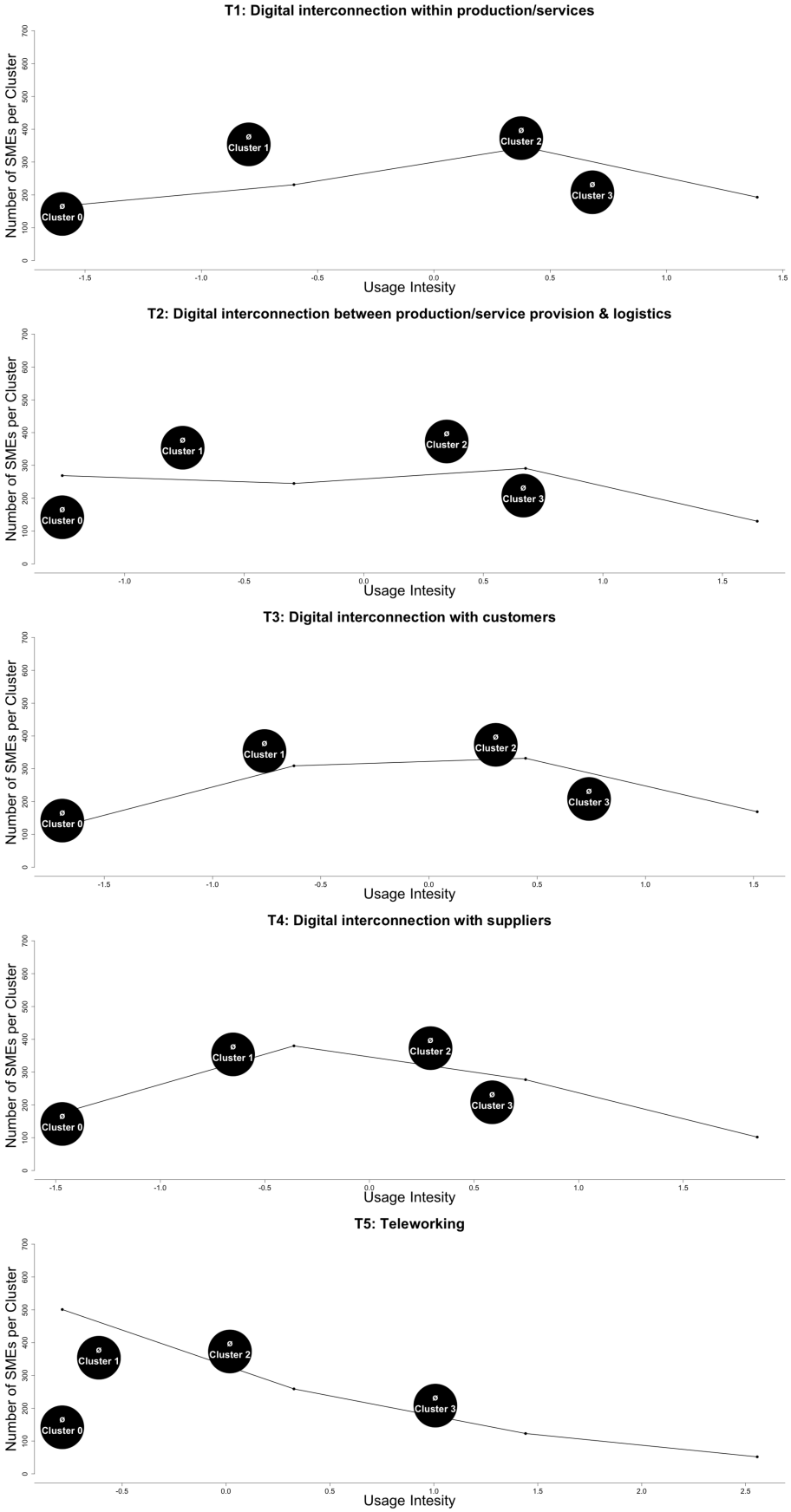


Figure 8.2: Digital Usage Intensity per Type of Technology (T6 – T10) & Average Cluster Usage Intensity

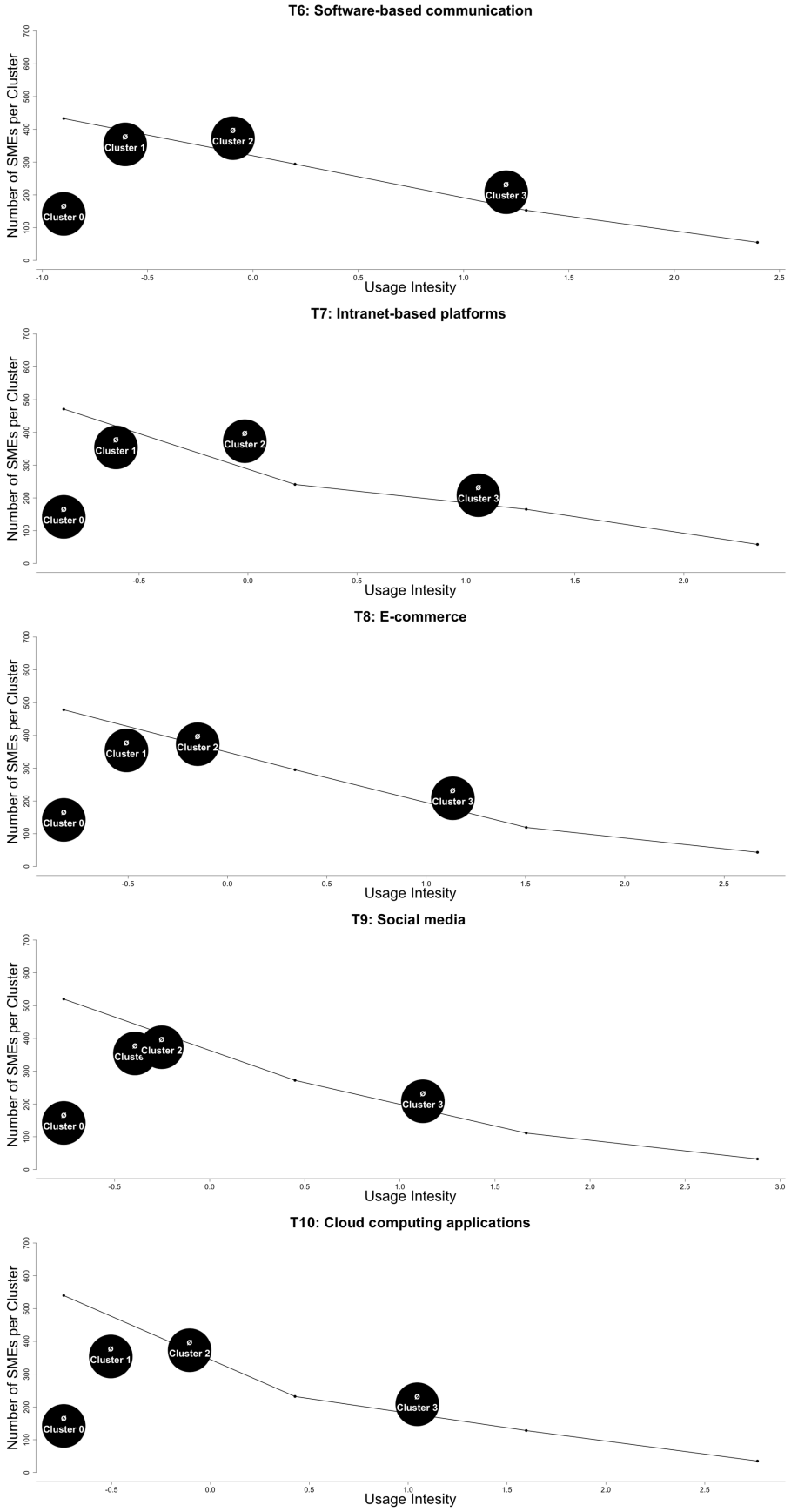
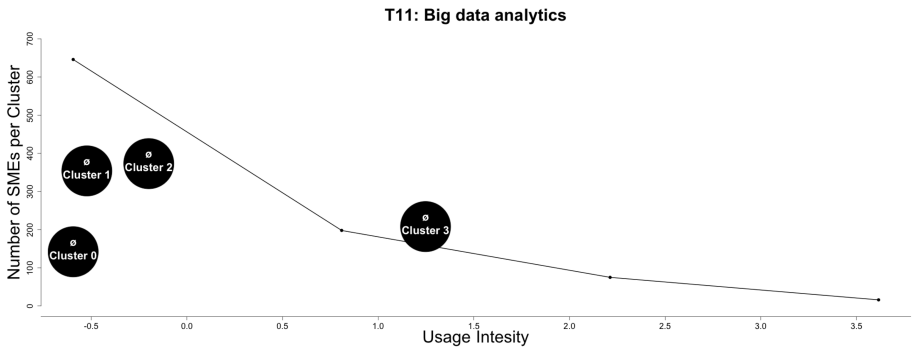


Figure 8.3: Digital Usage Intensity per Type of Technology (T11) & Average Cluster Usage Intensity



8.2 Appendix Article II/III

Title – Keeping Pace with the Digitalization – The Link between Digital Orientation and Performance in SMEs

Table 8.1: List of Digital Orientation Words

Category	Description
Architecture Configuration	”3-D printed”, ”3-D printing”, ”3D printing”, ”additive manufacturing”, ”advanced manufacturing”, ”algorithm”, ”algorithms”, ”analytical tool”, ”analytical tools”, ”automated”, ”automating”, ”automation”, ”chief digital officer”, ”chief information officer”, ”CIO”, ”computer”, ”computers”, ”cyber”, ”cybersecurity”, ”data”, ”database”, ”databases”, ”digital”, ”digitalization”, ”digitally”, ”digitization”, ”fintech”, ”hardware”, ”information security”, ”information systems”, ”information technology”, ”IT infrastructure”, ”IT infrastructures”, ”IT system”, ”IT systems”, ”operating system”, ”operating systems”, ”real time”, ”real-time”, ”remote monitoring”, ”robot”, ”robots”, ”robotics”, ”standardize”
Capabilities	”analytics”, ”artificial intelligence”, ”AI”, ”autonomous”, ”big data”, ”Bluetooth”, ”compute”, ”computing”, ”connectivity”, ”customizable”, ”deep learning”, ”designer”, ”designers”, ”developer”, ”developers”, ”electronic”, ”engineer”, ”engineers”, ”functionality”, ”functionalities”, ”informatics”, ”integrated solutions”, ”interface”, ”machine learning”, ”mobile”, ”programmable”, ”programmer”, ”programmers”, ”self-driving”, ”smart”, ”streaming”, ”technologist”, ”technologists”, ”technology-enabled”, ”ubiquitous”, ”user experience”, ”user interface”, ”wireless”
Ecosystem Coordination	”application programming interface”, ”API”, ”APIs”, ”desktop”, ”desktops”, ”device”, ”devices”, ”ecommerce”, ”e-commerce”, ”enterprise resource planning”, ”ERP”, ”multi-channel”, ”network infrastructure”, ”omnichannel”, ”online”, ”on-line”, ”open source”, ”phone”, ”resource planning system”, ”SaaS”, ”smartphone”, ”social media”, ”software as a service”, ”tablet”, ”tablets”, ”technology platform”, ”technology platforms”, ”web”, ”webs”, ”website”, ”websites”
Technology Scope	”advanced communications”, ”advanced technology”, ”advanced technologies”, ”app”, ”apps”, ”bandwidth”, ”blockchain”, ”bot”, ”broadband”, ”cloud”, ”cloudbased”, ”control system”, ”control systems”, ”drone”, ”drones”, ”electronics”, ”high-speed”, ”information management”, ”internet of things”, ”IoT”, ”internet,”, ”IT solutions”, ”network services”, ”programmed”, ”sensor”, ”sensors”, ”software”, ”telematics”, ”telemedicine”, ”virtual”, ”virtualize”, ”virtualized”, ”virtualization”, ”wifi”, ”wi-fi”

Source: Kindermann et al. (2021)