



The Triple Nexus: Digital Transformation of Manufacturing SMEs as Holistic Organizational Change

DIEPOLDER, Manuel

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The Triple Nexus: Digital Transformation of Manufacturing SMEs as Holistic Organizational Change

Manuel Diepolder

A thesis submitted in partial fulfilment of the requirements of
Sheffield Hallam University
for the degree of
Doctor of Business Administration

July 2025

Candidate Declaration

I hereby declare that:

1. I have not been enrolled for another award of the University, or other academic or professional organization, whilst undertaking my research degree.
2. None of the material contained in the thesis has been used in any other submission for an academic award.
3. I certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully acknowledged.
4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy, and ethics approval has been granted for all research studies in the thesis.
5. The word count of the thesis is 67,960.

Name	Manuel Diepolder
Award	Doctor of Business Administration
Date of Submission	July 16, 2025
Research Institute	Sheffield Business School
Director of Studies (until July 2023)	Dr Roy Woodhead
Director of Studies (since February 2024)	Dr Sohrab Moshiri
Supervisor	Prof. Dr. David Wagner

Para Santiago y Rafael,

**who graciously shared their dad with Academia
for quite a long time**

Acknowledgement

The world has changed entirely since August 16, 2018. On that very day, my admission to the Doctor of Business Administration program—offered jointly by Munich Business School and Sheffield Hallam University—was confirmed. When I decided to embark on this journey, much of what was going to happen during the upcoming seven years was unthinkable. Fast forward to July 2025, Germany has been facing economic stagnation for years, a war is raging in Europe, and the global atmosphere is heating ever faster.

But not only the big wide world is in upheaval. My professional microcosmos has been equally eventful. In our family firm, these seven years have been the most dynamic period in the company history. I onboarded my brother as a co-CEO and together we transitioned the company from the first to the second generation in an exceptionally smooth manner. We steered through a worldwide pandemic and drastic economic dislocations. Our headcount and revenue more than doubled by establishing a completely new business model.

Amidst all these fundamental turbulences, I permitted myself the luxury to work part-time on this research project. Whenever I was asked about the reasons for engaging in doctoral studies, the simple answer was: Because I want to. Driven by sheer intrinsic motivation, neither did I need a booster for my career, nor did I strive after reputation. Some regarded it as an useless plan to slake my selfish ambitions; for me, however, it was the grand quest to achieve a life goal that I had set years ago. I wanted to prove to myself that I was able to accomplish this target.

This thesis would not have been possible without the support of numerous special people. First, I heartily thank the participants of this study for allowing me to dive into their organizations and for spending their scant time on my research project. I am totally aware of the reluctance to disclose information in most SMEs, which makes their contribution even more valuable.

Second, I am sincerely grateful to the two universities that gave me the opportunity to enroll in the doctoral program. Particularly, my supervisor Roy during the first part of the research, later Sohrab as my Director of Studies and David who has been at my side throughout the project deserve my heartfelt thankfulness for assisting me along the way with their kind words of motivation, profound academic expertise and honest feedback.

Third and lastly, I owe eternal gratitude to my family from the bottom of my heart. My parents and my siblings believed in me from the beginning until the end, never questioning the rationale for my strange hobby. Above all, there are no words to express my immeasurable appreciation for my wife Gabriela, and still I attempt. From the moment she encouraged me to apply for the doctoral program until writing these lines just before submitting the thesis, she got my back. The countless hours I invested in the doctoral program would have been impossible without her unconditional support. Considering that we welcomed two lovely boys in our little family over the course of the doctoral program makes this even more admirable. Every minute I spent on my research was a minute I could not spend with them. That was by far the biggest sacrifice, and it was mutual.

It will never be forgotten.

Abstract

Our business world has become increasingly digital over the last decades. While the omnipresent digital technologies are generally unspecific to any firm type, incumbent SMEs are lagging behind big corporations regarding their adoption due to their liability of smallness. Especially manufacturing SMEs struggle to transform digitally because they depart from a comparably challenging starting position with products and services that are analog by their very nature. Accounting for a significant share of the economies in the Global North, incumbent manufacturing SMEs are of crucial relevance for the economic, social, and political wellbeing of these countries. However, holistic research on the digital transformation of SMEs is scarce and heterogeneous. This thesis addresses this gap by investigating ten manufacturing SMEs in Southern Germany through an organizational change lens. Applying an exploratory multiple-case study approach, the empirical data and the extant literature are abductively iterated to build a theory of digital transformation as holistic organizational change. With this research, I contribute a theoretical model consisting of the triple nexus for successful digital transformation: First, the technological nexus places emphasis on deploying digital initiatives in SMEs. Second, the commercial nexus requires establishing business rationales for digital initiatives to serve an economic purpose in the overall context of the company. Third, the human nexus postulates facilitating organizational change to render digital initiatives effective. The findings suggest that a holistic approach that balances the triple nexus enhances the success of the digital transformation of SMEs. Furthermore, I add to the organizational change literature by demonstrating that digital transformation in incumbent manufacturing SMEs is a matter of continuous organizational change. Moreover, I contribute to the management and information systems literature by consolidating the ambiguous body of knowledge with an integrated view on digital transformation. The implication for practice is a translatable theory that complies with rigorous academic standards and simultaneously appeals to SME decision-makers to orchestrate digital transformation. Additionally, I emphasize the necessity to place SMEs in the focus of policymakers. Lastly, the reflexive interpretation methodology permits novel perspectives on a phenomenon that has thus far predominantly been approached with positivistic assumptions. All in all, digital transformation is neither purely about technology nor strategy but about a holistic equilibration of technological, commercial, and human facets.

Key words: Digital transformation; digitalization; digitization; digital innovation; digital business model innovation; incumbents; SMEs; multiple-case study; digital technologies; manufacturing; organizational change

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Index of Abbreviations

Abbreviation	Long form
AI	Artificial Intelligence
AJG	Academic Journal Guide
APA	American Psychological Association
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
B2B	Business-to-Business
BIM	Building Information Modelling
CAD	Computer-Aided Design
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CEO	Chief Executive Officer
CPU	Central Processing Unit
CRM	Customer Relationship Management
CTO	Chief Technology Officer
DIL	Digital Innovation Lab
DMS	Document Management System
DNA	Deoxyribonucleic Acid
DORA	Declaration on Research Assessment
DOS	Disk Operating System
DT	Digital Transformation
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport
ERP	Enterprise Resource Planning
EU	European Union
FTE	Full Time Equivalent
GDPR	General Data Protection Regulation
GPT	Generative Pre-trained Transformer
GT	Grounded Theory
HLL	High-Level Language
HMI	Human-Machine Interface

Abbreviation	Long form
HR	Human Resources
i.e.	that is (latin: id est)
ICT	Information and Communications Technology
IHK	Industrie- und Handelskammer (Chamber of Industry and Commerce)
IP	Internet Protocol <i>or</i> Ingress Protection (depending on context)
ISIC	International Standard Industrial Classification
ISO	International Organization for Standardization
IT	Information Technology
KPI	Key Performance Indicator
MES	Manufacturing Execution System
n.e.c.	not elsewhere classified
n/a	not applicable
OECD	Organization for Economic Co-operation and Development
PC	Personal Computer
PDA	Production Data Acquisition
PDF	Portable Document Format
PIM	Product Information Management
PLC	Programmable Logic Controller
PSS	Product-Service Systems
QR	Quick Response
R&D	Research and Development
RFID	Radio Frequency Identification
SaaS	Software as a Service
SMACIT	Social, Mobile, Analytics, Cloud, Internet of Things
SME	Small and Medium-sized Enterprise
USA	United States of America
USP	Unique Selling Proposition
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
XML	Extensible Markup Language

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1. Digital Transformation of SMEs Matters

1.1. Background and Personal Interest

Digital technologies, defined as "combinations of information, computing, communication, and connectivity technologies" (Bharadwaj et al., 2013a, p. 471) and their effect on business and management are one of the dominating topics in my day-to-day professional life. A common acronym for digital technologies is SMACIT, referring to social, mobile, analytics, cloud, and internet of things (Westergren et al., 2024). No matter if intra-organizational processes or external relationships with customers, suppliers or other stakeholders are concerned, digital matters are omnipresent and no "sector or organization is immune to the effects of digital transformation" (Hess et al., 2016, p. 123). Or even worse, companies unable to keep up will fall victim to *digital Darwinism* (Goodwin, 2022). Accordingly, discussions about the topic always oscillate between great expectations and strong concerns (Oberländer et al., 2021), a dichotomy mainly attributed to the concept's intangibility and ambiguity. The ubiquity of digital-only trailblazers such as Google, Alibaba, or Amazon on the one hand and the cautionary tales of the downfall of former beacons such as Kodak and Nokia on the other hand add to the unsettledness of incumbent firms (Chan et al., 2019). In fact, there is a widespread trepidation that "digital transformation will create a completely new world order—a one-for-one disruption of old by new—as more data, connectivity, and digital intelligence eradicate global boundaries and upend the old industrial order" (Furr et al., 2022, p. 596). But independently if someone takes a rather negative stance or believes in the benefits, everyone seems to agree on one common denominator: Digital technologies have the potential to radically change the way business is being done.

My personal practical experience as the owner and leader of an incumbent manufacturing SME is the impetus for the research project (Siggelkow, 2007). The family firm I lead is a typical representative of this type of company: family-owned, flexible, and financially healthy, but also conservative about taking risks. Spearheading the second generation since 2015, I have already reinvented copious aspects of all facets of the company, including its digital trajectory. Being responsible for the digital alignment of the company, however, I have barely even walked the first steps on the long path of *digitality* (Negroponte, 1995). A successful digital management and its potential amenities (Zimmermann, 2018)

will be of paramount relevance for my own and for countless other companies all around the globe. The consequence of not taking the issue seriously would put the survival of thousands of SMEs at risk, which emphasizes the relevance and timeliness of this research project (Whetten, 1989). But in the middle of difficulty lies opportunity: SMEs can utilize digital technologies for their own strategic advantage if they decide to perceive the challenges ahead as an opportunity rather than a threat.

1.2. Approaching Digital Transformation

It is particularly puzzling that one of the premier journals for digital transformation, the Journal of the Association for Information Systems, published a special issue on the topic in 2023 called “Envisioning Digital Transformation” (Rowe & Markus, 2023). Being a subject with great impact for any organization and after a decade of academic investigation, it exemplifies the still nascent state of the field. Moreover, the editors call “to clearly define digital transformation in a way that differentiates it from its neighboring concepts” (Markus & Rowe, 2023, p. 329). This section heeds the call to set the stage for this thesis by elaborating the scope and the definition of digital transformation.

1.2.1. Scope of Digital Transformation

All things digital in general and digital transformation in particular carry an aura of ambiguity (Gong & Ribiere, 2021). The delineation of the concept’s scope enhances the precision, coherence and applicability of this research to avoid talking about “a phenomenon that is messy, complex, and chaotic” (El Sawy et al., 2010, p. 835). First, contextual ambiguity arises because the governmental, institutional or societal perspective uses the same terminology (Kraus et al., 2022). However, these views differ significantly compared to the organizational lens that is taken in this research (Legner et al., 2017; Rachinger et al., 2019; Unruh & Kiron, 2017). Moreover, alternative conceptualizations such as *relational digital transformation* (Lanamäki et al., 2020), which is particularly useful for studying industry-level changes, lie beyond the scope of this thesis. Since this research is centered around SMEs, the digital transformation of super-organizational entities such as markets, public authorities or entire nations is neglected (Piccoli et al., 2024). Furthermore, digital transformation as “collective social action” (Tana et al., 2023, p. 1618) on a societal level is not part

of this analysis. Some authors use the term *organizational digital transformation* for explicit clarification of the type of entity (Omol, 2024; Schiuma et al., 2024). However, since the SME is the object of study here, digital transformation implies the organizational view throughout this thesis. Moreover, digital transformation has often referred to the study of the evolution of technology (Markus & Rowe, 2023). This research adopts the perspective of technology-in-use rather than technology in itself.

Second, scholarly ambiguity originates from the divergence of the streams of research that have developed over the last decade. X. Zhu et al. (2021) identified seven research themes on digital transformation, namely digital business strategy, strategic action field, digital technology, agile digital transformation, digital enterprise architecture, DT of manufacturing, and DT of consulting services. Riasanow et al. (2019) even detected twelve schools of thought, with significant discrepancies in the viewpoints between the wider disciplines of management studies, information systems, and organization science. Also Hausberg et al. (2019) unearthed three dominant research streams on digital transformation, namely finance, marketing, innovation, and six further scientific domains, namely knowledge management, analytics, manufacturing, supply chain, society, and tourism. This fragmented academic landscape effectively prevents an integrated view of digital transformation. While this study is empirically situated in the manufacturing sector, it nevertheless strives for incorporating the quintessential ideas from all relevant disciplines for a holistic perspective. This is especially important for such a multifaceted concept (Verhoef et al., 2021) that sits at the crossroads of different fields (Soluk & Kammerlander, 2021).

Third, much of the confusion around *digitality* can be attributed to the undoubtful fuzziness and mutual resemblance of the terms that are employed to describe its multifold embodiments (Fischer et al., 2020). The result is terminological ambiguity. The terms *digitization*, *digitalization* and *digital transformation* are often used randomly without definition (Nambisan et al., 2019), inconsistently (Fernández-Rovira et al., 2021; Reinartz et al., 2019) or synonymously (Horváth & Szabó, 2019; Radicic & Petković, 2023). Following Verhoef et al. (2021), *digitization* refers to the encoding of information from an analog to a digital format; *digitalization* is the alteration of processes using digital technologies and digitized information; and *digital transformation* represents a

systemic view of the changes that take place on an organizational level. The former two are more concerned with the implementation of information and communication technologies, whereas the latter focuses on strategy, organizational structure, innovation, and business models (Vial, 2019). In the extant literature, the three stages have an inherent sequential order (Eller et al., 2020), which implies that the next stage can only be reached if the previous one has been completed.

Fourth, with a substantial potential of semantic ambiguity, authors such as Verhoef et al. (2021) use the term *digital transformation* both for a specific stage within the progression as well as the title for the progression itself. Taking into consideration the phenomenon's processual and therefore "fluid character that spreads out over both space and time" (Langley, 1999, p. 692) and simultaneously accounting for a semantic unambiguousness, the initial working title for the overall process was *digital evolution*. This nomenclature also incorporated the probability that just like in the context of its biological derivation (Zaman et al., 2014), an evolution is a never-ending sequence of adaptations—digital transformation is likely not the final stage (Piccoli et al., 2024; Soluk & Kammerlander, 2021). However, the term digital evolution was abandoned when starting the write-up phase of this thesis even if there is evidence (as will be demonstrated in the discussion chapter) that an evolution is a more fitting term in comparison to transformation. By sticking to an established term as digital transformation arguably is, the connectivity to the academic and professional audience is superior compared to a newly introduced term and does not further add to the different levels of ambiguity mentioned in this section.

Fifth and most essentially, digital transformation suffers from conceptual ambiguity. The buzzword *digital* has seen a sharp increase in its usage over the last two decades while the incumbent term *IT* has seen a decline over the same period—in many cases without clearly presenting an ontological justification the switch in terminology (Baiyere et al., 2023). With the goal of upending this mistiness, the next section defines the concept.

1.2.2. Definition of Digital Transformation

From a linguistic point of view, *digital transformation* consists of two words that each already had their discrete meaning before being entangled to form a wholly new term. In the Britannica Dictionary, *digital* refers to something that is

characterized by computer technology ([The Britannica Dictionary, 2025a](#)) and a *transformation* is defined as a complete or major change in someone's or something's appearance or form ([The Britannica Dictionary, 2025b](#)). In conjunction and applied to an organizational entity, a digital transformation is a complete or major change in an organization's form that is characterized by computer technology. Hence, a digital transformation implies entitative shifts for a company. At the same time, the perceived magnitude of a change might differ from company to company. For instance, one SME might already construe the implementation of mobile work as seismic while others implemented the corresponding technologies casually along the way. The following paragraphs add to the objectivization of the matter.

In the light of the diversity and heterogeneity of the pertinent literature ([Markus & Rowe, 2023](#)), the overview of extant definitions focuses on theoretical conceptualizations ([Morgan-Thomas, 2016](#)). Table 1 summarizes the papers that investigated digital transformation in its own right rather than from a related field that applies digital technologies. By synthesizing the vast accumulated knowledge, it enhances the understanding of the concept. Only definitions that were published recently in highly ranked journal articles (AJG 3 or 4) and that comply with the formal rules by [Wacker \(2004\)](#) were considered. These five publications are seminal papers that are hearkened back to throughout this thesis.

Digital transformation is characterized by three common core components. First, digital transformation is triggered by technology. All authors agree that the nature of technology is digital. However, there is a distinction regarding the types of technologies involved. [Vial \(2019\)](#), [Gong and Ribiere \(2021\)](#), [Hanelt et al. \(2021\)](#) and [Verhoef et al. \(2021\)](#) consider all non-analog technologies as a uniform set based on the seminal definition by [Bharadwaj et al. \(2013a\)](#). Contrarily, [Piccoli et al. \(2024\)](#) differentiate between *legacy* (information technology) and *modern* (digital) technologies. While this is a thoughtful theoretical distinction that will be discussed in more detail later, it is of no avail for the practical orientation of this thesis. Second, the factor time plays an important role. Digital transformation is described as a process ([Vial, 2019](#)), change ([Hanelt et al., 2021](#); [Verhoef et al., 2021](#)), change process ([Gong & Ribiere, 2021](#)), or

Table 1:*Extant Definitions of Digital Transformation*

Authors	Year	Paper	Journal	Approach	Definition
Vial	2019	Understanding digital transformation: A review and a research agenda	The Journal of Strategic Information Systems	Literature review	"Our framework foregrounds digital transformation as a process where <i>digital technologies</i> create <i>disruptions</i> triggering <i>strategic responses</i> from organizations that seek to alter their <i>value creation paths</i> while managing the <i>structural changes</i> and <i>organizational barriers</i> that affect the <i>positive</i> and <i>negative</i> outcomes of this process" (p. 118).
Gong and Ribiere	2021	Developing a unified definition of digital transformation	Technovation	Literature review	"A fundamental change process, enabled by the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity... and redefine its value proposition for its stakeholders" (p. 12).
Hanelt et al.	2021	A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change	Journal of Management Studies	Literature review	"Thus, we define DT as organizational change that is triggered and shaped by the widespread diffusion of digital technologies" (p. 1160).
Verhoef et al.	2021	Digital transformation: A multidisciplinary reflection and research agenda	Journal of Business Research	Scoping review	"To the best of our knowledge, there has been no multidisciplinary discussion on digital transformation, which we define as a change in how a firm employs digital technologies, to develop a new digital business model that helps to create and appropriate more value for the firm" (p. 889).
Piccoli et al.	2024	Digital transformation requires digital resource primacy: Clarification and future research directions	The Journal of Strategic Information Systems	Essay	"Our perspective, grounded in the notion of digital resources, defines digital transformation as the metamorphosis of an IT-enabled organization into a digital organization – one with a specific digital architecture and design principles" (p. 1).

Note. Definitions are sorted chronologically and alphabetically.

metamorphosis (Piccoli et al., 2024). A disruptive technology (Cozzolino et al., 2018) might seemingly arrive overnight, but its assimilation in a company is not a sudden endeavor. Given the phenomenon's complexity, a realistic timeframe reaches from a few years up to several decades. Third, all five conceptualizations agree that digital transformation is an entity-wide endeavor with fundamental implications for the whole organization. In line with the definition by The Britannica Dictionary (2025b), the very nature of a transformation is overarching and profound. To sum up, the five definitions share common traits regarding the trigger, the importance of time, and the all-encompassing nature of digital transformation.

However, there are also two main distinctions between the five definitions. First, the goal of digital transformation varies or is not particularized. Vial (2019) does not specify an explicit goal of digital transformation itself but mentions both positive and negative outcomes of the process. Therefore, I interpret that the goal must be to maximize the positive results (operational efficiency, organizational performance, and industry and society improvements) while simultaneously minimizing the negative consequences (security and privacy). For Gong and Ribiere (2021), the objective of digital transformation is to fundamentally improve an organization and redefine its value proposition for its stakeholders. Similarly, Verhoef et al. (2021) claim that digital transformation shall create and appropriate more value for the firm. Piccoli et al. (2024) regard the state of *being* a digital organization with a specific digital architecture and design principles as both the outcome and goal of digital transformation. The framework by Hanelt et al. (2021) explicates outcomes but no aim of digital transformation. Regarding the second main distinction, the mechanisms to reach the goal, if one is specified, differ accordingly. Following Vial (2019), digital transformation alters the value creation paths (consisting of value propositions, value networks, digital channels, and agility and ambidexterity) of a company. Gong and Ribiere (2021) regard radical improvement and innovation as the means of digital transformation. The development of a new digital business model is the course of action according to Verhoef et al. (2021). For Hanelt et al. (2021), the mechanisms of digital transformation consists of both elements that innovate and elements that integrate. Lastly, Piccoli et al. (2024) do not explicitly mention a mechanism for digital transformation. In sum, the goals and mechanisms of digital transformation vary between the definitions and no common denominator can be condensed.

While all five versions are perfectly valid and conceptually impeccable, this thesis relies on the definition by [Hanelt et al. \(2021\)](#). On the one hand, it represents the constituents of the other four definitions. On the other hand, it emphasizes the notion of organizational change to a bigger extent compared to the other four definitions.

All in all, the concept of digital transformation has been approached by delineating its scope and laying out its defining features. The next section sheds light on the research aim and the derived research objectives.

1.3. Research Aim and Objectives

The plethora of literature for digital matters in popular science and media—such as the renowned roadmap for billion-dollar organizations ([Westerman et al., 2011](#))—suggests an burgeoning abundance of theoretical and practical guides to shape the digital journey of companies. However, the vast majority of this literature is directed towards big corporations ([Petropoulou et al., 2024](#)) that does not account for the liability of smallness which characterizes SMEs ([Aldrich & Auster, 1986](#)). Accordingly, the idiosyncrasies of SMEs make them inherently different to big corporations ([Chan et al., 2019](#); [Eller et al., 2020](#); [Müller et al., 2018](#)). Even if the availability of digital assets have closed the resource gap between MNEs and SMEs to some extent ([Caputo et al., 2021](#)), significant differences with regard to the limitedness in resources remain ([Cenamor et al., 2019](#)). Accordingly, “SMEs are not small versions of large enterprises, and they face higher costs for adopting and using IT compared to their larger counterparts” ([Neirotti & Raguseo, 2017, p. 139](#)). As a result, SMEs merit their own theorizing regarding their digital trajectories. The extant literature is by and large void of such holistic concepts—a gap that will be addressed in this thesis. Accordingly, the research question is formulated as follows (for the process of its elaboration, refer to chapter 2.1.4.):

How can incumbent manufacturing SMEs successfully shape the organizational change that is induced by the incorporation of digital technologies?

Indeed, SMEs are the economic backbone of most developed countries ([OECD, 2019](#)). Particularly Germany, as a highly industrialized economy depends heavily on the progress of its *Mittelstand* for the economic wellbeing of the whole nation. [De Massis et al. \(2018\)](#) define the concept as follows:

The term 'Mittelstand' is widely recognized as connoting a subset of private German enterprises internationally known for their quality and innovation. [The authors use] the term Mittelstand to identify a German company that is generally small-to-medium in size, is controlled and owned by one family, is a global market player, and identifies itself as a Mittelstand firm. (p. 127)

While the term Mittelstand is commonly used within Germany and has spread to other languages such as English for the lack of a congruent translation, this thesis focuses on the wider and more internationally prevalent concept of SMEs. Following the official definition, SMEs are companies with less than 250 employees and a turnover of less than €50 million or a balance sheet total of less than €43 million (European Commission, 2003). In Germany, SMEs account for 99.6% of all firms, generate 35.3% of the revenue (Bundesverband der Deutschen Industrie, 2015) and employ 71.5% of the entire workforce (Schwartz & Gerstenberger, 2024). Therefore, they significantly conduce to the robustness and reputation of the German economy and deserve special attention.

Nevertheless, most SMEs lack the knowledge, resources and capabilities for properly tackling the digital challenges ahead (Cenamor et al., 2019; Chan et al., 2019) and many can therefore be considered digital laggards (Gruber, 2019; Schmieder et al., 2025). In fact, only 33% of German SMEs have already completed digital initiatives (Zimmermann, 2024a), suggesting that two thirds are digital novices. According to the EU's measurement *digital intensity*, German SMEs are slightly above average in an international comparison, but still far away from the target set for 2030 (European Commission, 2024). The digital pent-up demand is remarkable. Surprisingly, this is not a new phenomenon but can be traced back for decades (Levenburg et al., 2005). The gap between SMEs and big corporations has rather increased than decreased over the last years (Meier et al., 2025).

Incumbents have been challenged by new entrants and technological advancements ever since (Tripsas, 1997). In the wake of digital technology, "pre-digital organizations are established companies belonging to traditional industries ... that were financially successful in the pre-digital economy, but to which the digital economy poses an existential threat" (Chanas et al., 2019, p. 17). Born-digital companies diverge from incumbent firms "as the latter have to deal with a pre-existing organizational design, requiring a digital transformation

strategy and physical-digital harmonizing, while digital firms are regularly built from scratch" (Hanelt et al., 2021, p. 11). This circumstance impedes a swift adoption to the digital age for established companies (Nadkarni & Prügl, 2021). This applies especially for changes in their value creation, delivery, and capture mechanisms because traditional firms often lack the understanding and absorptive capacity for embracing new technologies (Siachou et al., 2021). Nevertheless, Verhoef et al. (2021) state that digital transformation

is particularly relevant for incumbent firms. Incumbents will face challenges and barriers when searching and implementing business model innovation for digital transformation given their legacy. They are often forced to deal with conflicts and trade-offs between existing and new ways of doing business. (p. 892)

Disruptive innovations are less likely to be developed by established firms, which tend to seek sustained innovation for existing products and services (Christensen, 2006). New market entrants, in turn, benefit from less—or even absent—path contingencies (Christensen et al., 2018). Frequently, start-ups threaten the very existence of incumbent firms (Mao et al., 2020). Nevertheless, many authors “overestimate the ability of new entrants to destroy and disrupt established industries and underestimate the capacity of incumbents to perceive the potential of new technologies and integrate them with existing capabilities” (Bergek et al., 2013, p. 1210). By applying what Bergek et al. (2013) call *creative accumulation*, incumbent firms can incorporate digital technologies to a conducive end. All in all, incumbent SMEs face additional challenges compared to newly founded ventures but can also benefit from established capabilities.

Moreover, this thesis places an emphasis on manufacturing firms according to the International Standard Industrial Classification of All Economic Activities (ISIC), in which it corresponds to section C (United Nations, 2008). Manufacturing firms have to assume a broader perspective on digital transformation because they inherently need to account for physical products and the fabrication thereof, often accompanied by analog services. The complexity added by this circumstance is considerable (Müller et al., 2018). In raw numbers, manufacturing firms account for 5% of the SMEs in Germany and employ 16% of the SME workforce (Schwartz & Gerstenberger, 2024). Accordingly, more than one out of ten participants in the labor market are employed in a manufacturing SME. This company segment is therefore one of the most relevant

macroeconomic factors in Germany, emphasizing the pertinence not to be overlooked by academia.

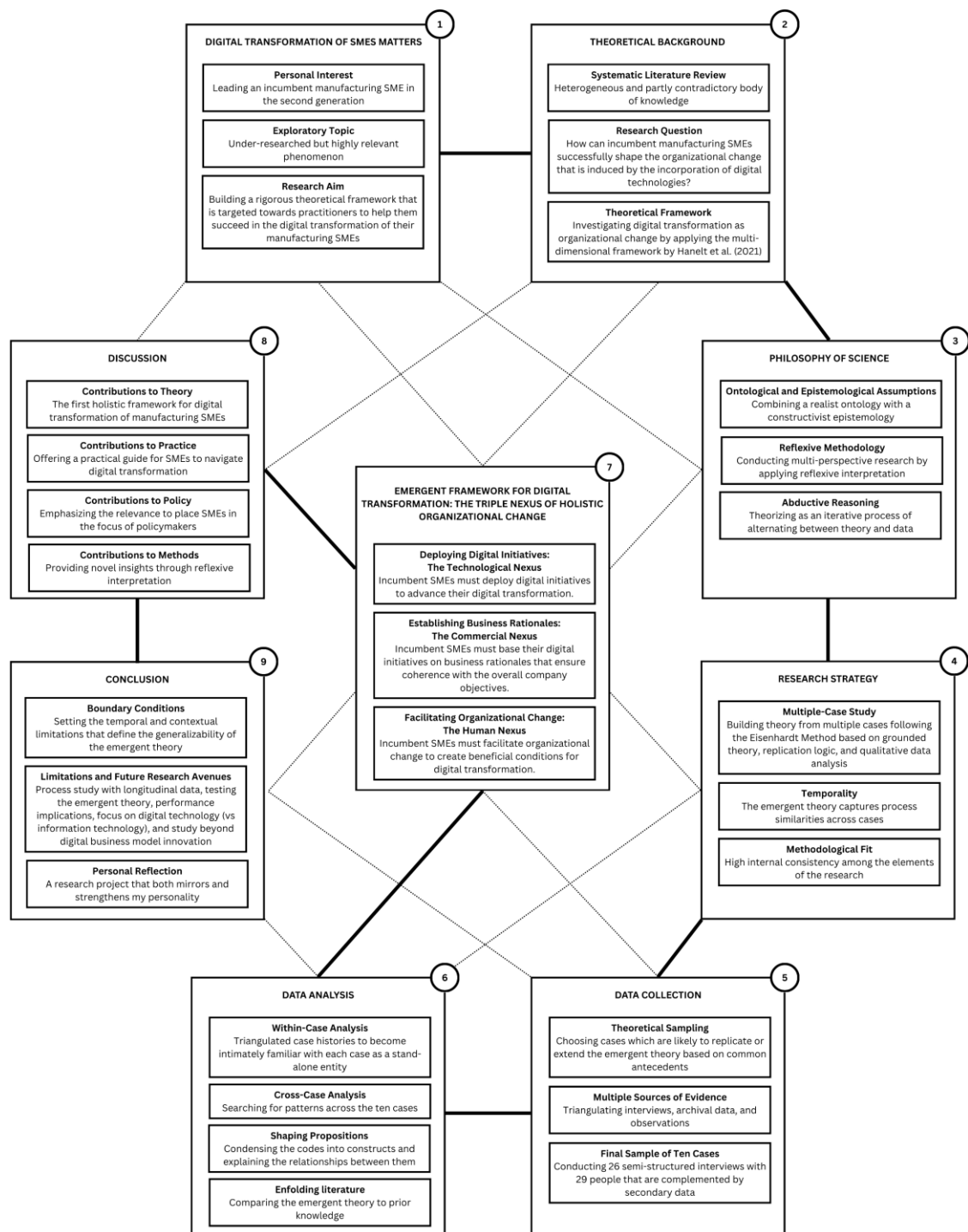
The modern psychology pioneer Kurt Lewin's renowned aphorism that "there is nothing more practical than a good theory" (Lewin, 1952, p. 169) reminds us of the fact that a theory shall not serve its own purpose. As I explained in the previous paragraphs, incumbent SMEs in the manufacturing sector are a notable segment of the German economy which face unique and extensive challenges to transform digitally. From countless conversations with owners and managers in such companies, I know first-hand that many of them encounter difficulties in initiating and successfully shaping their digital transformation. Some of them do not even pretend to be willing to digitalize, but the majority are eager to digitally transform. However, many SME owners have not yet found the key to getting started. This research aims at building a rigorous theoretical framework that is targeted towards practitioners to help them succeed in the digital transformation of their SMEs in the manufacturing sector. After all, the alternative of doing nothing will be the equivalent of waiting for the end to come in times of unrelenting digital developments in an ever more volatile business environment. This study represents "imaginative and impactful research" (Alvesson & Sandberg, 2024, p. 1737) that both practitioners and academics will find fruitful.

To achieve this research aim, three objectives are derived to define the intended scope and direction of the inquiry. The first research objective is to investigate incumbent manufacturing SMEs in Southern Germany to distill the core features of a successful digital transformation. The second research objective is to assess digital transformation in a holistic manner by incorporating non-technological factors. Lastly, the third research objective is to present the findings in the form of an actionable framework that appeals to academics and practitioners alike. In summary, the accomplishment of these objectives will enhance the theory and SME practice alike.

1.4. Structure of the Thesis

This section briefly outlines the structure of this thesis. Figure 1 graphically depicts the research leitmotif. In this thesis so far, the topic at hand has been introduced by elucidating the background and personal interest, approaching digital transformation in both scope and definition, and expounding the research aim and objectives. A sound theoretical background is condition precedent to

Figure 1:
Overview of the Research



Note. Own elaboration. Since the research design is highly iterative, a nonlinear representation of the structure was chosen. Even though this thesis is a linear text, the research itself underwent countless iterations from the research question until the conclusion. The solid lines represent the structure of the thesis with the numbers in circles indicating the order of the chapters, whereas the dotted lines insinuate the iterative and interconnected nature of the research process.

conducting purposeful research and will be presented in the next chapter. A systematic literature review sets the stage for the meaningful placement of this study within the multidisciplinary and fragmented academic landscape. It culminates in the formulation of the research question based on a critical assessment of the pertinent literature. Subsequently, the reader will be ushered in the research design which consists of four subchapters. First, the philosophy of science builds a stable foundation for the empirical investigation. Second, the Eisenhardt Method is illustrated as the research strategy of this project and thereby highlights its principal purpose, namely theorizing from multiple cases. Third, the data collection procedure and lastly the data analysis procedure are explained. Consequently, the findings of the multiple-case study are presented and gradually compose the emergent theoretical framework that constitutes the apex of this study. The following chapter discusses the findings and explicates the contributions to theory, practice, policy, and methods. Finally, the conclusion rounds off this dissertation by clarifying the boundary conditions and indicating limitations and future research avenues. The thesis ends with a reflection of my research journey.

2. Theoretical Background

The theoretical background that is explicated in this chapter represents the scaffolding of this research project. Only by placing the subject within the extant literature does it have the potential to contribute to the scientific discourse (Gehman et al., 2018). Hence, the aim of this chapter is twofold: First, a systematic literature review is conducted to assess and synthesize the body of knowledge. The chosen research strategy acknowledges the significance of previous academic work in order to identify research gaps and define possible contributions, rather than entering the empirical field from scratch as in pure grounded theory (Eisenhardt, 2021). Second, the multi-dimensional framework of digital transformation by Hanelt et al. (2021) is introduced as the theoretical conceptualization for the research (Eisenhardt, 1989). Even if this chapter describes the theoretical territory that was pegged down at the beginning of the research process, I remained critical and attentive throughout the journey to incorporate new developments in the field and to enhance the reflexivity of the research (Krlev et al., 2025).

2.1. Systematic Literature Review

Systematic literature reviews are particularly useful for heterogeneous bodies of knowledge (Ancillai et al., 2023), which is the case for the phenomenon of digital transformation (Markus & Rowe, 2023). The systematic literature review of this study followed the well-established procedure by Tranfield et al. (2003):

Systematic reviews differ from traditional narrative reviews by adopting a replicable, scientific and transparent process, in other words a detailed technology, that aims to minimize bias through exhaustive literature searches of published and unpublished studies and by providing an audit trail of the reviewers decisions, procedures and conclusions. (p. 209)

In fact, the transparency of the process is the defining feature of this review method (Post et al., 2020). Accordingly, the review procedure needs to be replicable by other researchers. The means to achieve this is a detailed review protocol which is described in the following section. The search process was conducted in two phases: Searching the databases and narrowing the sample to the relevant literature.

2.1.1. Review Procedure

This section describes how the systematic literature review was conducted. Regarding the first phase of searching the databases, formal search parameters were established which are summarized in Table 2. First, I chose the Web of Science database due to the quantity and quality of the indexed journals (Caputo et al., 2021). Furthermore, I cross-validated the results with the Scopus database in case the initial search had omitted relevant papers (Ancillai et al., 2023). Second, the language was limited to English as the lingua franca of academic management research. Third, the document type was restricted to peer-reviewed journal articles only. Fourth, the year 2014 was chosen as the baseline in order to grasp the most recent developments regarding the understanding of digital transformation. Fifth, the search string was developed to include all relevant publications about digital transformation and SMEs. To achieve this, the search terms were extended beyond the two themes and included associated themes and synonyms. Sixth, the search areas *all fields* (Web of Science) and *article title, abstract, keywords* (Scopus) were used for the search. Seventh, due to the tremendous number of publications in journals with a low impact factor, only articles with a minimum of 100 citations were included in order to reduce the body of articles to a manageable size without sacrificing impactful (i.e. highly cited) publications. Without the restriction regarding citations, Scopus and Web of Science yielded 1,503 and 1,406 results, respectively. Moreover, no subject area restrictions were applied. The quality of

Table 2:

Search Parameters for the Systematic Literature Review

Parameter	Value
Data bases	Web of Science Scopus
Language	English
Document type	Peer-reviewed articles
Publication date	2014 to 2024
Search string	("digital transformation" OR digitalization OR digitization) AND (SME* OR SMB* OR "small and medium-sized compan*" OR "small and medium-sized enterprise*" OR "small and medium enterprise*" OR mittelstand OR "small firm*" OR "family business*")
Search area	All fields (Web of Science) Article title, abstract, keywords (Scopus)
Citations	>100

Note. Own elaboration.

the study is enhanced by including "prior literature that is outside the focal research of the study Distant literature can reveal unanticipated theoretical mechanisms that can strengthen the logic of the emergent theory, lift its abstraction level, and improve its generalizability" (Eisenhardt, 2021, pp. 151–152). Such literature might stem from neighboring fields such as entrepreneurship, psychology, sociology, or strategy.

The search for relevant papers was initialized in July 2019 and persisted until the submission of the thesis. To ensure the completeness of the literature sample, the systematic literature search process was again conducted in August 2024 using the advanced search of the Scopus and Web of Science databases¹. Table 3 summarizes the search process and results. During the initial search, 115 papers were detected in the search. After subtracting duplicates, 69 papers were the result of the database search. All papers—just like all literature I gathered throughout the project—were meticulously catalogued in Citavi 7 including a complete version as PDF. In addition to the papers that were found in Scopus and Web of Science, 40 publications were appended to the selection, resulting in a total number of 109 articles as the outcome of the literature search. These manually added publications arose in the course of the research process, reflecting the iterative nature of the chosen research strategy (Eisenhardt, 1989, 2021).

¹ This footnote clarifies how the literature focus has changed over the years while I elaborated this thesis. According to Alvesson and Sköldbberg (2018) and Eisenhardt (1989), shifting the focus of the literature is neither methodologically nor methodically uncommon. The first iteration of the literature review was carried out in July 2019. Originally, the research had been centered around the newly introduced term of digital evolution. As of 2019, there have not been any publications that contained that term in business and management literature (one of the reasons why I had chosen the term in the first place), but that has changed as of lately, for example Markus and Rowe (2023), Omol (2024) or Yang et al. (2024). Anyway, the search term *digital evolution* had been complemented by its sub-concepts *digitization*, *digitalization*, and *digital transformation*. While most of the search parameters regarding journal quality, language and publication date have remained the same for the second iteration, there had been one crucial difference. In the first iteration, companies of any size had been considered. Contrarily, the second iteration of the literature review focused on SMEs to grasp the relevant academic knowledge regarding the setting of this research. While the first iteration of the literature review had been helpful to initially approach this study, the second iteration is coherent with the research design.

Table 3:
Search Process and Results

Review step	Number of journal articles
Scopus	59
Web of Science	+56
Database search total	115
Exclusions due to duplicates	-46
Database search total excluding duplicates	69
Inclusions from manual literature screening	+40
Selected publications based on literature screening	109
Exclusions based on journal ranking	-45
Selected publications based on formal criteria	64
Exclusions based on content	-25
Selected publications total	39

Note. Own elaboration.

In the second phase of the literature review, the set of publications is narrowed down based on the journal ranking and the content. There are plentiful books, conferences, websites, and reports about digital transformation. However, this review shall depict the current state of research solely based on highly ranked peer-reviewed journals and therefore excludes work in progress, conference papers, dissertations, or books. This decision deviates from the procedures of [Tranfield et al. \(2003\)](#) who include a broad range of document types; however, this line of action has been chosen in similar studies ([Kohtamäki et al., 2024](#); [Kraus et al., 2022](#)). The purpose is to capture the essential content of the most recent and impactful publications. Scientific relevance and scholarly rigor were judged according to the Academic Journal Guide 2024. Papers with a ranking below 3 in the AJG were discarded.² In the sample that resulted from the literature search, this was the case for 45 papers. Hence, 64 articles were left for in-depth review.

² For the sake of clarity, this procedure applies for the literature review. Further references might include lower ranked journal articles or other literature that does not comply with the review protocol. Academic papers must at least be published in a peer-reviewed journal to maintain the high standard of the thesis.

Table 4:***Reasons for Excluding Papers of the Literature Review***

Exclusion reason	Papers
Limited perspective on only one business function.	Nasiri et al. (2020), Scuotto et al. (2017)
The SME definition was not consistent with the EU definition.	Wu et al. (2022)
The object of study is an industry rather than the SMEs operating in this industry.	Llopis-Albert et al. (2021)
The object of study are platforms for SMEs rather than the SMEs themselves.	Holland and Gutiérrez-Leefmans (2018)
SMEs and large firms were mixed inseparably or no explicit focus on SMEs.	Brink (2017), Cannas (2023), Ceipek et al. (2021), Horváth and Szabó (2019), Kiel et al. (2017), Meier and Peters (2023), van Beijsterveld and van Groenendaal (2016), Zahra (2021), Zangiacomi et al. (2020)
Large firms were analyzed to derive a blueprint for SMEs, which is inconsistent with the perspective of this thesis.	Fischer et al. (2020)
Strong focus on other concepts such as internationalization and sustainability rather than digital transformation.	Chaudhuri et al. (2022), Denicolai et al. (2021), Pergelova et al. (2019)
A M2C context differs significantly from a M2B context.	Elia et al. (2021), Gavrilă Gavrilă and De Lucas Ancillo (2021)
The primary sector (agriculture) differs significantly from the secondary sector (manufacturing).	Annosi et al. (2019)
Research in geographically and economically incomparable settings, namely as Brazil, South Africa, Pakistan, India, and Malaysia.	Gaglio et al. (2022), Kahle et al. (2020), Mahmood and Mubarik (2020), Khurana et al. (2022), Malodia et al. (2023), Mohd Salleh et al. (2017)

Note. Own elaboration. Papers are sorted alphabetically.

The 64 articles were carefully read and examined. 25 papers were excluded because the content did not contribute to the research aim or significantly deviated from the setting of this study. Table 4 documents the reasons for excluding papers as suggested by [Tranfield et al. \(2003\)](#). Since this thesis is a long-term endeavor, the search is repeated continuously and throughout the research in order to spot new relevant publications until the day the thesis is finished ([B. Lee & Saunders, 2016](#)). This selection of publications was complemented by papers that were published after the systematic literature review was initially conducted. All in all, 39 journal articles form part of the sample for the systematic literature review.

The 39 papers were published in 17 different peer-reviewed journals as summarized in Table 5. The variety of outlets accounts for the necessity to embrace diverse schools of thought. The most frequent appearance were in the *Journal of Business Research* and *Technological Forecasting and Social*

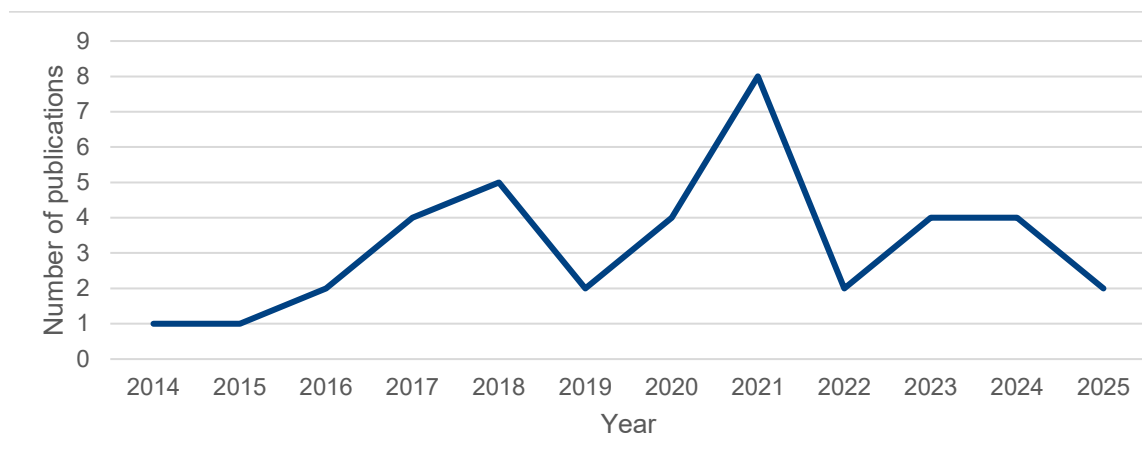
Table 5:*Publications per Journal in the Literature Sample*

Journal	AJG	Number of papers
Journal of Business Research	3	8
Technological Forecasting and Social Change	3	6
European Journal of Information Systems	4	3
International Journal of Production Research	3	3
Journal of Small Business Management	3	3
Computers in Industry	3	2
Information Systems Journal	3	2
International Journal of Production Economics	3	2
Journal of Product Innovation Management	4	2
Industrial Marketing Management	3	1
Information & Management	3	1
Information Systems Frontiers	3	1
International Small Business Journal	3	1
Journal of Information Technology	3	1
Production Planning & Control	3	1
R&D Management	3	1
Small Business Economics	3	1
Total		39

Note. Own elaboration. The journals are ordered according to the number of papers and alphabetically.

Change, which can also be observed in comparable analyses ([Ancillai et al., 2023](#)). Thematically, the journals cover a wide range, namely business management, technology, innovation, information system, marketing, and production.

As opposed to all academic papers about digital transformation which have shown exponential growth over the last decade ([Elsa et al., 2025](#)), the literature sample is distributed more evenly over the years. Figure 2 depicts the number of publications per year that are included in the final literature sample. The peak number of publications was reached in 2021 with eight articles and has since slowed down. However, it is important to note that this is not a representative sample but just describes the papers that were selected for review.

Figure 2:*Number of Publications per Year in the Literature Sample**Note.* Own elaboration.

There is a notable tendency towards quantitative research with almost half of the selected literature. Table 6 summarizes the diverse research approaches the authors of the papers employed. This can be attributed to the lasting influence of positivism in management studies and information systems research. However, qualitative studies are also represented with a majority being multiple-case studies.

Representing different literature streams ([Eisenhardt, 1989](#)), this knowledge base presents an extensive and thorough understanding of the state of the art of digital transformation.

Table 6:*Publications by Research Approach in the Literature Sample*

Research approach	Number of papers
Conceptual	2
Literature review	2
Mixed methods	2
Quantitative	19
Qualitative	
Action research	1
Delphi study	1
Interviews	1
Single-case study	3
Multiple-case study	8
Total	39

Note. Own elaboration.

2.1.2. Synthesis

The 39 papers significantly inform this research. Accordingly, this literature was scrutinized. Before synthesizing the articles, I give an overview of all the papers. Table 7 offers a summary by indicating the author(s), year of publication, name of the article, academic journal, and the research approach. For empirical papers, details about the sample type and size, the country where the data were collected, and the industries of the sample data are furthermore given. In addition, relevant literature references are given to research outside the SME context as it enhances the overall understanding of the phenomenon.

Digital transformation is by its nature a multidisciplinary concept ([Verhoef et al., 2021](#)). Hence, a wide array of research streams is relevant to grasp the phenomenon in its entirety. The literature selection consisting of 39 papers is synthesized into six perspectives on digital transformation in SMEs, namely innovation, firm performance, Industry 4.0, business models, capabilities, and leadership. These six categories represent the main focus of the papers and were derived during the literature review. Some of the papers appear in more than one category as they cover various aspects of digital transformation. For example, [Müller et al. \(2018\)](#) investigated business model innovations in manufacturing SMEs that are enabled by Industry 4.0 technologies, therefore appearing in two categories. The following six subsections thus synthesize the six categories across the literature selection of 39 papers.

Table 7:*Summary of the Papers From the Systematic Literature Review*

Authors	Year	Title	Journal	Research approach	Sample	Country	Industry
J. S. Lee and Kwon	2014	Exploring Key Factors of Application Software Services and Their Relationships for Organizational Success in SMEs	Journal of Small Business Management	Quantitative	220 SMEs	South Korea	Manufacturing, distribution, and service
T. H. Nguyen et al.	2015	Information Technology Adoption in Small Business: Confirmation of a Proposed Framework	Journal of Small Business Management	Quantitative	105 SMEs	USA	Manufacturing, retail, and financial services
Morgan-Thomas	2016	Rethinking technology in the SME context: Affordances, practices and ICTs	International Small Business Journal	Conceptual	n/a	n/a	n/a
W. Li et al.	2016	E-leadership through strategic alignment: An empirical study of small- and medium-sized enterprises in the digital age	Journal of Information Technology	Interviews	42 SMEs	United Kingdom, Spain, Denmark and the Netherlands	Various
Bi et al.	2017	E-business and fast growth SMEs	Small Business Economics	Quantitative	310 SMEs	Australia	Different industrial sectors
Coreynen et al.	2017	Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers	Industrial Marketing Management	Multiple-case study	4 SMEs	Belgium	Manufacturing
Giotopoulos et al.	2017	What drives ICT adoption by SMEs? Evidence from a large-scale survey in Greece	Journal of Business Research	Quantitative	3,500 SMEs	Greece	Mixed
Moeuf et al.	2017	The industrial management of SMEs in the era of Industry 4.0	International Journal of Production Research	Literature review	23 papers	n/a	n/a
Neirotti and Raguseo	2017	On the contingent value of IT-based capabilities for the competitive advantage of SMEs: Mechanisms and empirical evidence	Information & Management	Quantitative	5,000 SMEs	Italy	Manufacturing, wholesale and retail trade, transportation and logistics, and business services
Chester Goduscheit and Faillant	2018	Paths Toward Radical Service Innovation in Manufacturing Companies—A Service-Dominant Logic Perspective	Journal of Product Innovation Management	Multiple-case study	24 SMEs	Denmark	Manufacturing
Liang Li et al.	2018	Digital transformation by SME entrepreneurs: A capability perspective	Information Systems Journal	Multiple-case study	7 SMEs	China	E-commerce
Müller et al.	2018	Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0	Technological Forecasting and Social Change	Multiple-case study	68 SMEs	Germany	Manufacturing

Table 7 (cont.)

Authors	Year	Title	Journal	Research approach	Sample	Country	Industry
Saridakis et al.	2018	Industry characteristics, stages of E-commerce communications, and entrepreneurs and SMEs revenue growth	Technological Forecasting and Social Change	Quantitative	15,502 SMEs	United Kingdom	Primary, manufacturing, construction, wholesale/retail, transport/storage, accommodation/food, information/communication, financial/real estate, professional/scientific, administrative/support, education, health/social work, arts/entertainment, and other services
Cenamor et al.	2019	How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity	Journal of Business Research	Quantitative	230 SMEs	Sweden	Manufacturing
Chan et al.	2019	Agility in responding to disruptive digital innovation	Information Systems Journal	Single-case study	1 SME	Singapore	Technology
Moeuf et al.	2019	Identification of critical success factors, risks and opportunities of Industry 4.0 in SMEs	International Journal of Production Research	Delphi study	12 experts	France	Manufacturing
Eller et al.	2020	Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization	Journal of Business Research	Quantitative	193 SMEs	Austria	Not specified
Lizarralde Dorronsoro et al.	2020	An Industry 4.0 maturity model for machine tool companies	Technological Forecasting and Social Change	Single-case study	1 SME	Spain	Manufacturing
Masood and Sonntag	2020	Industry 4.0: Adoption challenges and benefits for SMEs	Computers in Industry	Quantitative	271 SMEs	United Kingdom	Manufacturing
Nasiri et al.	2020	Shaping Digital Innovation Via Digital-related Capabilities	Information Systems Frontiers	Quantitative	280 SMEs	Finland	Service and manufacturing
Amaral and Peças	2021	SMEs and Industry 4.0: Two case studies of digitalization for a smoother integration	Computers in Industry	Single-case study	1 SME	Germany	Manufacturing
Ardito et al.	2021	The duality of digital and environmental orientations in the context of SMEs: Implications for innovation performance	Journal of Business Research	Quantitative	369 SMEs	Canada	Mainly professional, scientific and technical services, manufacturing, and construction
Del Giudice et al.	2021	A Self-Tuning Model for Smart Manufacturing SMEs: Effects on Digital Innovation	Journal of Product Innovation Management	Quantitative	280 SMEs	Italy	Manufacturing
Matarazzo et al.	2021	Digital transformation and customer value creation in Made in Italy SMEs: A dynamic capabilities perspective	Journal of Business Research	Multiple-case study	6 SMEs	Italy	Food, fashion, and furniture design

Table 7 (cont.)

Authors	Year	Title	Journal	Research approach	Sample	Country	Industry
Ricci et al.	2021	External knowledge search, opportunity recognition and industry 4.0 adoption in SMEs	International Journal of Production Economics	Quantitative	174 SMEs	Italy	Manufacturing
Scuotto et al.	2021	A microfoundational perspective on SMEs' growth in the digital transformation era	Journal of Business Research	Quantitative	2,156,360 SMEs	Europe	Labor-intensive sectors
Soluk and Kammerlander	2021	Digital transformation in family-owned Mittelstand firms: A dynamic capabilities perspective	European Journal of Information Systems	Multiple-case study	15 SMEs	Germany, Austria, and Switzerland	Manufacturing
Stentoft et al.	2021	Drivers and barriers for Industry 4.0 readiness and practice: empirical evidence from small and medium-sized manufacturers	Production Planning & Control	Mixed methods	190 (survey) and 4 (case studies) SMEs	Denmark	Manufacturing
Han and Trimi	2022	Towards a data science platform for improving SME collaboration through Industry 4.0 technologies	Technological Forecasting and Social Change	Mixed methods	1 SME	Greece	Power solutions for utility-related services
Troise et al.	2022	How can SMEs successfully navigate VUCA environment: The role of agility in the digital transformation era	Technological Forecasting and Social Change	Quantitative	204 SMEs	Italy	Various
Battistoni et al.	2023	Adoption paths of digital transformation in manufacturing SME	International Journal of Production Economics	Quantitative	421 SMEs	Italy	Manufacturing
Etienne Fabian et al.	2023	Business value of SME digitalisation: when does it pay off more?	European Journal of Information Systems	Quantitative	293 (year 1) and 226 (year 2) SMEs	Netherlands	Manufacturing, services, retail/wholesale, and public/nonprofit
Radicić and Petković	2023	Impact of digitalization on technological innovations in small and medium-sized enterprises (SMEs)	Technological Forecasting and Social Change	Quantitative	2,854 SMEs	Germany	Manufacturing and services
Zoppelletto et al.	2023	Organizational roles in the context of digital transformation: A micro-level perspective	Journal of Business Research	Multiple-case study	7 large firms and 31 SMEs	Italy	Various
Coco et al.	2024	Fostering digital literacy among small and micro-enterprises: digital transformation as an open and guided innovation process	R&D Management	Action research	74 SMEs	Italy	Manufacturing, merchant wholesalers, professional, scientific, and technical services, service-providing industries, communication services, arts, entertainment, and recreation, constructions, accommodation and food services, agriculture, forestry, fishing and hunting, and others

Table 7 (cont.)

Authors	Year	Title	Journal	Research approach	Sample	Country	Industry
Hansen et al.	2024	Technology isn't enough for Industry 4.0: on SMEs and hindrances to digital transformation	International Journal of Production Research	Multiple-case study	30 SMEs	Denmark	Manufacturing
Schwaeke et al.	2024	The new normal: The status quo of AI adoption in SMEs	Journal of Small Business Management	Literature review	106 peer-reviewed papers	n/a	n/a
Syed et al.	2024	The role of managerial activities in achieving Information technology ambidexterity and new product development performance in small and medium-sized enterprises	European Journal of Information Systems	Quantitative	292 SMEs	United Kingdom	Manufacturing and service
Meier et al.	2025	Creating competitiveness in incumbent small- and medium-sized enterprises: A revised perspective on digital transformation	Journal of Business Research	Conceptual	n/a	n/a	n/a

Note. Own elaboration. The papers are sorted chronologically and alphabetically by authors.

Innovation. Activities that are dedicated to digitalizing products are commonly referred to as digital innovation ([Bogers et al., 2022](#)). Digital innovation is defined by [Yoo et al. \(2010\)](#) as

the carrying out of new combinations of digital and physical components to produce novel products. [The] use of the term digital innovation thus implies a focus on product innovation, distinguishing it from extant IT innovation research that has been primarily occupied with process innovation. (p. 725)

Other authors further include process and business model innovations ([Fichman et al., 2014](#); [Hund et al., 2021](#); [Nambisan et al., 2017](#)). However, in the context of SME, the cases justify a conceptual separation of products and services from processes and business models. Consequently, for increasing the conceptual clarity in this thesis, digital innovation refers explicitly to product and service innovation, following academics such as [Yoo et al. \(2010\)](#), [Hinings et al. \(2018\)](#) and [Bogers et al. \(2022\)](#).

The availability of a digital technology in and of itself is not an innovation for any company. Digital technology becomes an innovation when it is used to create new products or services by allocating sufficient slack resources ([Fichman](#)

& Melville, 2014), being defined as "an abundance of resources in excess of demand" (Dolmans et al., 2014, p. 513). In the context of SMEs, Chan et al. (2019) found agility to be one of the key determinants for technology adoption. In order to increase the agility, SMEs ought to reduce their organizational rigidity, build capabilities for innovation, and find an equilibrium for ambidexterity (Chan et al., 2019), i.e. balancing exploration and exploitation mechanisms. Del Giudice et al. (2021) made almost identical observations in that manufacturing SMEs can boost their digital innovation performance by promoting an organizational structure that facilitates agility, adaptivity, and ambidexterity. Therefore, it stresses the importance of non-technological factors such as structure and openness towards external stakeholders. From a technology perspective, SMEs restrict themselves to a limited number of technologies, namely cloud computing and internet of things (Moeuf et al., 2018). Drawing on the resource-based view, Ardito et al. (2021) conclude that a strategic digital orientation is beneficial for innovation capacity of a SME as long as environmental sustainability is not pursued simultaneously as a strategic goal. The resource constraints that are inherent in SMEs might lead to a cannibalization of both strategic orientations, even if both of them are well-executed and purposeful. Contrarily, Radicic and Petković (2023) were not able to ascertain a uniform positive effect of digital technologies on product and process innovations. Instead, they paint a more differentiated picture with overall modest impact of digital technologies on innovation. Most importantly, the firm size determines the innovation effectiveness of digital technologies. The smaller a SME, the less pronounced is the innovation performance through the implementation of digital changes. These findings suggest that SMEs are not a homogenous subset of companies; rather, the label subsumes a significant variety of businesses. While non-SME-specific studies have shown that innovation can increase productivity and firm performance (Hashi & Stojčić, 2013), this seems not to universally apply to SMEs.

For companies in the manufacturing sector, servitization in its own right plays an important role (Ambroise et al., 2018). Servitization as a standalone concept can be traced back to Vandermerwe and Rada (1988). For manufacturing firms, this is a paradigm shift from a resource-based view towards a demand-based view that places the customers' needs in the foreground (Priem, 2007). Today, it refers to a strategy where "a manufacturing firm with a product business model expands its offering into services related to its products and, as

a result, shifts from the 'product-only' business model to the 'service-oriented' model" (Visnjic et al., 2016, p. 36). The proliferation of digital technologies has fueled the adoption of servitization among manufacturers (Lenka et al., 2017). A neighboring term in the literature for *digital servitization* (Coreynen et al., 2017; Paschou et al., 2020) is *digital service innovation* (Soto Setzke et al., 2023). In a nutshell, the "merging trends of digitalization and servitization harbor extensive and largely unexplored potential for manufacturing firms. Digital systems can be linked with product-service bundles to build novel digitalized product-service systems" (Lerch & Gotsch, 2015, p. 45). In the context of SMEs, however, digital servitization is not so much a matter of innovating the business model; instead, physical or non-physical products are enhanced by digital service offerings. While the line between digital innovation, digital servitization and digital business model innovation is blurred, this thesis follows the notion that the former two do not directly impact the business model, but if (at all) indirectly. Chester Goduscheit and Faillant (2018) regard big data analytics as the principal driver for digital servitization in SMEs. The focus lies on the utilization of existing data rather than generating new data. Furthermore, placing the customer in the center and incorporating their desires is crucial for servitized SMEs. Moreover, Coreynen et al. (2017) stress the relevance of digital technologies for strategically underpinning servitization pathways of manufacturing SMEs. Appropriate resource configurations, especially capabilities, are key to supporting digital servitization. Syed et al. (2024) identified managerial activities as an enabler for IT ambidexterity, which in turn is a key factor in new product development. Therefore, the managers of SMEs play a crucial role in advancing the innovation performance. Research and development activities, both internal and with external partners, increase the likelihood of digital transformation (Giotopoulos et al., 2017). This might be attributed to a mindset that embraces innovation and progress that is more pronounced in R&D-heavy firms. The holy grail of innovation in the digital world are self-tuning enterprises that auto-adapt their value creation, delivery, and capture mechanisms, their resource allocation and their organizational structure via algorithms depending on changes in the environment (Reeves et al., 2015). Even if such artificial intelligence that does not require any human exertion of influence does not (yet) exist, SMEs have started to benefit from the underlying principles of rapid and regular adjustments to improve their innovation performance (Del Giudice et al., 2021). At its core, a

self-tuning model of an SME "is related to the capacity of an enterprise to adjust quickly to market changes (organizational agility), learn by an experimental approach (organizational adaptability), balance knowledge, and technological exploration and exploitation (organizational ambidexterity)" (Del Giudice et al., 2021, p. 68). To sum up, digital innovation is a broadly discussed element of digital transformation of SMEs, especially in the manufacturing sector.

Firm performance. For companies regardless of their size, a significant correlation between their digital transformation and financial performance has been found (Ferreira et al., 2019; Melville et al., 2004). More specifically, this observation can be transposed to companies in the manufacturing sector (Lixu Li et al., 2022). However, the impact of digital technologies on SME performance are still sparsely researched (Etienne Fabian et al., 2024). This paragraph attempts to give an overview of what is known so far. Saridakis et al. (2018) have found that the firm performance increases by the adoption of e-commerce technologies. This assertion holds true even for low-end solutions and discerning industries. Hence, the mere adoption of this sales channel can have a positive impact on the performance of a SME. Moreover, e-commerce solutions are not recommendable for every kind of product as the nature of the offerings significantly influences the success of an online store. J. S. Lee and Kwon (2014) emphasize the disadvantage of SMEs due to their inherent resource restraints and regard online software leasing as a pragmatic way to reduce the costs for purchasing, hosting, and maintaining hardware and software. They postulate a positive impact of cloud service usage and organizational success. Similarly, Bi et al. (2017) observe performance gains through the use of e-business, being defined "as using the Internet to conduct or support business activities along the value chain" (K. Zhu & Kraemer, 2005, p. 61). SMEs can achieve this by improving their IT resources, strategic IT alignment, market orientation, and business partnerships (Bi et al., 2017). Also regarding IT resources, Eller et al. (2020) detected their direct effect on digitalization and consequently on the financial performance of SMEs. While recognizing the resource restraints and the difficulties to adapt the business model, they nonetheless regard digitalization as an unprecedented opportunity for SMEs to drive their business success. The recent surge of artificial intelligence has the potential of further mitigating the disadvantage regarding size and multiply the effects of digital technologies to increase efficiency and profitability (Schwaeke et al., 2024). The role of

organizational agility in SMEs as a vital skill for survival in a hypercompetitive and highly volatile environment has been studied by [Troise et al. \(2022\)](#) who conclude that the

three antecedents of agility, namely digital technologies capability, relational capability and innovation capability ... contribute to build organizational agility in SMEs and that, in turn, agility has a positive impact on performance, thus confirming that agility contributes to the success of SMEs and that digital technologies play a central role in this process. (p. 1)

Hence, agility seems to be not only important for innovation performance ([Chan et al., 2019](#)) but also for financial performance. Similar to [Radicic and Petković \(2023\)](#), a recent study by [Etienne Fabian et al. \(2024\)](#) emphasize the heterogeneity of SMEs. The success of digital initiatives depends heavily on firm characteristics. Nevertheless, the authors were able to condense two success factors for firm performance as a consequence of implementing digital technologies, namely radical orientation and organizational rigidity. In conclusion, "SMEs who are oriented towards radical change and are more rigid are disadvantaged and attain lower returns on SME digitalization" ([Etienne Fabian et al., 2024, p. 1](#)). Moreover, the development of externally oriented IT-based capabilities generate an intra-industrial differential in revenue growth and profits ([Neirotti & Raguseo, 2017](#)). Crossing a SME's boundaries to ultimately improve the performance is also a key finding by [Cenamor et al. \(2019\)](#). Digital platform capabilities lead to network capabilities that eventually contribute to financial success, which is further amplified by an exploration orientation, rather than an exploitation focus. From a critical realist perspective and employing a conceptual theory synthesis approach, [Meier et al. \(2025\)](#) developed a multilayered model for how digital transformation fosters a SME's competitiveness and eventually constitutes a competitive advantage. Even though a competitive advantage does not necessarily concur with an increased firm performance, the findings are nonetheless crucial as they emphasize the complexity of digital transformation. Accordingly, holistic approaches are indispensable to fully grasp the phenomenon.

Industry 4.0. The research on digital transformation in SMEs frequently treats the concept of Industry 4.0. This observation might be explained by the notion that "Industry 4.0 can represent an intimidating concept for many SMEs" ([Müller et al., 2018, p. 8](#)) and therefore the multitude of studies aims at reducing

that trepidation by scientifically approximating the topic. On another note, it seems that many authors use the term Industry 4.0 to broadly refer to the incorporation of any kind of information and digital technology, deviating from the original meaning that is centered around specific technologies to enable smart manufacturing. Industry 4.0 is a term that originates from a German governmental initiative (Kagermann et al., 2013). At its core, "Industry 4.0 aims at establishing intelligent, self-regulating, and interconnected industrial value creation" (Müller et al., 2018, p. 2) by combining the digital and the material realm as cyber-physical systems. Therefore, the manufacturing of unitary and tailor-made products is enabled (Moeuf et al., 2020). Especially for SMEs, the academic literature tends to place an exaggerated and one-sided emphasis on the digitalization of the production process (Ghobakhloo & Iranmanesh, 2021; Han & Trimi, 2022; Mittal et al., 2018; Moeuf et al., 2020). However, digital transformation is more than just incorporating digital technologies in the production process. To sum up, "Industry 4.0 and similar initiatives are limited mainly to manufacturing process improvements enabled by smart manufacturing, whereas digitalization has the potential to affect many other functions beyond the manufacturing process" (Björkdahl, 2020, pp. 18–19). Nevertheless, this section gives an overview of the pertinent literature on Industry 4.0 in SMEs. Ricci et al. (2021) opine that for implementing Industry 4.0, SMEs ought to trespass their boundaries and intensely collaborate with key customers and suppliers. Moreover, an ecosystem that also bestrides external actors such as universities, research centers, or system integrators facilitates the adoption of Industry 4.0 technologies. For initiating the path of Industry 4.0, Amaral and Peças (2021) reckon that SMEs do not necessarily have to bear tremendous implementation costs or deal with high levels of complexity. Many SMEs initially have a low Industry 4.0 maturity which alleviates the implementation. However, increased Industry 4.0 maturity entails more sophistication and expenses. To assess Industry 4.0 maturity, Lizarralde Dorronsoro et al. (2020) developed a meta-model for manufacturing SMEs. It defines six dimensions to be crucial, namely strategy and organization, employees, smart products, smart operations, smart factory, and data-driven services. By weighting the dimensions differently according to the idiosyncrasies of the assessed SME, the maturity model allows for a granular analysis. Masood and Sonntag (2020) are convinced about the potential benefits that Industry 4.0 brings to SMEs. Increased manufacturing quality and flexibility combined with a

higher operational efficiency lead to lower operation costs and eventually to a competitive advantage. However, the required time and costs for implementation are regarded as barriers just like the lack of technology knowledge. [Moeuf et al. \(2020\)](#) confirm the lack of expertise which can be overcome by engaging external specialists. Furthermore, a short-term strategy mindset puts Industry 4.0 initiatives at risk. [Battistoni et al. \(2023\)](#) classify Industry 4.0 technologies into four hierarchical layers, namely sensors to collect data, integration to combine data, intelligence to process data, and response to use organizational data. The authors highlight the importance of the practical relevance of these relationships because they make a strong point for interconnected solutions, as opposed to the standalone implementation of individual technologies. A lack of ethical, technical, and legal standards hampers the widespread adoption of Industry 4.0 in SMEs ([Han & Trimi, 2022](#)). By building trust among SMEs regarding the policies and standards, the boundary-spanning utilization of data and therefore an increased collaboration along the value chain would be greatly enhanced. Especially for artificial intelligence, the absence of a governmental framework impedes the adoption among SMEs ([Schwaeke et al., 2024](#)). According to [Müller et al. \(2018\)](#), the motivation to engage in Industry 4.0 for manufacturing SMEs can be external or internal. Categorizing SMEs in users and providers, four clusters of companies are derived. From low to high adoption, they are named craft manufacturers, preliminary stage planners, Industry 4.0 users, and full-scale adopters. The higher the Industry 4.0 adoption, the more likely is that a SME becomes an industry leader. Making a case for positivity among SME leaders, [Stentoft et al. \(2021\)](#) advocate for focusing on the opportunities of Industry 4.0 rather than overstating the barriers. In practice, business development potential through smart technologies should be enforced rather than getting bogged down in the details of operational processes. Moreover, the authors emphasize the impossibility of a blueprint for all SMEs as they differ notably in the usefulness of certain technologies.

Business Models. There are countless academic definitions of the business model ([Massa et al., 2017](#)) and the individual elements that constitute the business logic of a company ([Baden-Fuller & Morgan, 2010](#); [Casadesus-Masanell & Ricart, 2010](#); [Zott et al., 2011](#)). This thesis follows the renowned idea by [Teece \(2010\)](#) that a

business model describes the design or architecture of the value creation, delivery, and capture mechanisms it employs. The essence of a business model is in defining the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit. (p. 172)

For successfully maneuvering a company through times of rapid technological advancements, the business model is an essential instrument for decision-makers (Snihur & Eisenhardt, 2022). The innovation of a business model is defined as “designed, novel, nontrivial changes to the key elements of a firm’s business model and/or the architecture linking these elements” (Foss & Saebi, 2017, p. 201). With the inclusion of digital technologies, the concepts have been expanded and are described in the literature as *digital business model transformation* (Klos et al., 2023; Soluk & Kammerlander, 2021), *Industry 4.0 business models* (Müller et al., 2021), or simply *digital business models* (Kohtamäki et al., 2024; Remané et al., 2017; Vendrell-Herrero et al., 2018; Verhoef & Bijmolt, 2019; Weill & Woerner, 2013), among others. The business model and business model innovation literature are both extensive streams of research in their own right. Throughout this thesis, digital business model innovation refers to purposeful, significant changes in how a SME creates, delivers, and captures value that are enabled by digital technologies. In the context of SMEs, Müller et al. (2018) scrutinize the influence of Industry 4.0 on the business model and found that all three components are affected. As for value creation mechanisms, servitization plays an important role. Value delivery innovations tend to incorporate inter-company connectivity along the whole value chain. The opportunities to capture value involve innovations in monetization practices and custom-made solutions that are tailored to the customer’s needs. Similarly, Matarazzo et al. (2021) confirm that digital technologies can enhance the customer value creation process. Industry 4.0 can potentially educe business model innovation (Moeuf et al., 2020), but most SMEs maintain a cost-centric perspective with an internal focus, mainly on the monitoring of production processes (Moeuf et al., 2018).

Capabilities. Digital transformation requires specific capabilities from managers and employees alike. Adopting a microfoundational perspective, Scuotto et al. (2021) point out the need for individual digital capabilities on the employee level. The digital literacy of employees is both crucial for growth and

innovation. However, they acknowledge the difficulty for employee training in the face of limited resources and the ambidextrous tensions. [Nasiri et al. \(2023\)](#) distinguish an internal and an external perspective of digital-related capabilities, namely business processes and market offerings, respectively. For both instances, human and technical capabilities are crucial for exploiting digital opportunities. Whereas innovation capabilities further enhance digital market offerings, collaboration capabilities complement the development of digital business processes. Taking on an entrepreneurial lens, [Liang Li et al. \(2018\)](#) emphasize the relevance of proactive capability building for both managers and their companies in order to drive their digital transformation. For the entrepreneurs, managerial cognition and management social network are key capabilities to tackle digital transformation. Moreover, the managers ought to foster organizational capabilities, mainly capabilities for platform utilization capabilities and business development. [Matarazzo et al. \(2021\)](#) underscore how sensing and learning capabilities enable digital transformation, principally from part of the employees. Moreover, managers ought to foster their integration and coordination capabilities to benefit from new knowledge and orchestrate the available assets. [Neirotti and Raguseo \(2017\)](#) differentiate between internally and externally oriented IT-based capabilities. They observed that internally oriented IT-based capabilities that mainly focus on efficiency improvements render lower financial outcomes regarding revenue and profit than externally oriented IT-based capabilities such as competences for new product development, market knowledge, and e-commerce. [Hansen et al. \(2025\)](#) underscore that technology alone is not enough for the digital transformation of SMEs; humans play an essential role. Specifically, they regard digital transformation as a learning process in which competencies and employee qualifications determine the outcome of the incorporation of digital technologies. In many SMEs, they are not sufficiently elaborate. But also from part of leaders, a general lack of strategic management capabilities hinders effective digital transformation. Similarly, [Moeuf et al. \(2020\)](#) and [Giotopoulos et al. \(2017\)](#) emphasize that training to achieve a well-educated and skilled workforce is fundamental for Industry 4.0 success. [Soluk and Kammerlander \(2021\)](#) acknowledge the relevance of both operational and dynamics capabilities; however, the latter influence digital transformation more significantly. In their three-stage model, each phase requires specific capabilities. The first stage of process digitalization implies the development of

new operational capabilities to maximize the outcome of the existing infrastructure and assets. The second stage is called product and service digitalization and involves the generation of both new operational and dynamic capabilities to advance new strategic business opportunities. The third and last stage of business model digitalization leads to new dynamics capabilities to engender a state of continuous renewal. All in all, digital transformation is an endeavor that presupposes the willingness to develop new capabilities for employees and managers alike.

Leadership. Leadership is an important factor for the digital transformation of SMEs (Moeuf et al., 2020). However, Zoppelletto et al. (2023) highlight that not only owners or managers can assume the role of as the digital driver, but also key employees who dispose of the required digital knowledge. Moreover, the authors reinforce the differentiation between large and small/medium companies, with the latter being characterized by a "bottom-up, informal, persuasive, and empathic approach" (Zoppelletto et al., 2023, p. 1). Based on strategic alignment theory, W. Li et al. (2016) constructed an e-leadership model. They identified six core leadership qualities for SME managers, namely agile leadership, hybrid skill development, architectural view, digital entrepreneurship, value creator, and value protector. The manifoldness of these qualities stresses the demanding requirements that SME leaders ought to master in their pursuance of digital transformation. Furthermore, decentralized decision-making and visionary leadership make the adoption of digital technologies more likely (Giotopoulos et al., 2017). A study by T. H. Nguyen et al. (2015) determined the customers as the main trigger for IT adoption. To comply with this driving force, managers ought to coordinate the following factors: organizational aspects including management and culture, relations with both suppliers and customers, internal IT resources, and external IT consultants. With an action research approach, Coco et al. (2024) challenge the common notion that SMEs are by design more agile and flexible. The overburdening multitude of digital opportunities might lead managers to lapse into inertia. In that case, the authors recommend peer-to-peer networking and interchange formats such as design thinking workshops to invoke a sense of collective strength. According to Liang Li et al. (2018), the pivotal significance of leaders' attitude also means that successful digital transformation starts with often transforming the SME entrepreneurs themselves. The entrepreneurs need to invest in

themselves to overcome cognitive limitations and see and embrace the potentials of IT. They need to consciously build up their social capital to facilitate their learning and gain better access to the resources they desire. These efforts are especially important when it is difficult to upgrade existing top management teams. (p. 1137)

In consequence, there is no successful digital transformation against the volition the SME leaders.

Lastly, [Morgan-Thomas \(2016\)](#) has forwarded impactful ontological thoughts on the technology-practice interrelation in SMEs that will be deepened in the next chapter.

2.1.3. Critical Assessment

The previous chapter demonstrated that there is clearly no scarcity of research on digital transformation in SMEs. However, all conceptual and empirical journal publications zoom in on certain aspects of digital transformation, resulting in an academic void regarding the big picture. Accordingly, recent studies have pointed to the notion that research on digital transformation is still in its infancy ([Cannas, 2023](#); [Kraus et al., 2022](#); [Nadkarni & Prügl, 2021](#); [Soluk & Kammerlander, 2021](#)). At first glance, this observation might seem contradictory given the ever-rising number of papers. My systematic literature review suggests that research about subjects *in the context* of digital transformation is gaining traction ever faster, but the digital transformation *as a construct* is still not well-theorized ([Markus & Rowe, 2021](#)). Hence, notwithstanding the significantly increasing number of academics from any conceivable discipline embracing the theme in recent years, "the phenomenon of digital transformation remains poorly understood. Both research and practice frequently struggle to provide actionable guidance for companies" ([Fischer et al., 2020, p. 12](#)). Even if the previous section might suggest otherwise, this applies specifically for SMEs ([Liang Li et al., 2018](#)). All in all, none of the papers presents a holistic theory of the successful digital transformation of incumbent SMEs and simultaneously offers practical recommendations, constituting an eminent gap in the academic literature.

Moreover, the papers of the systematic literature review tend to treat digital transformation as a primarily technological endeavor that can be mastered by following a mechanistic sequence of clearly separable steps. However, I adopt a perspective that goes beyond the mere adoption of new technologies ([Orlikowski,](#)

2010; Orlikowski & Scott, 2008). The context and business practices in organizations cannot be ignored when investigating the phenomenon (Feldman & Orlikowski, 2011; Leonardi, 2013). A holistic view on digital transformation needs to factor in humans. Following Orlikowski (2007), the combined and simultaneous contemplation of both the technological and the social perspective generates significant theoretical and practical value.

Moving beyond these conceptual difficulties and conventional approaches requires a way of engaging with the everyday materiality of organizational life that does not ignore it, take it for granted, or treat it as a special case, and neither does it focus solely on technology effects or primarily on technology use. Such an alternative view asserts that materiality is integral to organizing, positing that the social and the material are *constitutively entangled* in everyday life. A position of constitutive entanglement does not privilege either humans or technology (in one-way interactions), nor does it link them through a form of mutual reciprocation (in two-way interactions). Instead, the social and the material are considered to be inextricably related—there is no social that is not also material, and no material that is not also social. (p. 1437)

Consequently, in order to uncover the organizational success factors that spark digital transformation of manufacturing SMEs, the technological determinism that much of the literature and practitioners still seem to represent (Morgan-Thomas, 2016) needs to be outstripped. Recently, the concept of sociomateriality has been further refined to account for the ontological—not merely empirical—entanglement of the social and the material that is still disregarded by large parts of management research (Orlikowski & Scott, 2023). The “digital undertow” (S. V. Scott & Orlikowski, 2022) refers to the “many unobserved *corollary effects* of digitalization that are manifesting elsewhere—metaphorically in the undertow—away from the dramatic waves on the surface that are claiming most of the attention” (Orlikowski & Scott, 2023, p. 4). Digital transformation, be it merely abolishing the faxing machine or introducing a new digital division with a novel business model, incites an organizational change for a SME (Orlikowski & Scott, 2023; Volkoff et al., 2007). Organizational change is defined “as deliberate activities that move an organization from its present state to a desired future state” (Stouten et al., 2018, p. 752). The gestalt of that desired future state is

subject of shaping digital transformation and simultaneously accounting for the corollary effects that these changes inevitably bring to an organization.

Historically, the organizational transformation that arises from IT technologies has been labelled *IS-enabled transformation* (Besson & Rowe, 2012), *IT transformation* (Gregory et al., 2015), *IT-enabled organizational transformation* (vom Brocke et al., 2021), or *IT-enabled transformation* (Lucas et al., 2013; Wessel et al., 2021). In this thesis, the latter is used for organizational changes that are induced by information technologies. The concept of *IT-enabled transformation* received a lot of attention since the beginning of the 1990s especially in the IS research (Besson & Rowe, 2012; Markus & Robey, 1988; Orlikowski, 2000; Volkoff et al., 2007). However, it is not able to explain the current developments as it does not include changes in the value proposition (Vial, 2019; Wessel et al., 2021). In contrast, digital transformation is more profound than the conventional understanding of organizational change as in IT-enabled transformation. According to Hanelt et al. (2021), digital transformation goes

beyond the boundaries of established perspectives on organizational change [insofar as], due to the traits of digital technologies underlying the new organizational design and digital business ecosystems, even these episodic episodes lead to new phases of continuous change in organizations, which may endure for a comparably long time. (p. 1178)

Even if it involves both information and digital technologies in this thesis to guarantee a high degree of practicality, it is expedient to treat digital transformation as a separate concept. All in all, this research project conceives of digital transformation in incumbent manufacturing SMEs as an holistic organizational change that is induced by digital technology.

2.1.4. Research Question

In the literature review, the "researcher both maps and assesses the relevant intellectual territory in order to specify a research question which will further develop the knowledge base" (Tranfield et al., 2003, p. 207). Moreover, a thorough literature review is crucial for revealing promising research questions without obvious answer and meaningful contributions (Eisenhardt, 2021). Having spotted the gap in the extant body of academic literature (Sandberg & Alvesson,

2011) to investigate digital transformation from the perspective of holistic organizational change, the research question is formulated as follows³:

How can incumbent manufacturing SMEs successfully shape the organizational change that is induced by the incorporation of digital technologies?

The notion of success in for-profit organizations is mostly associated with firm performance (R. Johnson & Soenen, 2003). However, success can also refer to non-financial endeavors such as the implementation of information systems (DeLone & McLean, 1992). Hence, "success can be measured in many different ways" (Bostock, 2014, p. 8). In my view, non-financial success in SMEs can take other forms such as ecological sustainability, completed family business succession, beneficial working conditions, contribution to the common good, or workforce equality, which all eventually contribute to the financial success in the long run. This thesis widens the scope of digital transformation beyond mere conventional quantitative financial goals, in particular maximizing profits by increasing the revenue and decreasing the costs.

The next section will present the theoretical foundation upon which the empirical research of this thesis was built on, with the goal of establishing a practical theory that answers the research question.

2.2. Theoretical Framework for Investigating Digital Transformation

The papers that were included in the literature review were evaluated according to their appropriateness to constitute a theoretical conceptualization as a basis for the research on digital transformation of incumbent manufacturing SMEs. However, as has been mentioned in the previous section, none of the articles complies with the organizational change perspective to grasp the phenomenon holistically. Hence, for the lack of SME-specific intellections, the conceptual paper based on a systematic literature review by Hanelt et al. (2021) was chosen as the

³ As stated by Eisenhardt (1989) and Gehman et al. (2018), the research question might change as the project evolves, especially regarding new academic literature in the field or insights from the empirical material. In the present study, this was the case. The initial research question was formulated as follows: *How can incumbent SMEs successfully and proactively shape their digital evolution?* As the research progressed, it was adapted according to the insights that were generated from the literature and data along the way. First, "transformation" replaced "evolution". Second, for increasing simplicity and avoiding redundancy, the adjunct "and proactively" was removed as the success implies a proactive stance to digital transformation.

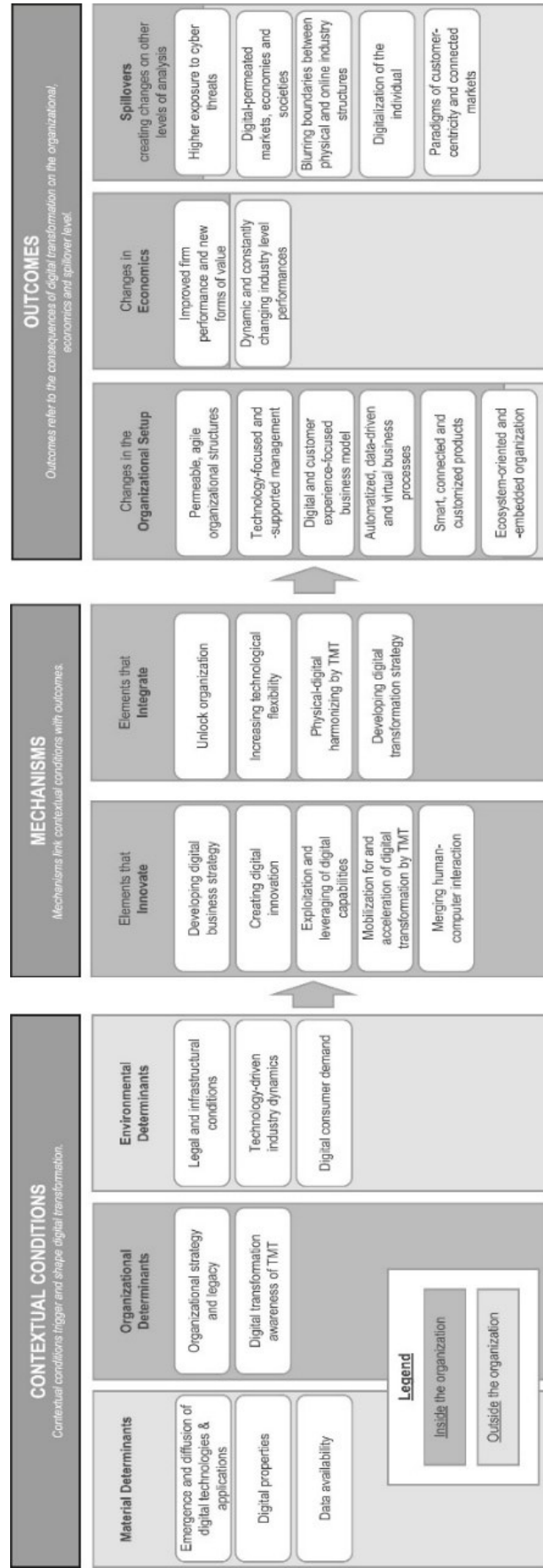
theoretical framework for this study. [Hanelt et al. \(2021\)](#) observe digital transformation from a management perspective and their definition considers the topic's profound implications for a firm's organizing processes. To the best of my knowledge, it is the only framework that adequately pays heed to the complexity and multi-dimensionality of a company's holistic digital transformation while recognizing the potential, if not necessity, for organizational change.

Figure 3 displays the multi-dimensional framework of digital transformation ([Hanelt et al., 2021, p. 7](#)). In its essence, it consists of three building blocks that are briefly explained in this paragraph. First, contextual conditions trigger and shape digital transformation. They consist of material, organizational, and environmental determinants. Whereas the material (technological developments) and environmental (legal, infrastructural, industry, and customer factors) antecedents lie outside an entity, the organizational antecedents characterize the individual firm and consist of strategic, historical, and awareness aspects. Second, mechanisms link the contextual conditions with outcomes. The mechanisms are made of elements of innovation and integration. Third and last, outcomes refer to the consequences of digital transformation on the organizational (mostly internal), economic (partly internal and external), and spillover level (mostly external). The firm performance does play a role in the outcomes but is only one aspect of many, which reinforces the notion that success of digital transformation is multifaceted and not restricted to financial figures.

In order to answer the research question, the research will investigate the mechanisms that shape the digital transformation of incumbent manufacturing SMEs. The reason is that only the mechanisms can be directly adjusted by a company as they lie within its boundaries. "Mechanisms of *innovation* involve the application of resources, processes and capabilities that are new to the organization, while *integration* includes the alignment of these with existing resources, processes and capabilities" ([Hanelt et al., 2021, p. 1166](#)). Companies must therefore utilize these mechanisms to achieve the desired results of digital transformation, which may indeed vary between firms.

Figure 3:

Multi-Dimensional Framework of Digital Transformation



Note. Illustration by Hanelt et al. (2021, p. 1165).

All in all, empirical research and theorizing about the digital transformation of SMEs is mainly characterized by its scarcity within the extant academic literature. Therefore, the multi-dimensional framework of digital transformation by [Hanelt et al. \(2021\)](#) will be the starting point of the empirical research of this thesis even if it is not idiosyncratically tailored to SMEs. As has been noted by the authors, "the multi-dimensional framework ... provides a practical tool for scholars and practitioners to analyze DT" ([Hanelt et al., 2021, p. 1165](#)). Most importantly, the model accounts for the organizational change perspective of this research.

These lines conclude the chapter on the theoretical background of this study. A systematic literature review placed the research within the academic context and served as the basis for the research question. Furthermore, the conceptualization of digital transformation as a process of organizational change was explained. The following chapter on the research design constitutes the bridge from the theoretical background to the findings.

3. Research Design

The research design of this study consists of four sections. First, my stance regarding philosophy of science is presented. Specifically, the ontological and epistemological assumptions that inform this study are explained. Furthermore, I demonstrate the methodology that links these assumptions with the research strategy. Next, the process perspective on organizing is illustrated, followed by the explication of the mode of reasoning that represents the underlying logic of theorizing. Subsequently, I introduce the research strategy based on a multi-case study approach including its quality criteria and ethical considerations. In the third section, the data collection is depicted. Finally, the data analysis procedure concludes this chapter. Table 8 summarizes the research design.

Table 8:

Summary of the Research Design

Criteria	My research choices
Ontological and epistemological assumptions	Realist-constructivist
Methodology	Reflexive interpretation
Mode of reasoning	Abduction
Research strategy	Exploratory multiple-case study with the aim of theory building
Sampling	Theoretical sampling based on common antecedents
Sources of evidence	Primary data by semi-structured interviews, complemented by secondary archival data and personal observations
Data collection	Cross-sectional
Data analysis	Qualitative data analysis in four iterative phases: Within-case analysis, cross-case analysis, shaping propositions ⁴ , and enfolding literature

Note. Own elaboration.

3.1. Philosophy of Science

3.1.1. Ontological and Epistemological Assumptions

At a first glance, digital transformation sounds like a technical term that is completely detached from any philosophical thoughts. Maybe that is even the

⁴ In the original paper by Eisenhardt (1989), the term *hypotheses* is used. Given its connotation to deductive theory-testing research, I consistently use the term *propositions* instead. In the later iterations of the Method by Eisenhardt and Graebner (2007) and Eisenhardt (2021), the term *hypotheses* has vanished altogether in favor of *propositions*, adding to the consistency of this terminology.

case for many studies; this thesis, however, adopts a stance that recognizes the influence of philosophy and values its contribution to thinking and theorizing. In that sense, it heeds the call by [Rowe \(2018\)](#) to incorporate philosophy in information systems research as it is indispensable for reflexive and critical thinking.

This chapter depicts my personal philosophical paradigm the thesis is built upon. It consists of ontological and epistemological assumptions and their effect on the methodology and the research design. In recent years, the terms methodology and method have been used synonymously by a majority of researchers of all domains ([Campbell, 2016](#)). Apparently, along with this terminological washout goes a general indifference regarding a proper philosophical placement of many research endeavors ([McGregor & Murnane, 2010](#)). However, a distinction at multiple levels, i.e. philosophical assumptions, methodology, and methods, is crucial for sensibly grounding research ([Molina-Azorin et al., 2017](#)) because "all social scientists approach their subject via explicit or implicit assumptions about the nature of the social world and the way in which it may be investigated" ([Burrell & Morgan, 1979, p. 1](#)).

My philosophical persuasions are fundamental to understanding this research project. After all, "it is not methods but ontology and epistemology which are the determinants of good social science" ([Alvesson & Sköldberg, 2018, p. 9](#)). To fully comprehend a social phenomenon in academic research, the relationship between the inquiry purpose and the chosen methods is crucial ([Schwandt, 1998](#)), especially for qualitative research where the academic consensus is significantly less established than in the quantitative realm ([Chamberlain, 2015](#)).

First of all, every researcher should be aware of their philosophical stance as the underlying assumptions greatly affect any scientific undertaking ([P. Johnson & Duberley, 2000](#); [van Maanen et al., 2007](#)). In the last decades, a binary system between subjectivist and objectivist social science has been prevalent ([Deetz, 1996](#)) which can largely be attributed to the seminal work of [Burrell and Morgan \(1979\)](#). The strict divide between subjectivism and objectivism has resulted in a widespread dissolution of ontology in epistemology, which has been referred to as "epistemic fallacy" ([Bhaskar, 2020, p. 113](#)). This notion has also been shared both in overall social sciences ([Schwandt, 1998](#)) as well as in management studies ([P. Johnson & Duberley, 2003](#)). In summary,

an objectivist view of epistemology presupposes the possibility of a theory-neutral observational language—in other words, it is possible to access the external world objectively. A subjectivist view of epistemology denies, for various reasons, the possibility of such an epistemological foundation. Meanwhile an objectivist view of ontology assumes that social and natural reality have an independent existence prior to human cognition whereas a subjectivist ontology assumes that what we take to be reality is an output of human cognitive processes. (P. Johnson & Duberley, 2000, p. 180)

Seen as an alternative between pure subjectivism and objectivism, a combination of realist ontology and constructivist epistemology is driven by "a desire to eschew what is seen as postmodernism's relativistic nihilism without recreating positivism's repressive discourses" (P. Johnson & Duberley, 2003, p. 1289). What might seem counterintuitive at first sight is a viable philosophical attitude, which hence implies "to say that reality is socially constructed is not to say that it is not real [and that therefore] constructionism in epistemology is perfectly compatible with a realism in ontology" (Crotty, 1998, p. 63). Hence, this research will be carried out with realist-constructivist assumptions.

3.1.2. Methodology

Methodology, or the "theory of method" (Collins & Stockton, 2018, p. 2), explains why and how certain methods (or combinations thereof) are used in their research context (Campbell, 2016; Chamberlain, 2015). In contrast, methods refer to specific tools or procedures of studying a topic through data collection, data analysis and presenting results (McGregor & Murnane, 2010). In "methodology, methods are the objects of study, not the tools for study" (Slife & Williams, 1995, p. 204). Accordingly, the methodology described in this section links the realist-constructivist philosophical assumptions with the research strategy (Feilzer, 2010). After all, theory and method are inextricably intertwined (Langley, 1999).

The research conducted in this project relies on a qualitative methodology. As opposed to quantitative research, which focuses on the quantification of social phenomena, qualitative research is defined by Denzin and Lincoln (2011) as follows:

Qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material

practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including fieldnotes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them. (p. 3)

Qualitative research is an umbrella term for a field of inquiry that includes a wide range of different disciplines, subjects, and methodologies. For the sake of clarity, the confusion between interpretivism and qualitative research that appears to prevail in large parts of the research community shall be briefly addressed (Prasad & Prasad, 2002). Put simply, all interpretive organizing research is qualitative, but not all qualitative studies adhere to interpretivism. Interpretive research can be regarded as a subset of qualitative research (Prasad & Prasad, 2002). For this study, both apply. At the core of interpretivism lays understanding the meaning of social phenomena (Schwandt, 1998). Interpretivists argue that they can understand the subjective meaning of social actions, for example an interviewee's beliefs, in an objective manner (Schwandt, 2003). They do so by entering the world to study things in their natural setting (Denzin & Lincoln, 2005) and deeply immerse in multiple kinds of data (Gehman et al., 2018).

However, I added a further perspective to the interpretivist approach of this study. This dissertation is informed by the methodology of reflexive interpretation (Alvesson & Skoldberg, 2018). The goal is to conduct multi-perspective research and a well-balanced textual dissertation. In essence, reflexive interpretation as a methodology combines notions of grounded theory, hermeneutics, critical theory, and postmodernism. The four streams represent, in the same order, "contact with the empirical material; awareness of the interpretive act; clarification of political-ideological contexts; and the handling of the question of representation and authority" (Alvesson & Skoldberg, 2018, p. 321). Table 9 summarizes the chief contributions of each of the four methodological streams for this research.

Table 9:*Chief Contributions to Reflexive Interpretation*

Methodological streams	Chief contributions to reflexive interpretation
Grounded theory	Interaction with the empirical material for a close fit between the data and the theory that emerges from it
Hermeneutics	Interpretation of underlying meaning by an observer who inherently forms part of the phenomenon under investigation
Critical theory	Critical awareness of the researcher to avoid reproducing harmful political, ethical, and ideological social conditions
Postmodernism	Self-critical reflection on text production and language use for addressing potentially problematic forms of researcher-led bias in the thesis

Note. Own elaboration based on [Alvesson and Sköldberg \(2018\)](#).

In the following paragraphs, the four methodological strands and their value for this research are explained. First, grounded theory offers a coherent logic to interact with and process the data. Therefore, it presents systematics and techniques for conducting the research ([Alvesson & Sköldberg, 2018](#)). It was originally rooted both in symbolic interactionism and positivism, personified by [Glaser and Strauss \(1967\)](#). According to [Walsh et al. \(2015\)](#), grounded theory describes at the same time both the research process and the end result—namely, a new theory that is empirically grounded in data. The GT research process may be described as investigating an area of interest to the researcher in order to highlight the main concern that emerges from the field through collected data. (p. 582)

The main contribution to this study is a rigorous procedure for data collection and analysis. This research applies by no means a pure grounded theory approach but takes its core principles for a meaningful inclusion of empirical material. As will be explained later, the research strategy itself also relies on grounded theory ideas, assuring a close theoretical fit between methodology and method ([Edmondson & McManus, 2007](#)).

Second, hermeneutics adds a view that all research, even all life, is interpretation and understanding ([Schwandt, 2003](#)). Therefore, research is never detached from the subject of study, but always part of the scene. Following [Alvesson and Sköldberg \(2018\)](#),

research can be seen as a fundamentally interpretive activity, which in contrast to—or at least to a greater degree than—other activity is aware

of this very fact. The recognition that all research work includes and is driven by an interpreter—who in the social sciences, moreover, often interacts with and contemplates other interpreters (the people studied)—here provides the key to a qualified methodological view. Thus method cannot be disengaged from theory and other elements of preunderstanding, since assumptions and notions in some sense determine interpretations and representations of the object of study. (p. 13)

The thoughts of hermeneutics' originators such as Heidegger, Gadamer, and Dilthey, in their most essential version, can be summarized in one sentence: the part can only be understood from the whole, and the whole only from the parts (Alvesson & Sköldberg, 2018). Hermeneutics as a highly interpretive body of thought highlights the search for meaning and understanding in the research process during this project.

Third, the guiding principle of critical theory in the original Frankfurt school of Adorno, Marcuse, Horkheimer, and Habermas is a desire for emancipation in knowledge (Alvesson & Sköldberg, 2018). Societal conditions are never natural and inevitable, but created in their historical context (Alvesson & Sköldberg, 2018). Critical theory does not bring any concrete procedures or protocols to the table of this research—its inclusion in this project aims at surfacing social imbalances and making them explicit. In the economic entities that SMEs are, this refers mainly to disparate power distribution.

Fourth and last, postmodernism with its most prominent thinkers Foucault, Derrida, and Lyotard does not offer any methodological guidance—in fact, postmodernism could be called "anti-methodological" (Alvesson & Sköldberg, 2018, p. 261). In the context of this thesis, postmodernism mainly adds a perspective to text production: The author is decoupled from the text they produce. The text, therefore, is as if it had its own life. The consequence for the author is to take full responsibility for the research and the resulting writing. Alvesson and Sköldberg (2018) admit that by incorporating postmodernist ideas in their methodological concept of reflexive interpretation, they purposefully include an antipode to some of the previous streams and also to the notion of a realist ontology. However, they conclude that postmodernism contributes "to problematizations, to questioning and reappraisal of established truths and

categories, which generally can stimulate creativity and innovation" (Alvesson & Sköldberg, 2018, p. 275) in the research process.

Methodologically, this qualitative research is therefore a matter of interpretation at four distinct levels without letting one of them dominate the others. However, it is not a specific methodology that inherently guarantees reflexivity—it is rather a framework to stimulate reflexive thinking and writing in research. Especially the criticality and the questioning of the taken-for-granted assumptions will facilitate the incorporation of ethical aspects of digital transformation (Vial, 2019). Indicating the details of every research choice maximizes the methodological transparency (Aguinis et al., 2018).

3.1.3. Mode of Reasoning

Traditionally, theory building in general and grounded theory in particular have been described as an inductive endeavor (Mantere & Ketokivi, 2013; Suddaby, 2006). However recently, "scholars have tended to see this label as problematic, as it suggests a form of naïve empiricism that ignores the inevitable contribution of pre-existing theoretical ideas (however amorphous) to emerging insights as well as underplaying the role of imagination" (Klag & Langley, 2013, p. 151). Theorizing, at its heart, is an abductive process and is the most suitable logical operation for producing new ideas (Suddaby, 2006). "Abduction is probably the method used in real practice in many case-study-based research processes" (Alvesson & Sköldberg, 2018, p. 4) even if many researchers do not state it explicitly or even deny it.

Summarized in one sentence, "we predict, confirm, and disconfirm through deduction, generalize through induction, and theorize through abduction" (Mantere & Ketokivi, 2013, p. 72). For studying a process such as digital transformation, abduction is a suitable logic for theory building (van de Ven & Poole, 2005). In a setting where the phenomenon in question is underexplored, the "abductive approach is fruitful if the researcher's objective is to discover new things" (Dubois & Gadde, 2002, p. 559). In this vein, this research project makes use of abductive reasoning for theorizing. Alvesson and Sköldberg (2018) neatly encapsulate the relation between empirical data and theory:

Induction has its point of departure in empirical data and deduction in theory. Abduction starts from an empirical basis, just like induction, but does not reject theoretical preconceptions and is in that respect closer to

deduction. The analysis of the empirical fact(s) may very well be combined with, or preceded by, studies of previous theory in the literature, not as a mechanical application on single cases, but as a source of inspiration for the discovery of patterns that bring understanding. The research process, therefore, alternates between (previous) theory and empirical facts (or clues) whereby both are successively reinterpreted in the light of each other. (p. 5)

All in all, abductive theorizing is characterized by discovery (Locke et al., 2008), creativity (Alvesson & Sköldberg, 2018), serendipity (Langley et al., 2013), and disciplined imagination (Weick, 1989). Considering the nature of this study, it is the suitable mode of reasoning.

3.2. Research Strategy

3.2.1. Multiple-Case Study

As has been shown in the systematic literature review, the digital transformation of SMEs is a conceptually underexplored phenomenon in a nascent academic field. Authors from different ontological and epistemological backgrounds allude to a case study approach as being the suitable research strategy for exploring new or scarcely examined academic grounds (Eisenhardt, 1989; Hannah et al., 2021; B. Lee & Saunders, 2016; Stake, 1995; Yin, 2018). The digital transformation of SMEs (the unit of analysis) fulfills typical settings that usually call for a case study approach, such as a lack of (good) theory, complex processes, and constructs that are hard to measure (Gehman et al., 2018). The context of digital transformation and the technologies involved need to be investigated in conjunction as they are co-constitutive elements of the phenomenon (Morgan-Thomas, 2016), presenting another strong argument for an in-depth exploration.

The case study approach, defined as "a research strategy that examines, through the use of a variety of data sources, a phenomenon in its naturalistic context, with the purpose of 'confronting' theory with the empirical world" (Piekkari et al., 2009, p. 569), is often chided for not instituting generalizable insights and therefore the overall legitimacy in academia is challenged (Tsang, 2014). Especially in information systems, quantitative, statistical, sampling-based research is dominant for generating theory, but is problematic if applied

uncritically (A. S. Lee & Baskerville, 2003; Tsang & Williams, 2012). However, the value of a theory built from case study research can be superior to any other approach (Flyvbjerg, 2006). Differing from other types of generalization such as naturalistic (Stake, 1995) and empirical (Gomm et al., 2000), this thesis makes use of theoretical generalization which strives "for generalizable findings or lessons learned—that is, analytic generalizations—that go beyond the setting for the specific case . . . that had been studied" (Yin, 2018, p. 38).

The research strategy is based on the work of Kathleen Eisenhardt as she described it in three main iterations (Eisenhardt, 1989, 2021; Eisenhardt & Graebner, 2007). Langley and Abdallah (2011) coined the name the 'Eisenhardt Method' which Eisenhardt (2021) picked up herself later. This thesis henceforth makes use of the term or simply the 'Method'. The singular aim of the Method is theory-building using multiple cases. It does not provide a rigid template of how to conduct a multiple-case study (Gioia et al., 2022); rather, it is a research strategy that enables a broad variety of studies (Eisenhardt, 2021). The Method is not a step-by-step cookbook that ensures academic rigor per se (Harley & Cornelissen, 2022) and thus does not exempt the researcher from thoroughly engaging with methodology. It is therefore up to the researcher to substantiate the concrete specification of a research project that follows the Eisenhardt Method.

The Method is also about offering explanations, not just evidence (Langley & Abdallah, 2011) with the purpose "to generate knowledge about the inner workings of organizational phenomena—that is, their causal relations" (Sandberg & Alvesson, 2021, p. 497). The advantage is that, "keeping other things constant, a multiple-case design provides a stronger basis for theoretical generalization than a single-case design" (Tsang, 2014, p. 374) and potentially yields a better grounded theory (Graebner & Eisenhardt, 2004). Moreover, the method recognizes a priori specification of constructs—defined as a conceptual abstraction of a phenomenon that cannot be directly observed and has been created on purpose for a particular scientific purpose (Suddaby, 2010)—as a valuable starting point (Eisenhardt, 1991). In this research, the multi-dimensional framework of digital transformation by Hanelt et al. (2021) served as preliminary conceptualization and constituted a neat fit because the authors "think that the phenomenon of DT offers opportunities for inductive theory generation" (Hanelt et al., 2021, p. 26). The fact that the emergent theory is generated abductively in

this study does not derogate the multi-dimensional framework's methodological fit as abduction involves significant elements of induction.

The Eisenhardt Method draws on three main influences, namely grounded theory's iterative process of perpetual juxtaposition of theory and data (Glaser & Strauss, 1967), case study research with replication logic (Yin, 1984), and qualitative data analysis (Miles & Huberman, 1984). Table 10 summarizes the three influences and indicates the most recent iterations that are used in this thesis.

Table 10:

Key Influences for the Eisenhardt Method

Original publication	Most recent iteration	Defining feature
Glaser and Strauss (1967)	Corbin and Strauss (2015)	Grounded theory
Yin; Yin (1981, 1984)	Yin (2018)	Multi-case research with replication logic
Miles and Huberman (1984)	Miles et al. (2020)	Qualitative data analysis

Note. Own elaboration based on (Eisenhardt, 1989, 2021).

Originally published in 1989 and having been refined over the last decades, the Eisenhardt Method has become one of the most influential research frameworks in management and beyond (Langley & Abdallah, 2011; Ravenswood, 2011). Table 11 offers a brief summary of the three main iterations.

Table 11:

Evolution of the Eisenhardt Method

Publication	Content
Eisenhardt (1989)	The method was explicated for the first time as a positivist approach to build theory from multiple cases.
Eisenhardt and Graebner (2007)	The Method is enhanced, especially by indications about the handling of interview data, the presentation of empirical data, and the writing process.
Eisenhardt (2021)	Clarifications and concretizations of the Method, especially regarding more flexible philosophical assumptions, a greater emphasis on time, and the role of abductive reasoning.

Note. Own elaboration.

In itself, the Eisenhardt Method presents an appropriate research strategy for building a theory of an underexplored phenomenon from multiple cases. The

following section sheds light on temporal aspects of digital transformation in the context of organizational life.

3.2.2. Temporality

There is no single blueprint for conducting qualitative research (Pratt, 2009). Rather, there are probably as many approaches as there are researchers (Langley & Abdallah, 2011). Nevertheless, a few predominant research templates have crystallized over the last decades in qualitative management and organization studies (Bansal et al., 2018). Apart from the Eisenhardt Method that has been introduced in the previous section, theorizing from process data as most prominently promulgated by Ann Langley has received particular attention (Langley, 1999; Langley et al., 2013). This section addresses how process thinking accommodates in this research and therefore accounts for clarification of the "potentially incommensurable assumptions" (Gehman et al., 2018, p. 285) of the two perspectives. Accordingly, I hereby recognize "the centrality of time" (Langley et al., 2013, p. 4) for studying an organizational process such as digital transformation (Soluk & Kammerlander, 2021). This notion is in line with the latest iteration of the Eisenhardt Method which acknowledges the crucial importance of time in understanding organizational phenomena (Eisenhardt, 2021).

The traditional understanding of organizational change as depicted in management and organization studies views companies "as already-constituted entities, with predefined properties waiting to be discovered by the researcher" (Langley & Tsoukas, 2017a, p. 2). The predominantly quantitative deductive research focused on variance as expressed by correlations and the relationship between variables. Starting in the late-1960s, authors have increasingly focused on how emerging phenomena unfold over time within organizations. Essentially, organizations are viewed as the constellation of processes and their relation to each other, rather than independent and stable things (van de Ven & Poole, 2005). Linguistically, this paradigm shift is most notable by using the gerund *organizing* rather than *organization* (Weick, 1979). The process point of view assumes a relational ontology as it does not conceive all things in isolation, but always in their relation to other things (Langley & Tsoukas, 2017a). As opposed to variance theory, process theory is especially suitable for research that focuses "on how and why things emerge, develop, grow, or terminate over time" (Langley et al., 2013, p. 1). In this vein, time plays a crucial role in organizing and

management. Moreover, this perspective offers an contemporary interpretation of organizational life by treating change as the standard rather than the exception (Tsoukas & Chia, 2002). Accordingly, “strong-process thinking highlights the ever-changing nature of reality, focusing on *becoming* rather than being. Reality is seen as a process of creative advance, in which the past is brought forward to the present” (Langley & Tsoukas, 2017b, p. 6).

Digital transformation is arguably a process that enfolds over time. Nevertheless, this research project is not a process study because longitudinal data is a prerequisite (Gehman et al., 2018). Instead, this study uses cross-sectional data due to the inherent circumstances of the research project which did not allow for a long enough data collection period that would be expedient for studying digital transformation—a process that can endure years, if not decades.

The Eisenhardt Method favors neither process nor variance approaches; rather, it is designed for developing theory in a broad sense (Eisenhardt, 2021). The Method therefore transcends the paradigm that has vexingly been called “normal science” (Bansal et al., 2018, p. 1193), insinuating that everything outside conventional hypothetico-deductive or variance-based research is abnormal. The Eisenhardt Method places “time more directly in the spotlight” (Eisenhardt, 2021, p. 156) than commonly assumed and is therefore suitable for studying a process such as digital transformation. “Rather than seeking explanations for differences between cases, a process theoretical analysis requires looking for regularities in temporal patterns across cases” (Langley & Abdallah, 2011, p. 115). In contrast to longitudinal data that is collected over time, cross-sectional data is collected at one point of time. Nevertheless, it is still possible to go back in time by investigating the participants’ recollections of factual events in the past or time-stamped archival data (Gehman et al., 2018). Research with a comparable temporal setting has been conducted before in management studies (Ambos & Birkinshaw, 2010). I mitigated retrospective bias by relying on at least two participants per case. Moreover, I focused my questions on factual events rather than beliefs or interpretations, as the latter are prone to distortions (Golden, 1992). The primary data was backed up by recent archival data. Apart from these retrospective accounts, the data is contemporary in nature, reflecting what participants opine at the moment of the interview.

All in all, this study investigates the process of digital transformation by looking for similarities across multiple cases making use of cross-sectional data with both retrospective and contemporary foci. Hence, "the emergent theory captures *process similarities* across cases" (Eisenhardt, 2021, p. 153). The next section justifies the utilization of the Eisenhardt Method within the philosophical and methodological assumptions of this study.

3.2.3. Methodological Fit

The Eisenhardt method offers a tight methodological fit, meaning the internal consistency among the elements of the research (Bansal et al., 2018; Edmondson & McManus, 2007). The Method's most recent iteration (Eisenhardt, 2021) was a crucial development for its applicability in this study. The Eisenhardt Method has become more open, pragmatic and flexible—that is, more creative—over the course of more than three decades (Gioia et al., 2022), making it increasingly attractive for subjectivist researchers. Without distancing the Eisenhardt Method from pure (post-)positivist assumptions (Gehman et al., 2018), the theory-method fit between my philosophical paradigm and the Method would not have been given; (post-)positivism and an interpretivist methodology would not have matched. This fit was then even increased by allowing process thinking and abductive reasoning to find their place in the Method (Eisenhardt, 2021). Moreover, Eisenhardt (2021) specified that her Method is not exclusively aimed at measuring performance. In this research, company performance plays only a minor role, with digital transformation through organizational change being the center of attention. In the following paragraphs, the methodological fit between the nature of the research and the Eisenhardt Method is described.

First, the internal consistency regarding the realist-constructivist assumptions is given. Being one of the principal authors on case study research, Eisenhardt has been considered a positivist for decades, but has recently advocated for a philosophically flexible interpretation of her Method (Eisenhardt, 2021; Eisenhardt et al., 2016). Specifically, she now locates herself in the realist-constructivist field by stating that "there is an objective reality. . . . But there is also a social construction of reality" (Eisenhardt, 2021, p. 155). Therefore, the exploratory Eisenhardt Method is a perfect fit between my philosophical assumptions and the nature of the research problem, even if Eisenhardt does not overestimate the importance of the philosophical underpinnings because

"ontology and epistemology are research choices that are not core to the Method" (Eisenhardt, 2021, p. 155).

Second, the four elements of reflexive interpretation, namely "contact with the empirical material; awareness of the interpretive act; clarification of political-ideological contexts; and the handling of the question of representation and authority" (Alvesson & Sköldberg, 2018, p. 321) are all compatible with the Eisenhardt Method. Especially grounded theory and hermeneutics are inherent to the Method. The democratic emphasis of critical theory and the claims to authority of postmodernism are additional lenses for applying the Method.

Third, a multiple-case study represents a focused method to study processes of organizational change in companies (van de Ven & Poole, 2005). A multiple-case research design represents, for that matter, a comparison of processes by replicating them across various entities, in this case incumbent manufacturing SMEs (Langley et al., 2013). Even if the Eisenhardt Method and process theorizing have been described as competing approaches to theory building (Gehman et al., 2018), they are highly complementary (Eisenhardt, 2021). However, it has to be noted that this is not a process study, as longitudinal data is a prerequisite (Gehman et al., 2018), while this research builds on cross-sectional data (Tidhar & Eisenhardt, 2020). Going back in time is limited to the recollection of the informants regarding factual events or archival data that represent historical events. It is therefore not possible to interpret the participants' cognition of historical processes but focuses on their recollection of factual events in the past (Gehman et al., 2018). Accordingly, the Eisenhardt Method is in line with the studying digital transformation as a process of organizational change based on cross-sectional data. Previous studies have relied on cross-sectional data to study the process of organizational change induced by information technology (Orlikowski, 1993).

Fourth, regarding the mode of reasoning, Eisenhardt originally described her method as inductive theory building (Eisenhardt, 1989; Eisenhardt et al., 2016; Mantere & Ketokivi, 2013). However, later she admits that abduction is a valid contribution to her method (Eisenhardt, 2021). Induction is complemented by deductive logic, especially when comparing data to previous knowledge (Strauss & Corbin, 1998). The "identification of empirical tendencies by induction, while crucial, constitutes only one part of the research process. In seeking theoretical interpretations for the observed empirical tendencies and in choosing

between possible theoretical interpretations, scholars always engage in abductive reasoning" (Mantere & Ketokivi, 2013, p. 83). As abductive reasoning is inherently iterative and recursive (Klag & Langley, 2013), there is a close fit to the Eisenhardt method. Furthermore, abduction is a suitable mechanism for studying organizational change (Golden-Biddle, 2020). Moreover, Yin (2018) affirms that such an explanation-building process is partly deductive and partly inductive, adding further to the fit.

Fifth and last, this research aims at building a scientifically robust theoretical framework that is targeted towards practitioners to help them succeed in the digital transformation of their incumbent manufacturing SMEs. Case study research is deeply rooted within real organizational practices and involves interacting closely with the participants. Hence, the chosen research strategy fits the quest for generating knowledge that is relevant to practitioners such as SME managers (Gibbert et al., 2008). Accordingly, the Eisenhardt Method is ideally suited to reach the research aim of building a scientifically robust theoretical framework that is targeted towards practitioners to help them succeed in the digital transformation of their incumbent SMEs in the manufacturing sector.

All in all, the individual elements of this research are internally consistent, assuring a tight methodological fit from the research problem to the contributions.

3.2.4. Quality Criteria

The quality criteria of a qualitative study that aims at theorizing are fundamentally different from deductive research that strives for testing or falsifying hypotheses (Pratt, 2008). This divergence refers both to the inquiry process and the inquiry product (Lincoln & Guba, 1990). Conventional quality criteria for case study research such as internal validity, external validity, construct validity, or reliability lie within a positivist tradition (Lincoln & Guba, 1986). To account for the interpretivist nature of this study, they shall be complemented by other traits such as authenticity, trustworthiness, credibility, confirmability, and dependability that are prime to interpretivist research (Denzin & Lincoln, 2011). This section defines the quality criteria based on the Eisenhardt Method's inherent characteristics of its most recent iteration (Eisenhardt, 2021) that has widened its scope towards non-positivist assumptions.

This research is informed by a range of different theoretical streams and strives for incorporating the beneficial aspects of each, which makes it more

difficult to agree on a definitive set of quality criteria in such a setting (Easterby-Smith et al., 2008). For example, Denzin and Lincoln (2011) state that in constructivist research, terms "like credibility, transferability, dependability, and confirmability replace the usual positivist criteria of internal and external validity, reliability, and objectivity" (Denzin & Lincoln, 2011, p. 13). Nevertheless, positivist quality criteria do not become irrelevant. They remain important features of the emergent theory but are complemented by *new* criteria. Specifically, validity in its different forms (construct, internal, and external) plays an important role for key authors in this study (Eisenhardt, 2021; Langley & Abdallah, 2011; Yin, 2018). The core features of the Eisenhardt Method define the set of quality criteria for this study. Hence, the "successful outcome of a multi-case theory-building study is a theory that balances parsimony (not complicated spaghetti diagrams), accuracy (captures the core features of the phenomenon), and generalizability (relevant beyond the immediate setting), is logically coherent... and is (hopefully) surprising" (Eisenhardt, 2021, p. 152). The following paragraphs explain these quality criteria that this study shall live up to and how they relate to the terms from fundamentalist qualitative-interpretivist and quantitative-positivist research.

First, parsimony is one of the key features of good theory (Weick, 1979). The challenge for parsimonious theory, which essentially aims at simplicity, is handling the complexity of empirical data and reduce it to its most basic underlying mechanisms (Cloutier & Langley, 2020). A multiple-case study, which inherently involves an abundance of empirical data, must therefore focus on the quintessential inferences that are relevant for theorizing, even if it comes at the expense of details to some degree.

Second, empirical accuracy is important for multiple-case studies (Gehman et al., 2018). Accuracy is defined "by a theory's fit with the essence (i.e. core features) of the phenomenon, not every detail" (Eisenhardt, 2021, p. 157) and is related to construct validity (Gibbert et al., 2008). The theory, therefore, does not need to fit to every detail in the empirical data; rather, the theory must be consistent with the essential nature of the cases. A rigid execution of the research methods therefore pays significant dividends to the accuracy of the resultant theory. Data triangulation, meaning the combination of several data collection methods, is key to enhance accuracy (Gibbert et al., 2008; Langley & Abdallah, 2011; Yin, 2018).

Third, "logical coherence as a foundation for analytical generalization is an important criterion for quality in case research" (Dubois & Gadde, 2002, p. 559). Logical coherence, or internal validity, plays an important role in the Eisenhardt Method (Eisenhardt, 2021). The application of diverse lenses enhances the validity of the theory (Eisenhardt, 1989). In this project, the complementary theoretical lenses (realist-constructivist assumptions and reflexive interpretation) greatly add to the validity. Furthermore, all elements of the research were chosen to be logically coherent in terms of a methodological fit (Edmondson & McManus, 2007).

Fourth, generalizability lies at the heart of the Eisenhardt Method, which essentially is about theorizing from multiple cases through replication logic (Eisenhardt & Graebner, 2007). Effective theoretical sampling helps to control the setting and is therefore the foundation for generalizability (Eisenhardt, 1989). The generalizing strength of a theory depends on its versatility, which refers to "the degree to which it can encompass a broad domain of developmental patterns without modification of its essential character" (Poole et al., 2000, p. 43). In the context of this study, generalizability, which is related to transferability (Denzin & Lincoln, 2011; Eisenhardt, 2021) and external validity (Gibbert et al., 2008), accounts for the theory to be applicable to a wide range of SMEs. The generalizability of a theory highly depends on the previous two types of validity, i.e. construct validity and internal validity (Gibbert et al., 2008).

Fifth and last, theory built from multiple cases shall be surprising and avoid to merely reproduce existing knowledge by framing it differently (Alvesson & Kärreman, 2007). Moreover, Weick (1989) further adds to this view that

a good theory is a plausible theory, and a theory is judged to be more plausible and of higher quality if it is interesting rather than obvious, irrelevant or absurd, obvious in novel ways, a source of unexpected connections, high in narrative rationality, aesthetically pleasing, or correspondent with presumed realities. (p. 517)

As interpretivism is less formalized than hypothetico-deductive research, the credibility of a study highly depends on the researcher's reflexivity (Mantere & Ketokivi, 2013). By applying a reflexive methodology (Alvesson & Skoldberg, 2018) and by studying a research phenomenon beyond the usual suspects (Alvesson & Sandberg, 2024), the prerequisites for surprising results are fulfilled.

To sum up, the quality criteria for positivist and interpretivist research are not all too different (Seale, 1999). Slightly different terms and connotations give them divergent spins. In the end, they both call for rigor and integrity in research.

3.2.5. Ethical Considerations

The legal requirements of the General Data Protection Regulation and the Research Data Management Policy of Sheffield Hallam University represent the ethical framework for the following ethical considerations. The nature of the data is mixed. In the qualitative interviews, personal data was collected. The participants were given an information sheet containing all the relevant aspects of the research project. Moreover, they filled out a consent form prior to data collection. Archival data did not involve sensitive data, but mostly openly accessible documents. Documents used in this research that were not publicly available were pseudonymized. Confidentiality was guaranteed throughout the research by using pseudonyms that were borrowed from the metric system (Brown, 2025). All names of companies and interviewees were anonymized throughout the thesis as confidentiality was guaranteed to all participants without any exception. Moreover, intellectual property was respected. Credit and acknowledgement for all sources are given if applicable. Data was only stored temporarily on my personal computer because the analysis software technically required it, relying on Sheffield Hallam University infrastructure (Microsoft OneDrive). The data will be stored in the Sheffield Hallam University's Q:\Research drive with no access for any third party upon completing the research project. The ethical innocuousness is testified by an assessment on Converis with the registration number ER20878869 (see also Appendix A).

Generally speaking, digital transformation might be challenged on the basis of ethical considerations. Or, formulating it even more critically, its right to exist might be put into question. Do companies have to evolve digitally at all or are there alternative ways? If so, to what degree should companies evolve digitally, or may it be an end to itself? Does it reinforce decayed macroeconomic and societal structures such as climate change or wealth inequality by adhering to the principle of continuous growth, rather than contributing to abolishing them? By bearing in mind these pitfalls from the very beginning of the research process, their repercussion shall be mitigated.

3.3. Data Collection

The Eisenhardt Method is particularly explicit about flexible data collection as "controlled opportunism in which researchers take advantage of the uniqueness of a specific case and the emergence of new themes to improve resultant theory" (Eisenhardt, 1989, p. 539). Nevertheless, data collection is a systematic endeavor that is described in this section. First, theoretical sampling is the approach for choosing the cases. Second, the primary and secondary sources of evidence are explained. Third, I elucidate the data collection procedure, to be followed by fourth, a classification and short descriptions of the ten case companies. Fifth and last, this section ends with the data analysis.

3.3.1. Sampling

For theory building from cases, theoretical sampling (as opposed to random sampling which aims for a statistical representation of the total population and is primarily used in quantitative studies) is recommended (Eisenhardt, 1989). The "goal of theoretical sampling is to choose cases which are likely to replicate or extend the emergent theory" (Eisenhardt, 1989, p. 537). Moreover, theoretical sampling strengthens the focus on the phenomenon of interest, mitigates alternative explanations, and enhances generalizability (Eisenhardt, 2021). The theoretical sample of this research project was determined on two levels: Company characteristics and organizational antecedents.

First, the research question narrows the scope of potential case companies due to their basic characteristics. This research focuses on incumbent SMEs in the manufacturing sector. Furthermore, the focal companies were to be involved with business customers, at least to some extent. Moreover, to account for a more manageable data collection, the region was limited to Southern Germany. Table 12 summarizes the criteria that were deduced from the company characteristics.

Table 12:
Sampling Criteria

Criterion	Specification
Foundation date	Previous to 2012
Staff headcount	< 250
Turnover or balance sheet total	≤ €50 million or ≤ €43 million
Industry (primary)	ISIC section C
Transaction type	B2B (at least to some extent)
Headquarter location	Bavaria or Baden-Württemberg

Note. Own elaboration.

Second, from a methodical point of view, a research design with *common antecedents* is chosen in order to zoom in on the mechanisms of the digital transformation of incumbent SMEs with comparable baselines (Eisenhardt, 2021). While not the most common sampling approach in case-study research, it is in line with previous qualitative studies on SMEs (J. B. Li & Piezunka, 2020). According to Eisenhardt, controlling the antecedent conditions allows the researcher to "focus on uncovering novel process insights" (Gehman et al., 2018, p. 288) because cases that fail to succeed in digital transformation simply due to poor antecedent conditions are effectively removed in the first place. Sampling cases based on common antecedents allows for controlling variance to focus on the focal phenomenon, which is the process of digital transformation.

The selection criteria for the cases were based on the contextual conditions within the multi-dimensional framework by Hanelt et al. (2021), namely material, organizational, and environmental antecedents. Both the material and the environmental antecedents lie outside of the companies and are therefore equal for any SME because they share the same company characteristics. For example, the legal and infrastructural conditions such as the regulatory framework (environmental antecedent) or the availability of digital technologies such as cloud computing (material antecedent) apply equally for all companies in the same geographic region. Hence, merely the organizational antecedents are suitable determinants to evaluate whether a company possesses beneficial antecedents for digital transformation, or not. The organizational antecedents comprise of two subsets, namely *organizational strategy and legacy*, and *digital transformation awareness of the top management team*. By selecting companies with favorable organizational antecedents, the focus lies on the digital

transformation mechanisms and their implications for digital transformation success ([Bingham & Eisenhardt, 2011](#); [J. P. Davis & Eisenhardt, 2011](#)). The focus explicitly does not lie on companies that have already experienced successful digital transformation (or any other dependent variable, for that matter). The favorable antecedent conditions tend to predispose these SMEs to successful digital transformation, but does not guarantee it ([J. B. Li & Piezunka, 2020](#)). In a nutshell, the theoretical sample of this research involves cases in which the antecedent conditions to digital transformation generally predisposed successful digital transformation.

Sampling is also about a very practical issue: Who lets me in? As a departure point for getting access to cases, the databases of the Chamber of Industry and Commerce in Bavaria ([Industrie- und Handelskammern in Bayern, 2021](#)) and Baden-Württemberg ([Baden-Württembergischer Industrie- und Handelskammertag, 2021](#)) represented the basic population that was potentially relevant for the study. This procedure is consistent with other qualitative research on SMEs ([Eisenhardt & Schoonhoven, 1990](#); [Kammerlander & Ganter, 2015](#); [J. B. Li & Piezunka, 2020](#)). The databases allow for fine-grained search criteria to match the target group as defined by the company characteristics in the previous chapter. In total, 3,447 records were extracted from the databases.

However, the databases did not allow me to infer to common antecedents for digital transformation among the SMEs. In order to account for this second part of the chosen theoretical sampling approach, a questionnaire was designed to assess the common antecedents. The aim of the survey was to identify potential cases and being able to gain a superficial estimation of their digital transformation status. The aim was explicitly not to draw statistical conclusions. Even though the systematic literature review had not been finalized at that point because new additions were made throughout the research process, the theoretical foundation for composing the questionnaire was determined to be the model by [Hanelt et al. \(2021\)](#). The operationalization of the common antecedents was executed in the form of nine statements in the questionnaire. The statements were arranged according to their complexity, with simpler statements prior to more complex statements, to not discourage respondents from the beginning. Table 13 presents the common antecedents and the corresponding questionnaire statements. The level of measurement for the statements was an ordinal scale

from 0 to 100. The higher the average of the nine statements, the higher the predisposition for successful digital transformation.

Table 13:

Questionnaire Statements Based on the Common Antecedents

Dimensions	Questionnaire statements
Existing resources & slack	We possess enough resources to drive our digitalization.
Positive attitude towards change & technology	The top management team has a positive attitude towards change and technology.
Internal structure	Our company's internal structure allows for effective digitalization.
Perception of market shifts	Our managers have a good perception of market shifts.
Existing processes & culture	The corporate culture and our processes are beneficial for our digital transformation.
TMT awareness of capabilities of technology	Our management is aware of the capabilities that technology can bring to our company.
Mindfulness	The management is reflective regarding the threats and chances of digitalization.
Path dependence	We can shape our future digitalization initiatives without restriction through past strategic decisions.
Readiness to lead change	The top management team is eager to lead the change that the digital transformation implies.

Note. Own elaboration. The dimensions are based on [Hanelt et al. \(2021\)](#). The statements for the questionnaire are derived from these dimensions.

Apart from the nine statements, the survey assessed if a company was a SME, the foundation year, the company name, the company's headquarters location, the industry, the name and the email address of the contact person (who did not necessarily have to be the respondent of the questionnaire). Finally, the questionnaire asked for the willingness to contribute to the research project as a case.

The e-mails were sent in February 2022 in several batches. As the sender address, my business account was used to increase the likelihood of acceptance and avoid being classified as spam. In total, 3,002 e-mails were sent. 68 people responded, out of which 34 completed the survey. This equals a low response rate of 1.13 %. There are several possible reasons for that. First, I have experienced a tendency towards adversity and skepticism in academia among SMEs. Many SME leaders do not have an academic background and do not

usually engage in scientific endeavors. Second, a lack of resources, especially time, might have prevented companies from participating. Third, recipients of the survey might have dreaded participating due to their limited knowledge of the topic or the low digital maturity of their company. Fourth, also technical reasons might have played a role. The high bounce rate due to non-existent email recipients reduced the number of possible survey participants in the first place. Moreover, recipients who do not carry responsibility for digital transformation might not have forwarded the message to suitable persons.

After scrutinizing the 34 responses, twelve respondents complied with the company characteristics (antecedent conditions) and showed an interest in being part of the study. Subsequently, the respondents were contacted. Six companies discontinued the correspondence. One company turned out not to be active in the manufacturing industry. All in all, five companies could be acquired as cases through the survey. Interestingly, the five companies that proceeded were among the ones with the highest average scores. They ranged between 67 and 77, with the average being 60. This observation suggests that digitally advanced companies are more confident to share their insights than digitally less mature companies.

Even if there is no predefined number of required cases for the Method (Eisenhardt, 2021), I continued to acquire cases by contacting incumbent manufacturing SMEs in my professional network. While simultaneously conducting the data collection, another eleven companies could be obtained as cases. All in all, 16 cases formed part of the data collection phase.

3.3.2. Sources of Evidence

The sources of evidence for this study are interviews, archival records, and direct observations (Yin, 2018). These are the most common sources in case-study research (Eisenhardt, 1989). Each source type has specific advantages and shortcomings. Therefore, they are highly complementary and the convergence of multiple source types is an indicator for good case-study research (Yin, 2018). By triangulation the data, the strengths of one type can—at least partly—compensate for the weaknesses of another. This procedure increases the likelihood of precise and staunch theory (Eisenhardt, 1989).

First, interviews, being defined "as verbal exchanges initiated by the interviewer in order to obtain relevant information, opinions or beliefs from the

interviewee for research purposes" (Welch & Piekkari, 2006, p. 418), were conducted as the primary source of evidence. Semi-structured interviews were chosen for theoretical consistency (Tidhar & Eisenhardt, 2020) and the interview guideline—or interview protocol (Eisenhardt, 1989)—was based on the model by Hanelt et al. (2021). Qualitative research is often pejoratively associated with a lack of scientific rigor by the positivist-inclined management studies discipline; well-designed research instruments such as the interview guideline aim for increasing the notion of validity (Eisenhardt, 1991). Whereas the survey to access potential cases referred to the antecedents of digital transformation, the interviews aimed at disclosing the mechanisms that underly successful digital transformation. Hence, the focal aspects of the model that served as the foundation for the interviews were developing digital business strategy, creating digital innovation, exploiting and leveraging of digital capabilities, mobilization for and acceleration of digital transformation by TMT, merging human-machine interaction, unlocking organization, increasing technological flexibility, physical-digital harmonizing by TMT, and developing digital transformation strategy. The interview guideline is presented in Appendix B. While unstructured interviews lack the basis for replication and structured interviews are too narrow for a fruitful conversation, semi-structured interviews are the sweet spot in between. They are flexible enough for further probing of the informant in the progress of the conversation while maintaining a comparability through the predefined guideline. The insights from interviews also serve to develop and enhance the guideline for subsequent data collection events. Moreover, the process lens was applied by asking the informants about their recollection of events in the past (Gehman et al., 2018). For example, the interviewees were asked about the milestones in their digital transformation that lead the companies to their current state of digitality. The semi-structured interviews were taped as audio recordings for the subsequent data analysis.

Regarding interview techniques, ethnographic elements of a "friendly conversation" (Spradley, 1979, p. 58) were included. The aim was to gain the confidence of the informants and reduce the reservations towards me as the interviewer. For many informants, it was the first time ever to explicitly and formally talk about digital transformation. With that in mind, a "few minutes of easygoing talk interspersed here and there throughout the interview will pay enormous dividends in rapport" (Spradley, 1979, p. 59). Moreover, the familiarity

with the topic greatly varied between the informants. For example, some the informants from lower hierarchical levels expressed their unease of being interviewed regarding a topic that, in their opinion, lies outside their field of expertise and therefore outside of their comfort zone. Consequently, colloquial and lay language was used to assure connectivity between the interviewer and the interviewees. Furthermore, pushing on a subject or insisting even if the interviewee was evidently overchallenged was avoided. By applying these interview techniques, the quality of the collected interview data was improved and a critical awareness in terms of reflexive interpretation was demonstrated.

Second, the collection of secondary archival data is a continuous process that started as soon as the first contact with the case organizations was established. Indicative archival data included organization reports, brochures, websites, meeting minutes, news reports, social media, and slide decks. They originated both from within the organizations as well as external to the entity. However, there was a reluctance to disclose extensive secondary data because of the belief among SMEs that the less others know about them, the better for the company. Moreover, many processes and documentation are usually less formalized than in big corporations. The spoken word has a higher relevance in SMEs than in big ventures.

Third, direct observations provided additional information about the companies with the goals of "deep immersion in the setting" ([Gehman et al., 2018, p. 288](#)). With a sensible level of pragmatism, "direct observations [were] made throughout [the] fieldwork, including those occasions during which other evidence, such as that from interviews, [was] collected" ([Yin, 2018, p. 122](#)). The data collection of observations was less formalized than the interviews, with mainly field notes and some photographs being taken on site as the concrete data that collected. One important factor in opting for on-site interviews exclusively was the possibility of gaining real-world impressions from the SMEs. Depending on the case, other observations were made during company walkabouts, follow-up calls, workshops, joint lunch, and casual conversations with the informants and other staff before or after the interviews.

The informants within the case organizations represented different perspectives ([Eisenhardt & Graebner, 2007](#)). The focal phenomenon, the digital transformation of incumbent manufacturing SMEs, was assessed not only through the top management lens, but also from perspectives of diverse

hierarchical ranks. The point of view of the higher echelons was explicated by CEOs or CDOs, whereas frontline workers mainly informed about how they are affected by the incorporation of digital technologies. Therefore, in methodological accordance with the criticality of reflexive interpretation ([Alvesson & Sköldberg, 2018](#)), a voice was given also to those who are part of the transformation, but usually do not actively shape it. This democratic procedure proved valuable for building a theory that also takes into consideration the human and emotional factors, not just the technical and economic features.

3.3.3. Data Collection Procedure

The societal setting during the data collection phase was mostly favorable. Bavaria and Baden-Württemberg are among Germany's economically strongest regions ([Statista, 2024b](#)). The Covid pandemic had mostly subsided by the start of data collection in February 2022, which led to more optimism among businesses on the one hand and boosted digital initiatives on the other hand. On the downside, SMEs and especially family firms are rather reluctant to give access to information. And unfortunately, the day of the first interview coincided with Russia's inhuman attack on Ukraine, which from then on dampened the economic atmosphere. However, all interviews were conducted as planned.

Before starting the cross-sectional data collection, a pilot case study was conducted with the aim "to refine [the] data collection plans with respect to both the content of the data and the procedures to be followed" ([Yin, 2018, p. 106](#)). The identification of the pilot case study was based on the amenability due to the professional connection to them ([Yin, 2018](#)). Through this test phase, adjustments to the interview guideline were made. For example, all three informants mentioned the influence of the Covid pandemic early on in the interviews. This led to the decision to include a specific Covid-related question in the introductory section of the interview guideline.

Case-study research is, among other traits, an opportunistic endeavor ([Eisenhardt, 1989](#)). The pilot case study yielded fruitful data from all three primary sources of evidence and some archival data. Consequently, this case was also included in the final sample as there was no reason to exclude the material.

The interviews were conducted between February 24, 2022, and March 30, 2023. During these almost 13 months, I drove 2,541 km to 16 companies with a total of 20 visits (some companies were visited twice). All in all, 41 people were

interviewed summing up to 30:50 hours of recorded data. The duration of the interviews ranged from 0:25 to 1:24 hours. Most of the interviews were one-on-ones, but two were combined (one with two informants and one with three). On each visit, archival data to support the statements from the interviews was requested. Additionally, publicly available archival records were collected through internet research. Moreover, the observations on-site were recorded or written down as field notes.

The raw data was screened, organized, and backed up after each visit. Moreover, the transcription of the interviews was started. This period of the research was also characterized by the continuous search for more cases, which was a tedious task. In the end, by end of March 2023, the data collection was finished.

Since many of the cases were mostly unknown to me prior to the fieldwork, it was not foreseeable if a case would actually fit with the research design. The knowledge about the cases was mostly limited to contact via e-mail or short phone calls to arrange the interviews and the collection of publicly available archival data. After returning from the field, the 16 cases undergone a preliminary analysis to choose the appropriate cases for data analysis. The selection criteria that had been devised previously for the initial sampling (respondents from different hierarchical levels and the compliance with the company characteristics and the organizational antecedents for digital transformation) were applied to the material. It was only after conducting the interviews and visiting the firms that a case could definitely be determined to fit the research design or not. By applying the selection criteria, six cases were discarded due to different reasons ([Ott & Eisenhardt, 2020](#)): In two cases, only one interviewee was present; in three cases, the antecedent conditions for successful digital transformation were not given; and one case had initially confirmed to fulfill the SME criteria while it actually did not (as part of a group, the affiliated enterprises have to be factored in which made it too big to classify as a SME).

The number of cases for a multi-case research design depends on factors like theoretical saturation, data availability, cognitive limits, and time ([Eisenhardt, 2021](#)). Moreover, the researcher has to avoid an unmanageable amount of data which poses the threat of "data asphyxiation" ([Pettigrew, 1990, p. 281](#)). With the final sample of ten cases, all of these aspects were successfully accomplished.

3.3.4. Case Classification

In this research, ten incumbent SMEs from the manufacturing sector were analyzed regarding their digital transformation. Table 14 summarizes the demographic descriptions of the cases in chronological order of the interviews.

Table 14:
Case Classification

Case	Manufactured products	ISIC	Foundation	Employees	Family business
<i>Kilo</i>	Industrial battery equipment	25	1982	250	1 st and 2 nd generation
<i>Mega</i>	IT hardware	26	1966	50	3 rd generation
<i>Giga</i>	Industrial brushes	25	1948	250	3 rd generation
<i>Tera</i>	Electrical equipment for buildings and industrial production	27	1959	240	2 nd and 3 rd generation
<i>Peta</i>	Photovoltaic systems	27	2009	180	1 st and 2 nd generation
<i>Exa</i>	Technical and decorative metal components	25	1959	90	2 nd generation
<i>Zetta</i>	Sewer inspection camera systems	28	1992	25	No
<i>Yotta</i>	Instrumentation for precision metrology	28	2001	170	No
<i>Ronna</i>	Machinery and components for industrial production	27	1943	120	No
	Manufacturing software	62			
<i>Quetta</i>	Machinery for beverage production	28	1906	100	5 th generation
	Distillery	11			
	Beverage production software	62			

Note. Own elaboration.

The oldest company of the sample was founded in 1906, where the youngest was founded in 2009. The case companies had between 25 and 250 employees. Three companies were not family businesses, the remaining seven were led by family members. For the family business, the leaders belonged to anything between the first and fifth generation. The case pseudonyms were given based on the metric system and in chronological order from low to high potency.

Out of the ten cases, eight were active in only one industry. *Ronna* and *Quetta* have diversified their portfolio and were active in two and three branches, respectively. Table 15 indicates the distribution between the cases regarding their primary branch.

Table 15:*Distribution of the Cases by Industry*

Division number	Division name	Percentage
25	Manufacture of fabricated metal products, except machinery and equipment	30%
26	Manufacture of computer, electronic and optical products	10%
27	Manufacture of electrical equipment	20%
28	Manufacture of machinery and equipment n.e.c.	40%
		100%

Note. Own elaboration.

The primary source for data analysis were 26 semi-structured interviews with 29 people. Table 16 summarizes the interviewees' position and their job tenure at the time of the interview. Regarding the job tenure, the overall stay at a company was relevant, not in the current position. Moreover, the table indicates the identifiers for each respondent that will be used throughout this chapter.

In *Exa*, the CEO's tenure is significantly less than the other two interviewees. In *Quetta*, all three interviewees entered the company at the same time. For the other eight cases, the management respondents have been longer in the company than the other respondents.

Moreover, the interviewees were classified according to their digital knowledge, meaning their experience with digital initiatives from a technological and organizational perspective. The scale took the following values into account: 0 means rudimentary digital knowledge, 1 means some digital knowledge, 2 means intermediate digital knowledge, and 3 means significant digital knowledge. I evaluated each respondent based on the overall impression during the interview, informal interactions before and after the interview, and other observations. Therefore, the evaluation is highly subjective and merely serves to present a preliminary impression to the reader. Two respondents are digital novices, and three respondents are considered digital experts. The remaining 24 respondents are classified as persons with some or intermediate digital knowledge, representing the mainstream.

Table 16:*Description of the Interview Participants*

Case	Identifier	Interviewees	Job tenure at the time of the interview	Digital knowledge
<i>Kilo</i>	K1	CEO	30	1
	K2	Head of Inside Sales	6	2
	K3	Key Account Manager	0,5	1
<i>Mega</i>	M1	CEO	6	2
	M2	Head of IT	2	2
	M3	Office Worker	5	1
<i>Giga</i>	G1	Digitalization Manager	13	2
	G2	Commercial Director	32	2
<i>Tera</i>	T1	CEO	30	2
	T2	Head of HR	9	1
	T3	Head of Automation	17	3
<i>Peta</i>	P1	Head of Digitalization	1	2
	P2	Office Worker	0,5	0
	P3	CEO	13	1
<i>Exa</i>	E1	Deputy Head of Project Management	26	1
	E2	Manager for Production Planning and Control	24	1
	E3	CEO	7	1
<i>Zetta</i>	Z1	Management Assistant	4	0
	Z2	CEO	13	1
<i>Yotta</i>	Y1	Head of Sales	16	1
	Y2	Executive Assistant	4	2
	Y3	CTO	21	2
<i>Ronna</i>	R1	Sales Coordinator	11	1
	R2	Software Developer	10	2
	R3	CEO	21	3
	R4	CEO	9	1
<i>Quetta</i>	Q1	Head of IT	7	3
	Q2	Head of HR	7	1
	Q3	CEO	7	2

Note. Own elaboration. Cases and interviewees are sorted in chronological order of the interviews.

Concerning secondary sources of data, archival data and direct observations formed part of the body of data for this study. Table 17 summarizes the concrete documents and interactions that informed the data analysis and therefore the results of this chapter.

Table 17:*Sources of Evidence per Case*

Case	Archival data	Direct observations
<i>Kilo</i>	Website Excerpt of the ISO 9001 quality manual IT project roadmaps Online employee evaluations	Interview impressions on site Company walkabout Personal conversations
<i>Mega</i>	Website	Interview impressions on site Company walkabout Lunch with the two CEOs Follow-up call
<i>Giga</i>	Website Pre-study survey IHK brochure	Interview impressions on site
<i>Tera</i>	Website Management system slides Organizational slides	Interview impressions on site Leadership workshop Informal exchange with members of the HR team
<i>Peta</i>	Website Pre-study survey Goal management method slides Kununu employees' evaluations Vision 2030	Interview impressions on site Company walkabout
<i>Exa</i>	Website Success story	Interview impressions on site
<i>Zetta</i>	Website	Interview impressions on site Company walkabout
<i>Yotta</i>	Website Company brochure LinkedIn profile	Interview impressions on site Corporate culture workshop Lunch with all managers
<i>Ronna</i>	Website	Interview impressions on site Company walkabout
<i>Quetta</i>	Website Success story	Interview impressions on site Company walkabout Follow-up calls

Note. Own elaboration.

Even though the companies share many similarities, which is inherent to the theoretical sampling design based on common antecedents, they are still relatively heterogeneous. Whereas they are similar regarding region, size, age, and industry and share beneficial organizational preconditions, their digital transformation pathways and experience differ more or less significantly.

3.3.5. Case Descriptions

Kilo is a family business that was founded in 1982. It is currently led by the second generation, which are two siblings. The mother, who founded the company with her late husband, is still working in the company at the age of 82 and responsible for accounting. *Kilo* produces equipment for industrial batteries in three locations across Germany and the Czech Republic. Each of the subsidiaries is an independent limited liability company. The company's goal is to constantly improve, particularly represented by their claim. With their 250 employees, *Kilo* operates in ISIC 25 (Manufacture of fabricated metal products, except machinery and equipment).

Mega sells IT hardware. It is led by two brothers in the third generation as a family business, headquartered in Bavaria. Originating from the computer sector, the company provides customized products for professional and industrial use to customers worldwide. Beyond individual solutions, *Mega* supports customers throughout the entire product life cycle, from development and manufacturing to after-sales service. Additionally, the company emphasizes sustainable and efficient solutions, aligning with its long-term strategy for its German location. Historically, the company used to be a system house, retailing not just hardware, but also software (for example document management systems). Due to that legacy, they still have a small team of three people that supports their remaining customers. *Mega* operates in ISIC 26 (Manufacture of computer, electronic and optical products).

Giga is led by two brothers as the third generation of the family business, which was founded in 1948. The company employs 250 people, all located at headquarters in Bavaria. *Giga* operates in ISIC 25 (Manufacture of fabricated metal products, except machinery and equipment). The company specializes in manufacturing surface tools for standard applications and custom technical brushes for industrial clients. Customers rely on the high-quality products, cutting-edge manufacturing facilities, and advanced production techniques. All operations, including production, administration, warehousing, logistics, and R&D, are centralized at the company's single location. This setup not only ensures rapid process flows but also facilitates the personal transmission of the company's values and objectives to each employee. The company's aim is to guarantee quality by training and motivating employees and managers, while consistently treating all stakeholders fairly. With a global network of customers

and suppliers, the company commits to offering "Made in Germany" products at competitive market prices.

Tera was founded in 1959. The company remains a family business and is currently led by members of the second and third generation. The company comprises several sub-companies in Germany, Switzerland, and China. The headquarters are located in Bavaria. Overall, *Tera* employs 240 people. The company operates mainly in ISIC 27 (Manufacture of electrical equipment) with the three business units electrical engineering, building technology, and automation. *Tera* offers comprehensive project solutions, from consultation and planning to execution and service.

Peta was founded in 2009 and is still led by the original founders. One of the two children is also active in the company, but he has no ambition in the company succession. With its 180 employees, the company operates in ISIC 27 (Manufacture of electrical equipment). The headquarters are in Bavaria with several subsidiaries around Southern Germany. The company designs tailored solutions for private, commercial, and municipal solar needs. They boast extensive experience in photovoltaics and provide environmentally friendly solar concepts for communities without significant investments. A diverse team of professionals, including electrical masters, infrared specialists, solar consultants, and heating installers, supports their clients. *Peta* collaborates with a network of partner firms to deliver comprehensive services beyond their core competencies. The company has grown between 50-80% in recent years.

Exa was founded in 1959 and is currently led by three brothers in the third generation. The business succession was formally completed by the end of 2022. With 90 employees, the company operates in ISIC 25 (Manufacture of fabricated metal products, except machinery and equipment). The company specializes in the design and production of complex technical and decorative components. With decades of experience, *Exa* offers a wide range of products and services, including project planning, toolmaking, zinc die casting, and surface finishing. As a complete provider, they deliver comprehensive solutions from development to manufacturing, ensuring short setup times, clear responsibilities, simplified communication, and reduced overall costs. Their high manufacturing depth allows for quick responses to individual customer needs, with all production processes, including intricate surface treatments, conducted under one roof. The company prides itself on flexibility, customer proximity, and the ability to adapt

processes and facilities to client requirements. They offer modular assembly systems and flexible setup systems to accommodate a high product variance. The company's commitment to quality is evident in their certified quality management and advanced measuring technology, focusing on process reliability and reproducibility. They also emphasize sustainability through certified environmental management and efficient resource use. The company has a rich history dating back to 1959 and has evolved to focus on precision parts for the electrical industry since 2015. *Exa's* dedication to quality and performance positions them as a specialist in form and surface solutions. The management consists of four people: the three brothers and a *Commercial Director*. The *Commercial Director* is the son of the previous *Commercial Director*. Therefore, the current management consists of the sons of the two prior CEOs. Neither of the three sons have a technical background, that is why a *Commercial Director* was hired from outside the family.

Zetta was founded in 1992. The *CEO* joined *Zetta* in 2009 as the *CEO*. In 2014, he acquired the company. *Zetta* is headquartered in Bavaria without any subsidiaries and employs 25 persons. *Zetta* operates in ISIC 28 (Manufacture of machinery and equipment n.e.c.). *Zetta* specializes in canal inspection systems and camera technology. With over 30 years of experience, the company prides itself for providing robust and user-friendly equipment that withstands harsh working conditions and requires minimal repairs. *Zetta* emphasizes its commitment to quality and service, ensuring that their products simplify the daily workflow of their clients. Their product development is driven by creative ideas that emerge from close collaboration with customers, ensuring practicality and durability. The company offers comprehensive support, including loaner devices, swift repair services, competent advice, and reliable delivery times, fostering a worry-free service experience. The firm values its global partnerships, maintaining transparent communication and fair pricing. Customer feedback is integral to their continuous product improvement, benefiting the end-users. The team, encompassing technical, sales, and administrative professionals, is dedicated and passionate about their products, which undergo rigorous testing and efficient manufacturing in accordance with ISO 9001 standards before market release.

Yotta was founded in 2001 as a spin-off from a renowned technical university. The company is known for its Nobel Prize winning optical frequency

comb technology. The Nobel Prize was awarded in 2005. Two of the four founders are still in the management today. *Yotta* is headquartered in Bavaria, international subsidiaries exist in USA, China, and Japan. Moreover, sales and service offices in Berlin, Vienna, and Bordeaux. With their 170 employees, thereof 50 in the production department, the company operates in ISIC 28 (Manufacture of machinery and equipment n.e.c.). The company is a leading developer and global supplier of instrumentation for precision metrology. These tools are pivotal for metrology and spectroscopy, providing unparalleled accuracy and reliability. They pride themselves for working closely with selected customers and develop new solutions for laser-based precision measurements, inventing and producing products of the highest quality for worldwide customers in academia and industry.

Ronna was founded in 1943. Having been subject to a management buy-out, it is no family business. The company is headquartered in Baden-Württemberg and has no subsidiaries. *Ronna* operates mainly in ISIC 27 (Manufacture of machinery and equipment n.e.c.). The firm operates four business units: Mechanical engineering, contract manufacturing, plastics technology, and digitalization. With their digitalization department, *Ronna* has diversified and can now also be considered a software producer according to ISIC 62 (Computer Programming, Consultancy And Related Activities). Offering comprehensive solutions from development to manufacturing, assembly, and commissioning, the company prides itself on its expertise in special machine construction. The company's innovative strength is backed by a team of 120 employees, who specialize in the development and design of special machines, as well as the individual and series production of metal parts and plastic injection molding articles.

Quetta was founded in 1906 as a machinery sales agency for breweries and creameries. Own products were developed and produced starting in 1949. Today, the company is incorporated and led by the fifth generation of the family. Across all subsidiaries, *Quetta* employs roughly 100 employees. The headquarters are in Bavaria. The primary industry is ISIC 28 (Manufacture of machinery and equipment n.e.c.). *Quetta* has three sub-companies in different industries (distillery, software, and purification plants). Therefore, it operates also in ISIC 62 (Computer programming, consultancy and related activities) and ISIC 11 (Manufacture of beverages). The customers are mainly in the food, beverage, and pharmaceutical industries. *Quetta* strives to solve their customers'

individual problems in an ever more complex world. The employees' sole aim is to build perfect plant equipment.

3.4. Data Analysis

In the previous section, the data collection has been described. Even though these two sections are separate units of text in this thesis, they are by no means detached from each other during the actual research process. Indeed, the fact that they overlap is a striking feature of the Method's iterative nature (Eisenhardt, 1989).

While qualitative data analysis does not follow mathematical rules like its quantitative counterpart, the approach is nonetheless systematic (Miles et al., 2020). This chapter explains the practical execution in computer-assisted qualitative data analysis software, describes the levels of abstraction, expounds language considerations, and elucidates the data analysis procedure.

3.4.1. CAQDAS

Computer assisted qualitative data analysis software facilitates the data analysis process in qualitative research that is usually characterized by huge amounts of messy data (O'Kane et al., 2021). This applies in particular for multiple-case study research (Miles et al., 2020). When employing CAQDAS, the researcher does not relinquish the hermeneutic procedure to the computer's logic. Instead, the software serves as an efficient tool, aiding in data storage, handling and analysis without independently conducting analysis or drawing conclusions (Miles et al., 2020). This remains the main task of the researcher. Moreover, a CAQDAS enhances the transparency of the data analysis process (Bringer et al., 2004), increasing both trustworthiness and plausibility. For this research project, the software NVivo 12 was applied for structuring the data, transcribing the interviews and coding.

3.4.2. Levels of Abstraction

In qualitative research in general and case study research more specifically, different terms are used by different researchers with similar meaning. In essence, the following paragraph develops a coherent vocabulary that unifies various interchangeable terms. Each level of abstraction is

Table 18:*Terminology and Style of the Levels of Abstraction*

Term used in this thesis	Equivalent terms used by other authors	Stylistic text feature
Code	n/a	CODES ARE SET IN SMALL CAPS
Measures	First-order concepts (Corley & Gioia, 2004) Dimensions (Eisenhardt, 1989) Categories (Saldaña, 2021)	MEASURES ARE SET IN ITALIC SMALL CAPS
Constructs	Second-order themes (Corley & Gioia, 2004) Concepts (Gioia et al., 2013; Saldaña, 2021) Themes (Saldaña, 2021)	CONSTRUCTS ARE SET IN BOLD SMALL CAPS

Note. Own elaboration.

represented by a particular stylistic text feature to consistently identify symbolic summaries throughout the text. Table 18 gives a short overview.

Put in a nutshell, "constructs are essential components of any theory, and measures help to ensure that the emergent theory is well-grounded and testable" (Eisenhardt, 2021, p. 151). A construct is therefore a more abstract grouping of several measures that, in contrast to theory that is generated without empirical evidence, arise from the data (Eisenhardt, 1989). Regardless of the different terminologies, "the common notion is iteratively organizing and grouping raw data and then forming more abstract conceptualizations as part of constant comparison between theory and data" (Eisenhardt, 2021, p. 151). Table 19 gives two examples of the levels of abstraction.

Table 19:*Examples for the Levels of Abstraction*

Level of abstraction	Example 1	Example 2
Transcribed and translated interview data	"Digitalization is not expensive if you digitalize the right things. It's more expensive not to digitalize." (G1)	"The whole thing was also connected a bit with an external perspective. What is currently happening in the market, right? What, what is happening in the university? What are they currently researching, right?" (T3)
Code	FINANCING DIGITAL TRANSFORMATION	INCORPORATING MARKET SHIFTS
Measure	ENSURING MANAGEMENT ADVOCACY	ENHANCING PORTFOLIO COMPETITIVENESS
Construct	FACILITATING ORGANIZATIONAL CHANGE	ESTABLISHING BUSINESS RATIONALES

Note. Own elaboration.

3.4.3. *Language Considerations*

With a thesis written in English and the research being undertaken in Germany, language considerations arise at various levels: The language of the collected data, conducting the data analysis, and the thesis itself must be coherently aligned. The translation on whichever level is not merely a technical issue but an integral component of the knowledge production process—a subject known as the *equivalence paradigm* where "the aim of translation is to achieve a text in the target language that is equivalent ... to the original source-language version" (Chidlow et al., 2014, p. 563). A translation is considered equivalent when it accomplishes "the conveyance of identical meaning from culture to culture" (Hult et al., 2008, p. 1035). The awareness for language is vital for qualitative and interpretative research in general and to interviews as a source of empirical data in particular, especially with regard to questions of representation, power and hierarchy (Alvesson & Deetz, 2000). Language, after all, is more than just a medium for exchanging words but contains decisive information between the lines to ultimately become a constitutive act (Welch & Piekkari, 2006). Accordingly, the "translation process constitutes a (re)construction of the social reality of a culture in a different language, in which the translator interacts with the data, actively interpreting social concepts and meanings" (Xian, 2008, p. 233). In the English-dominated academic environment of management studies that usually implicitly assumes monolingual research, there is no blueprint for cross-cultural research projects; the most common denominator seems to be that it is up to the researcher's abilities and judgement to make informed and explicit decisions about language issues (Welch & Piekkari, 2006). With the high claim to reflexivity of this thesis and consistent with the epistemological assumptions (Temple & Young, 2004), a proper placement of the study regarding its language considerations seems expedient.

In the context of incumbent SMEs in the manufacturing sector in rural areas in Southern Germany, the proficiency of the English language cannot be taken for granted. Many people understand and speak English to a limited degree that is not sufficient for a conversation about a topic such as digital transformation. Moreover, people are more reluctant to speak in a language that they might feel uncomfortable with. In order to open doors and to establish trust

with potential participants, [Welch and Piekkari \(2006\)](#) recommend the respondents' native tongue as *access language*. The cognitive and temporal hurdle for SMEs to participate in academic studies is high under favorable circumstances; had the inquiry for the interviews been written in English or had the inquiry specified English as the interview language in the first place, the response rate would have plummeted.

Regarding data collection and thus what [Welch and Piekkari \(2006\)](#) term the *interview language*, consequently German was chosen. By conversing in their native language (except for K3 und Y1), the interviewees seemed to feel confident, and the results are certainly more profound than if they had to be thinking about linguistical issues of understanding and formulating during the interviews, even more so when being recorded on tape. The positive effect is a noticeable elevation in authenticity and accuracy ([Welch & Piekkari, 2006](#)). For K3 and Y1, the choice was left to them to decide whether to converse in English, German or Spanish (K3) and English or German (Y1), respectively. Both opted for German as the interview language. On a side note, the secondary data sources are exclusively in German.

The data analysis, or *post-interview language* ([Welch & Piekkari, 2006](#)), was executed by applying English codes to the German data. This decision was carefully pondered and chosen from a range of different options (see Appendix C). The closest alternative would have been to translate all the data ([Saldaña, 2021](#)). However, translating the data would have meant an additional step that would have implied the danger of losing meaning. First, some terms do not exist in English. For example, there is no linguistical equivalent for 'Duz-Kultur' as there is no grammatical differentiation between the formal *you* ('Sie') and the informal *you* ('du'). The level of formality between people can only be grasped by considering the context. Another example is 'verschlimmbessern' which means making something worse through trying to make it better. Second, dialect, which is common in all regions of Southern Germany, would have been streamlined in the translation process, including subtle changes in meaning. The same applies to colloquial statements and proper names.

Since at some point in this study whose *project language* and *reporting language* ([Welch & Piekkari, 2006](#)) are English, the language has to be switched eventually,

it is the researcher's best judgment as to whether to code the original or translated versions. The consensus of bilingual colleagues is to not apply English codes to non-English data, but in selected cases the researcher's fluency in multiple languages can enhance rather than confound the analysis. (Saldaña, 2021, p. 54)

Moreover, English has a more concept-oriented vocabulary which makes it more suitable for formulating codes (Tarozzi, 2019). For example, there is no distinction between *digitization* and *digitalization* in German (both of which are *Digitalisierung*), which is crucial for this thesis. Furthermore, the use of the gerund as applied for process coding in this thesis is grammatically uncommon in German. The findings chapter displays sections of the data. These quotes were translated to maintain an ease of reading and for non-German speakers to be able to read the passages seamlessly. Equally, tables and figures involving data excerpts were translated as well.

For the sake of unambiguousness, American English is used throughout this thesis due to my linguistic imprint and the resulting familiarity with this variant of the English language. Moreover, the APA citation and style guide that this thesis adheres to dictates American English. Direct quotations that are originally written in British English are adjusted accordingly.

3.4.4. The Four Steps of Data Analysis

The data analysis following the Eisenhardt Method consists of four iterative steps: Within-case analysis, cross-case analysis, shaping propositions, and enfolding literature. The Eisenhardt Method describes data analysis at an abstract level. In practical application, the textbooks for qualitative data analysis by Miles et al. (2020) and Saldaña (2021) provided guidance. Table 20 summarizes the analytical process, the practical application in NVivo, the strategic objective, and the iterative process throughout the analysis.

Step 1: Within-Case Analysis. First, the interviews were transcribed in their original language German. The interview transcripts were the foundation for the within-case analyses. They were then enriched by the secondary data, resulting in a case history for each case. All case histories are attached in Appendix D. There is no standard format for case histories, but essentially, they are triangulated summaries of each case taking into consideration the interviews, the archival data and the direct observations. This step is essentially descriptive

Table 20:
Analytical Strategy

Analytical process	Practical application in NVivo	Strategic objective	Iterative process throughout analysis
Within-case analysis	Transcribing the interviews Writing case histories	Descriptive	Familiarization with the cases and triangulation of data sources ↕
Cross-case analysis	Open coding of the data Categorizing the codes to measures		Preliminary theory generation with codes ↕
			Refining and distilling more abstract measures ↕
			Defining constructs ↕
			Constant comparison of data to constructs through iterative tabulation of case evidence for each construct ↕
Shaping propositions	Condensing the measures to constructs	Interpretive	Searching for relationships between constructs within and across cases using replication logic ↕
			Comparing the emerging theory to extant literature (both conflicting and similar) ↕
Enfolding literature	Refining the measures and constructs	Analytic/explanatory	Generating a conceptual framework from the case data

Note. Own elaboration. This table summarizes the analytical strategy for the data analysis based on [Eisenhardt \(1989\)](#).

and consists mainly of insightful descriptions. Ultimately, this first step aims “to become intimately familiar with each case as a stand-alone entity” ([Eisenhardt, 1989, p. 540](#)). Furthermore, preliminary theory generation started. Ideas were systematically collected as analytical memos within NVivo.

Step 2: Cross-Case Analysis. Second, a cross-case analysis ensured that the investigator questioned and enhanced initial impressions from the within-case analysis that might be misguided or inaccurate. Moreover, these tactics foster the discovery of novel insights by looking at the data from different angles. It is essentially a search for patterns and probably every researcher has

their own style of executing cross-case analysis (Eisenhardt, 1989). To conduct the cross-case analysis, the original empirical data, not the case histories, were used to stay as close to the original meaning as possible. Cross-case analysis was conducted in two phases: First-cycle coding and second-cycle coding (Saldaña, 2021).

During first-cycle coding, three coding methods were employed: Open coding, simultaneous coding, and process coding (Saldaña, 2021). For open coding, or initial coding, the data was worked from the ground up, which means that no preliminary codes were derived from the literature (Yin, 2018). Moreover, simultaneous coding was applied, which implies that pieces of data (i.e. meaning) were coded one or several one codes (Saldaña, 2021). Furthermore, process coding, or action coding, was applied account for the dynamics of time (Saldaña, 2021). As the name suggests, this coding style is rooted in process theory and accordingly, the naming convention of the initial codes that arose during this stage of coding were gerunds. After coding all interviews, archival data and direct observations, the codes were revisited to rename, split, or merge codes if necessary. At the end of this stage, 47 codes were derived from the data. Figure 4 shows an excerpt of the codes.

Figure 4:
Excerpt of the Codes During First-Cycle Coding

Name	Files	References
Accessing specialized knowledge	13	26
Adapting quickly to changes in the environment	5	10
Adding digital value to physical products	8	16
Adopting a positive mindset	20	43
Aligning the corporate culture and organizational structures	24	74
Aspiring to high digital maturity	20	36
Assuring data and IT security	11	29
Attaining temporal and local flexibility	11	27
Automating processes	11	19
Avoiding manual mistakes	8	11
Collaborating with colleagues	10	29
Coming to better decisions	4	7
Complying with regulatory policies	3	5
Connecting with customers	4	11
Contributing to ecological sustainability	2	3
Cooperating with external IT partners	15	68

Note. Own elaboration.

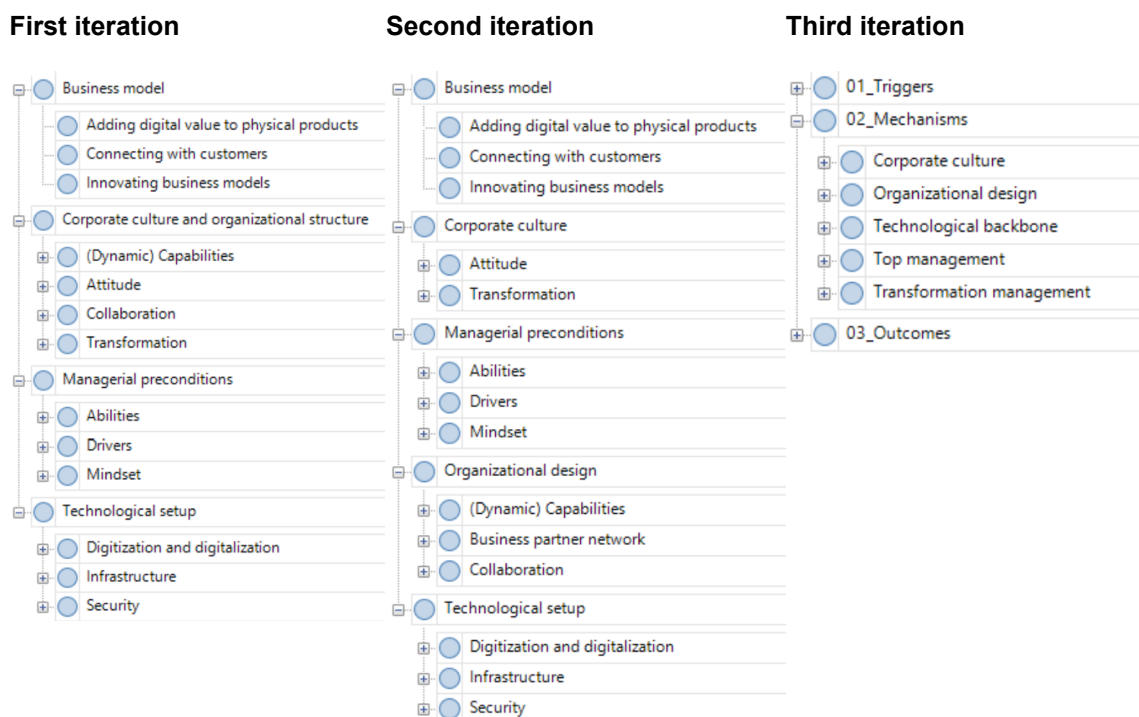
Subsequently, second-cycle coding was conducted. Figure 5 displays the three iterations of this step. During second-cycle coding, pattern coding was applied (Saldaña, 2021), which is described as follows:

Pattern Codes are explanatory or inferential codes, ones that identify a theme, configuration, or explanation. They pull together a lot of material from first cycle coding into more meaningful and parsimonious units of analysis. They are a sort of 'meta code'. (Saldaña, 2021, p. 322)

In the first iteration of second-cycle coding, a set of 13 measures arose from pattern coding. They were grouped into four preliminary constructs which were termed the *building blocks of digital transformation*, namely "Business model", "Corporate culture and organizational structure", "Managerial preconditions", and "Technological setup". In the second iteration, one construct was divided into two (namely "corporate culture and organizational structure") and the now 14 measures were slightly rearranged. The now five building blocks of digital transformation were "Business model", "Corporate culture", "Managerial preconditions", "Organizational design", and "Technological setup". However, the

Figure 5:

The Three Iterations During Second-Cycle Coding



Note. Own elaboration.

grouping of the codes into these measures and constructs was not satisfactory. Within the measures, the codes were too heterogeneous. Therefore, a third iteration of second-cycle coding was conducted from scratch, which organized the initial codes into three categories, namely "triggers", "mechanisms", and "outcomes". Conceptually, it made more sense than just having the five building blocks, which were not interrelated in a chronological, hierarchical, process, or any other kind of order. However, whereas the triggers and outcomes contained a manageable amount of initial codes, the mechanisms were populated with too many initial codes. So, the five building blocks from the second iteration of second-cycle coding were reactivated. With some adaptations from the previous five building blocks, the mechanisms were grouped into five measures, namely "Corporate Culture", "Organizational design", "Technological backbone", "Top management", and "Transformation management".

Step 3: Shaping Propositions. Third, the insights from the previous within-case and cross-case analysis were condensed into tentative higher-order constructs and relationships. By doing that, the codification is elevated to a more abstract level ([Eisenhardt et al., 2016](#)). During this step of shaping propositions, the "central idea is that researchers constantly compare theory and data—iterating toward a theory which closely fits the data" ([Eisenhardt, 1989, p. 541](#)). This was achieved via sharp construct definitions and the tabular display of the evidence grounding the constructs through measures. The definitions of the constructs aim to (1) effectively represent the core characteristics of a construct, (2) avoid tautology and circularity, and (3) a high degree of parsimony ([Suddaby, 2010](#)). The following paragraphs depict only the data analysis itself.

In this phase, an important observation was that it was difficult to differentiate between triggers and outcomes. Many times, a trigger could be an outcome, and an outcome could be a trigger. Accordingly, they were combined into one category named "Motivation". This term is used by [Soluk and Kammerlander \(2021\)](#). Hence, the motivation simultaneously refers to the incitement to engage in digital transformation and the desired result. When rearranging the codes and measures according to the new scheme with "Motivation", the tentative concept "mechanisms" was renamed. Being a term that usually appears in the sequence of triggers, mechanisms, and outcome, it felt out of place now. [Warner and Wäger \(2019\)](#) use the terms "Enablers" and "Barriers" in their model. For the parsimony in this research, an inversed barrier is regarded

Figure 6:

Two Preliminary Constructs During the Data Analysis



Name	Files	References
MOTIVATIONS		400
Data		79
Processes		200
Products and services		68
Value creation, delivery, and capture		53
ENABLERS		1145
Malleable organizational design		200
Modern IT architecture		193
Positive corporate culture		136
Proactive transformation moderation		291
Promotive top management		325

Note. Own elaboration.

as an enabler. For example, the barrier "Change resistance" converts into an enabler if termed "Coping with resistance", which also gives it a more actionable spin from the perspective of a manager who seeks to employ the model. Consequently, two constructs arose from the data, namely "Motivation" and "Enablers". "Motivation" contained four measures and "Enablers" contained five measures.

Step 4: Enfolding Literature. Fourth and lastly, the emergent theory was critically compared to the extant literature to enhance "the internal validity, generalizability, and theoretical level of theory building" (Eisenhardt, 1989, p. 545). For this step, it is essential to consider a wide range of literature from diverse streams of research (Eisenhardt, 1989). Table 21 summarizes the most relevant academic papers, their theoretical lens, and their key contributions to the emerging theory (in alphabetical order).

Within the two constructs, the measures were organized anew. The enablers consisted of five measures which each held between three and six codes. In this phase, the codes were rearranged, and many passages of the interviews were re-coded. Some codes were eliminated and some emerged. Furthermore, previously established nomenclature was used, for example by including the concept of dynamic capabilities. In the end, the construct "Enablers" consisted of five measures which in turn contained between three and five codes each.

Table 21:*Relevant Academic Papers for Theorizing*

Academic paper	Theoretical lens	Key contribution	Key difference
Hanelt et al. (2021)	Strategy Organizational change	Digital transformation is essentially a process of organizational change	The multi-dimensional framework of digital transformation lacks practicability
Müller et al. (2018)	Industry 4.0 SMEs	In manufacturing firms, the digitalization of the production process plays a crucial role	Industry 4.0 is only one aspect of digital transformation
Soluk and Kammerlander (2021)	Dynamic capabilities Mittelstand firms	The motivations influenced the business rationales	Data and process digitalization are two separate phases; phases are not sequential
Verhoef et al. (2021)	Business model innovation	Digital transformation consists of different phases	Digital transformation is not a linear process
Vial (2019)	Information systems	The building blocks influenced the constructs and measures	The use of digital technologies and disruptions are not the key triggers of digital transformation
Warner and Wäger (2019)	Dynamic capabilities	<i>Internal enablers</i> and <i>internal barriers</i> influenced the construct <i>Facilitating Organizational Change</i> ; Process approach and visualization	Dynamic capabilities are just one, but not the only determinant for digital transformation

Note. Own elaboration.

Regarding the construct "Motivation", the four measures corresponded to different stages of digital transformation. Drawing on the literature, they were named "Digitization", "Digitalization", "Digital innovation", and "Digital business model innovation". In the same order, they correspond to a focus on "Data", "Processes", "Products/services", and "Value creation/delivery/capture". Initially, the motivation for "Digital innovation" and "Digital business model innovation" appeared to be the same, but upon revisiting the data, the two measures warrant conceptual differentiation. In the next step, the codes were rearranged. Just as with the enablers, this resulted in the renaming, eliminating and creation of codes. Equally, the interviews were re-coded in some parts. This resulted in four measures with between two to six codes in each.

Relatively late in the analysis process, a third construct was established. The evidence was not coded anew, but the codes were assigned to new measures that make up the new construct **DEPLOYING DIGITAL INITIATIVES**. This construct united the technical aspects of digital transformation. Before this step, digital initiatives were interlaced in the two previous preliminary constructs. By extracting the technological codes, the foundation for the final structure of the emerging theory was laid.

For consistency and logical coherence with the methodology, all constructs and measures were formulated as gerunds to emphasize the process character (Saldaña, 2021). To reach closure in the data analysis, "the iteration process stops when the incremental improvement to theory is minimal" (Eisenhardt, 1989, p. 545). The initial coding was finalized on November 27, 2024. However, the write-up of the theory resulted in slight adaptations, including sharpening the measures and codes. Some passages were even re-coded during this stage. In the end, the state of theoretical saturation was reached on January 25, 2025. Figure 7 demonstrates the final set of constructs and measures that arose from the data analysis.

Figure 7:

Final Set of Constructs and Measures From the Data Analysis

Name	Files	References
DEPLOYING DIGITAL INITIATIVES	52	842
01_Digizing data	49	366
02_Digitalizing processes	29	398
03_Extending physical products and services	13	33
04_Innovating the business model	11	45
ESTABLISHING BUSINESS RATIONALES	31	411
01_Maximizing workplace flexibility	22	93
02_Increasing process efficiency	26	199
03_Enhancing portfolio competitiveness	16	57
04_Sustaining economic success	9	62
FACILITATING ORGANIZATIONAL CHANGE	33	945
Allocating resources	29	250
Ensuring management advocacy	27	323
Moderating the transformation	26	240
Nurturing the corporate culture	25	132

Note. Own elaboration.

This section presented the data analysis procedure and the coding process. The codebook is attached to Appendix E.

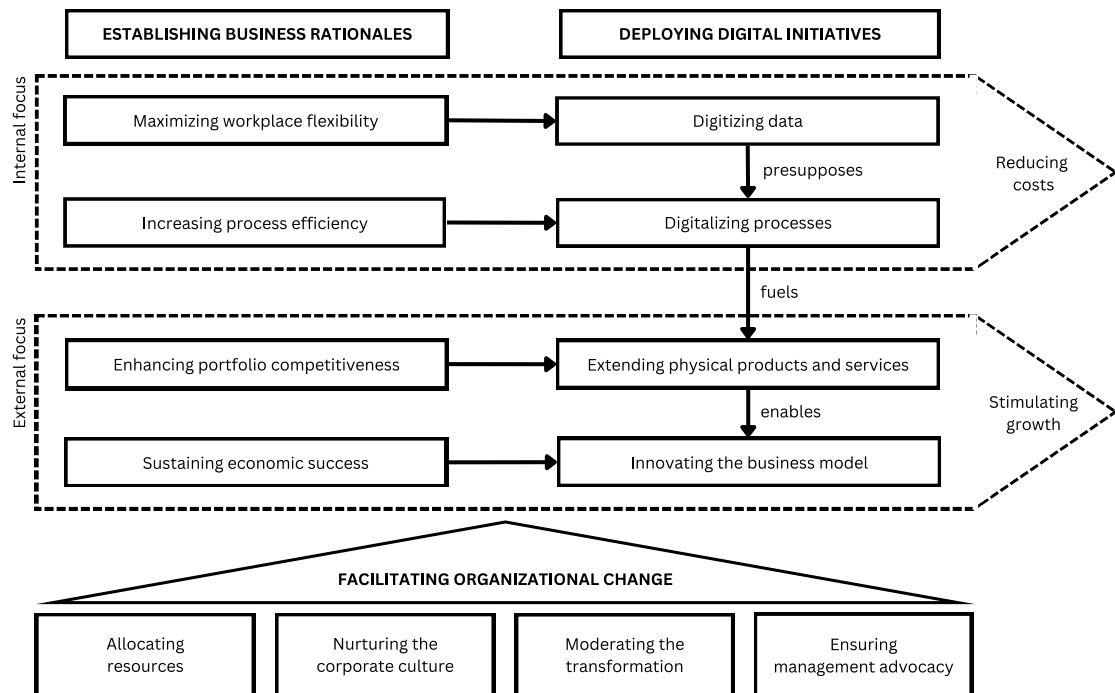
With these lines, I conclude the research design chapter. First, I described my stance towards philosophical assumptions, which were then connected with the research strategy by the methodology. Subsequently, I introduced the data collection and analysis following the Eisenhardt Method. The following chapter will present the findings in detail.

4. Emergent Framework for Digital Transformation: The Triple Nexus of Holistic Organizational Change

This thesis aims to answer the research question of how incumbent manufacturing SMEs can successfully shape the organizational change that is induced by the incorporation of digital technologies. This chapter presents the empirical findings that constitute the emergent theoretical framework of this study. The Eisenhardt Method is particularly explicit about the nature of its results. In a nutshell, it consists of three components. First, the Method encourages the elaboration of an "overarching diagram" (Gehman et al., 2018, p. 288) that summarizes the theory with "boxes and arrows" (Eisenhardt & Graebner, 2007, p. 30). While the boxes represent the 'whats' of the theory, the arrows stand for the 'hows' that link the constructs (Whetten, 1989). Second, the findings depict the constructs, measures and propositions that arise from the data. Importantly, the findings explain the mechanisms of how the constructs are related with the aim "to come up with logical explanations that [Eisenhardt calls] 'the whys' for the underlying logic of the emergent relationships among constructs" (Gehman et al., 2018, p. 288). Even though researchable propositions are usually associated with deductive research and must not per se be included in a theory (Gehman et al., 2018; Whetten, 1989), I offer propositions as a means to test my theoretical arguments. Both the visual representation of the theory—the model—and the propositions add value to the thesis through clarification rather than obfuscation (Kilduff, 2006). Third, empirical evidence from the cases is weaved into the presentation of the results to exemplify the constructs and the underlying theoretical logic of the emergent theory (Gehman et al., 2018). In accordance with the Eisenhardt Method, the literature informs this section where appropriate.

Figure 8 constitutes the overarching diagram and illustrates the emergent theoretical model of the digital transformation of incumbent manufacturing SMEs. This visual summary is intentionally simplistic and prioritizes functionality over design to focus on the content. Moreover, exuberant texts are avoided in favor of compact gerund phrases to ensure parsimony and accentuate the process perspective.

Figure 8:
The Emerging Theoretical Framework



Note. Own elaboration.

The data analysis has revealed three constructs: **DEPLOYING DIGITAL INITIATIVES**, **ESTABLISHING BUSINESS RATIONALES**, and **FACILITATING ORGANIZATIONAL CHANGE**. In the following, this thesis introduces the emergent theoretical model in detail. Each of the constructs is presented and propositions for the three constructs and their relationships are established.

4.1. Deploying Digital Initiatives: The Technological Nexus

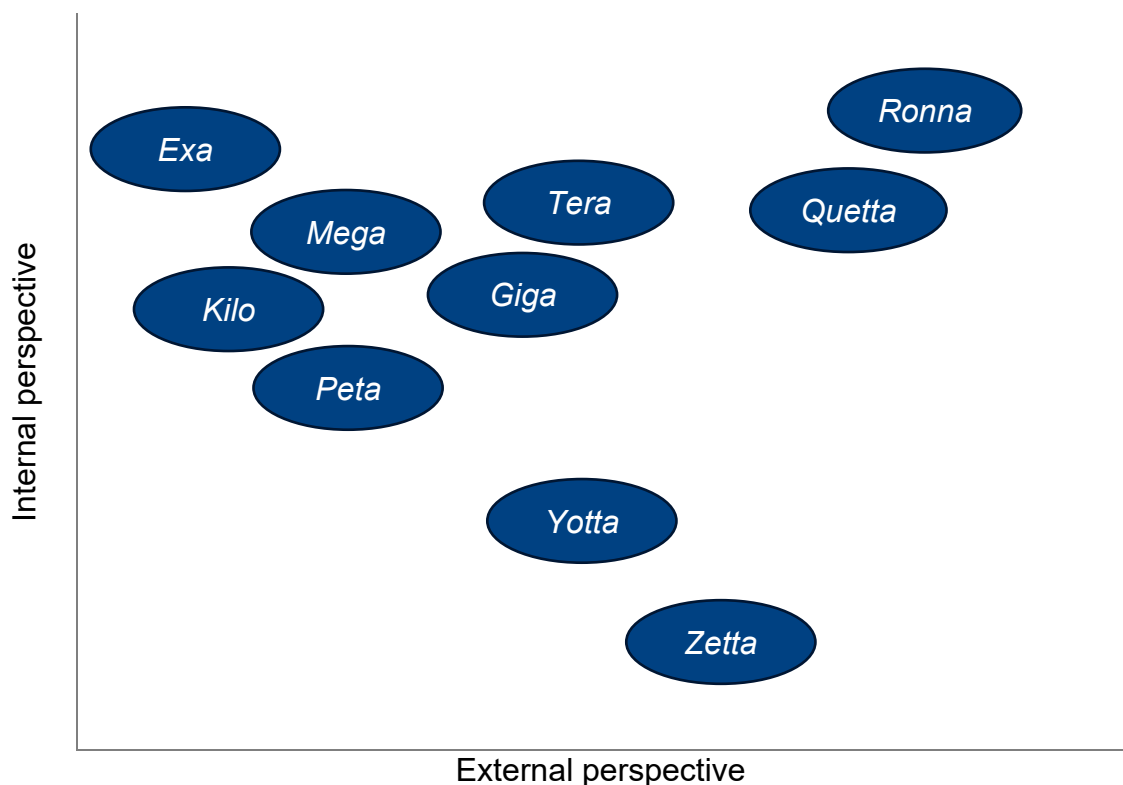
The data point to **DEPLOYING DIGITAL INITIATIVES** as an elementary component of the digital transformation of incumbent manufacturing SMEs, making it the first construct. The term is taken from [Grover and Kohli \(2013\)](#) in order to avoid ambiguity with alternative terms such as *measures*, *activities* or *projects*. Here, a digital initiative is defined as a deliberate implementation of a digital technology in a company. What seems self-evident and not worth mentioning is at the heart of the problem that many incumbent manufacturing SMEs are still digital laggards—they simply do not deploy digital initiatives, or at

least not to an adequate extent. Hence, the construct is an elementary component of the emergent theory.

The case companies vary significantly regarding the extent to which they have deployed digital initiatives. Figure 9 locates the ten cases in a matrix with the two axes of internal and external perspectives. It helps the reader to estimate the big picture of where the case companies stand regarding this construct.

Figure 9:

Applied Typology of Digital Transformation Perspectives



Note. Own illustration which is inspired by the typology of digital transformation perspectives (Hanelt et al., 2021, p. 1174). The localization of the cases is subjective based on the evidence. The scale is not meant to be mathematical with no absolute zero point; rather, it demonstrates the relation between the cases.

Any incumbent manufacturing SME should get started rather sooner than later. Indeed, there will never be the ideal moment to initiate the digital transformation because it always implies a laborious departure from well-trodden paths before the fruit can be yielded, as described by the CEO of *Quetta* (Q3):

But I'm investing a lot of time and money today so that tomorrow my process might run more efficiently and faster. But I have to get over that

hill first so that things get better. And I think that's often the barrier, because at the moment it's probably more convenient and quicker to just keep doing it analogically. And I think I just have to force myself to develop these things further, even if it hurts, because otherwise it just won't get any better.

Similarly, expansive projects like an ERP introduction seem daunting to SME leaders and can result in procrastination. The CTO of *Yotta* (Y3) explains that “we probably waited too long to take such big steps, which are associated with some pain. We may have procrastinated a bit there, to some extent. In retrospect.”

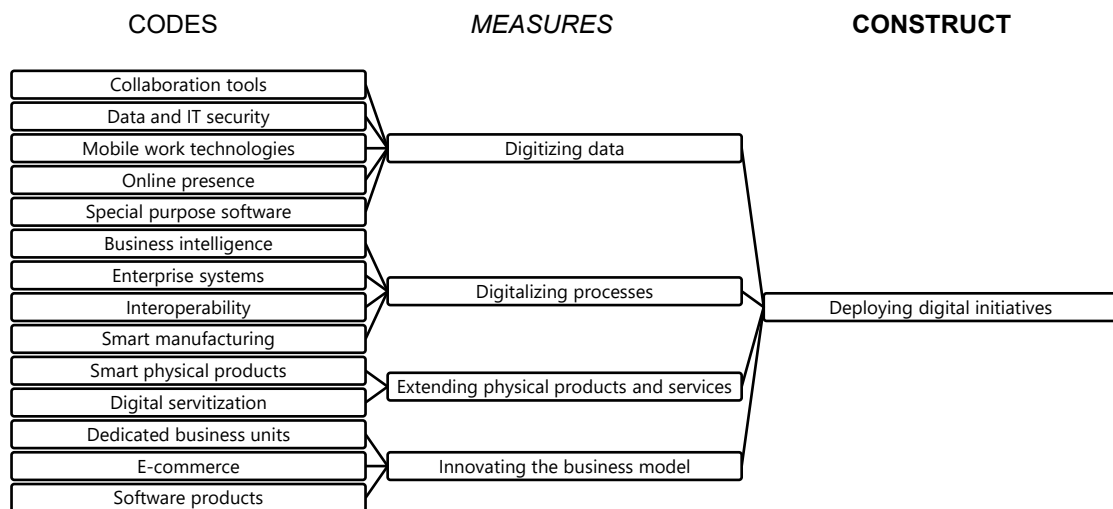
As has been argued above, the field of digital initiatives is extremely vast. The wide spectrum of digital initiatives differs significantly in their technological complexity and therefore in difficulty to be incorporated in a SME. Both the abundance of applications and the opacity of possibilities can lead to a feeling of being overwhelmed. R3 utters the refreshingly simple formula to approach the seemingly impregnable challenge: “Just do it. Even if you initially get certain questions somewhere internally: Do we need this? We've always done it that way. So just start with an example.” In the same vein, Q1 stated:

I believe that it is very important that you really take one step at a time, even if this topic stands in front of you like a giant elephant. I don't think it helps to say: Oh my God, what do I start with now? I have so many topics. There is no remedy. You have to start with something. And my motto is generally always: get started instead of waiting. I'd rather go in the wrong direction. But I did go in a direction rather than just standing in one place.

Apparently, he is not afraid of decisions that later turn out to be suboptimal, indicating a carefreeness regarding path dependency that is as notable as it is conducive to foster exploration.

The SMEs that were investigated in this study have all employed digital technologies to varying degrees. To further elaborate on the construct **DEPLOYING DIGITAL INITIATIVES**, the four measures *DIGITIZING DATA*, *DIGITALIZING PROCESSES*, *EXTENDING PHYSICAL PRODUCTS AND SERVICES*, and *INNOVATING THE BUSINESS MODEL*, are described in the following paragraphs. The categorization of digital initiatives in four clusters serves to operationalize the “giant elephant” (Q1) and break it down into manageable and comprehensible subthemes.

Figure 10:
Coding Scheme for Deploying Digital Initiatives



Note. Own elaboration.

Of the three constructs, deploying digital initiatives represents the technological nexus of holistic digital transformation. The SMEs of this study were predominantly occupied with *DIGITIZING DATA* and *DIGITALIZING PROCESSES*, which is why the codes of these two measures include subcodes that represent specific technologies. For example, the code *ENTERPRISE SYSTEMS* has several subcodes such as ERP or CRM. These subcodes are not represented in Figure 10 that summarizes the coding scheme for the construct **DEPLOYING DIGITAL INITIATIVES** in order not to get lost in detail. The complete scheme is included in the codebook in Appendix E.

Table 22:

Cross-Case Evidence for Deploying Digital Initiatives

Measure	Deployed digital initiatives	Identified in cases	Selection of quotes
Digitizing data	Collaboration tools such as e-mail, DMS and video conferencing Data and IT security such as internet connection and backup systems Mobile work technologies such as cloud computing, portable devices and virtualization Online presence such as websites and social media Special purpose software such as CAD, finance and HR software	<i>Kilo, Mega, Giga, Tera, Peta, Exa, Yotta, Ronna, Quetta</i> Partially: <i>Zetta</i>	"We first had a different e-mail server, then switched to Microsoft Exchange. First locally in our facilities, then into the cloud. That was a huge step that improved things incredibly much, because the Microsoft thing with appointments and so on just works really well. It definitely took us to another level." (Q1) "But I think a huge issue, I think it's the same for everyone, is simply the issue of security. I think the worst-case scenario for everyone is still that the company comes to a standstill because the servers are blocked and you can only get out of the whole thing by paying two Bitcoins. So this is currently a topic that medium-sized businesses are currently seeing a lot of. ... The issue of security is certainly one of the top, if not the most important, points." (G1) "And now, with the new landscape, we will make sure that we take our first hybrid steps. In other words, we will also use cloud services that are ultimately fully connected to our location in order to meet the demands of mobile working, working with customers, and so on." (T3) "And at the same time, we're basically setting up a digitization channel in social media, where we're making it palatable with short videos, so to speak, in our own production, we do a lot of that, 10-second videos. What are we doing here? So we're basically setting up a portal and a social media channel. It started last week and is supposed to be fed now, so that we can transfer ideas through this channel [to create a kind of] Facebook for digitalization. That's basically what we want to achieve." (R3) "For example, one program that we use to do financial planning and with which we then generate the monthly statement of profit and loss and balance sheet and with which we do planning calculations. This program is smart, it's great and it works well. ... And that's not really trivial in a manufacturing company, because you also have to do an inventory." (G2) "The ERP introduction in 2009 was definitely a milestone. We had a very outdated merchandise information system. There was no warehouse management, no planning in that sense, no tool management. All of that was included in the new ERP, so to speak, which we introduced at the time. You could manage tools. You could plan roughly. You could basically see the capacity utilization of individual departments. Not quite as nice as it probably is now, but it was an important point." (E2) "Now when I think about it, we are currently working on mobile data capture for the warehouse, barcode scanner devices, so that the processes in the warehouse can be made faster and digital. No more paper or anything else." (Q1) "That machines talk to each other. Or that I now combine two different software systems, for example, so that we don't have to enter something at one point and then switch back, because then we come to a standstill, because then the milling machine can't talk to it again. That
Digitalizing processes	Enterprise systems such as ERP, CRM and project management Smart manufacturing such as scanning, robotics, MES and PDA Interoperability such as EDI or interconnecting internal systems Business intelligence such as data warehouse and visualization	<i>Kilo, Mega, Giga, Tera, Peta, Exa, Yotta, Ronna, Quetta</i> Partially: <i>Zetta</i>	

Table 22 (cont.)

would be the general term for digitalization for me. That means that everything is somehow connected to each other." (E1) "Because in my view, digitization is closely linked to data. And, of course, the basic prerequisite is data, data collection, data quality, data analysis. And from that I can then derive numbers that I can then work with. And from that you can again, you can set goals. From that I then derive the numbers that I need." (E3)		
Extending physical products and services	Smart physical products such as control interfaces and sensors Digital servitization such as remote and complementary services	Zetta, Yotta, Ronna, Quetta Partially: Giga "But what happens after days like that, when users say: That was the highlight of the day, working with the [company's] product and the software for those 20 minutes. And I assured it works. I didn't have a bad feeling. I knew that, because if a software keeps crashing, then I always have that in the back of my mind. If you can then say at the end of the day, but at least that worked perfectly, then you as a manufacturer won, because you have your customers, because they buy more systems. And word gets around. That is extremely important." (Z2) "The devices themselves can be controlled remotely. And, but that has always been our pretension. So this is not something new. They all have some kind of computer that is integrated, and software runs on them and these devices have to be integrated into the customer's experiment for the measurements. So this interface to the customer's experiment is one issue, but so is the fact that these devices can then be controlled remotely from elsewhere." (Y1) "The next level of digitalization, or what we are offering here, is that we offer training videos, that we now have, we already have them on the Internet, but that we also provide even more technical information." (G2)
Innovating the business model	Dedicated business units such as new departments and spinoffs E-commerce such as online shops Software products such as own programmed tools	Zetta, Ronna, Quetta Partially: Peta "This ... division was set up as a fourth pillar, after what we already have. And we are overwhelmed by how successful it is. That means that the demand is really there. As an SME, we have now made it our mission to support other SMEs as well." (R1) "Or digitization of the service, yes, where I say: OK, maintenance, a customer can use an app to call up, here, this is my machine, now spare parts, quick, quick, quick. Like a kind of online shop ordering from us. Plus with a service technician." (Q1) "That means we need touch surfaces, which are all technically programmable. That shouldn't be a problem. But our industry is poorly positioned in that regard. ...] And that's why we said four years ago that we need to develop our own sewer inspection software, go down that path, take that step, that's a big step for a smaller company." (Z2)

Note. Own elaboration.

4.1.1. Digitizing Data

As opposed to most of the academic work on all things digital, there "is a general consensus in the literature concerning the first phase of digitization. It is understood as a technical process which involves converting analog signals into digital ones, creating data for information system processing and computation" (Eller et al., 2020, p. 120). In its most basic form, paper documents are scanned, compact discs or vinyl are ripped, or photographs are taken digitally rather than developed in darkrooms. There is one common denominator: "Digitization dematerializes information and decouples information from physical carriers and storage, transmission, and processing equipment" (Legner et al., 2017, p. 301). In a business context, there is a wide range of digitization techniques. All ten cases of this study were analyzed with regard to the digitization technologies they employed and summarized in five codes: COLLABORATION TOOLS, DATA AND IT SECURITY, MOBILE WORK TECHNOLOGIES, ONLINE PRESENCE, and SPECIAL PURPOSE SOFTWARE.

All of the cases have introduced COLLABORATION TOOLS. First, all of the analyzed SMEs have kicked off their digital collaboration with e-mail. The possibility of having a personal and paperless communication tool was a big leap forward for all of them. While this certainly is not a technology that any German SME has yet to implement, it is nevertheless worth mentioning as it represented to initial access to digital technologies for many companies. K1 explains that "e-mail, of course, moving away from post and fax to e-mail, that was a really big step, in my opinion." In *Exa*, E2 remembers the switch anecdotally:

So, I mean, when we started, I didn't have, we didn't even have e-mails. So everything came by fax. Then the twelve of us in the office had one e-mail account with twelve users. And now everyone has their own e-mail address and digital access, of course.

Second, video conferencing software has also had a great influence on how employees collaborate in SMEs. The CEO of *Kilo* (K1) describes how the Covid pandemic was a catalyst for these tools: "And now, accelerated by Covid, these [Microsoft] Teams stories and all that, that's a huge advantage for me personally." Even if the technologies had been available and affordable for years even before the pandemic, this exogenous shock resulted in a widespread acceptance by business owners, managers and employees. Before that, video conferencing was

not regarded as a serious alternative to real-life meetings and conversations. By the pervasive usage across all types of firms, industries, and countries, video conferencing has not only partly replaced telephone usage, but also revolutionized the communication among employees, but also with external business partners, as G1 explains:

So, for example, we work a lot with consultants. And if you just bring them together quickly via [Microsoft] Teams and then include the IT person, that's very productive. In the past they always had to drive here, which costs money, I would say, you had to pay for the trip, then you also had to pay for the hotel. So we save a lot of money and can then invest the money in the further development of the company. So that makes sense.

Third, the usage of seminars that are delivered through the world wide web has been adopted by the SMEs. Similarly to video conferencing, webinars have proliferated significantly through Covid (*Peta* and *Zetta*), but also through internationalization (*Yotta*). Webinars are therefore an extension to the classic in-person communication channels towards customers. They are easily scalable as theoretically they are not limited in terms of user participation. Moreover, recording of webinar can be disseminated to other audiences and thereby further improve the cost-benefit ratio.

Furthermore, the SMEs use software for chats, document management systems, e-learning, intranet, ticketing, and VoIP. Without further detailing technical specifications, they all contribute to a new form of digital collaboration.

The more a SME moves to the digital realm, the more it is exposed to cyber threats and the more it needs to account for its data and information technology safety. The office worker in *Peta* (P2), even though not being an IT professional, senses the increased cyber threat: "It is definitely a threat to a company in that sense. I could imagine that, because we are more transparent. And if someone hacks a company account or blocks something. The dangers are of course greater than before." In the field of information technology security, there is nothing to gain, but much to lose. All of the SMEs have in common that they rely on external specialists for their DATA AND IT SECURITY. The SMEs want to make sure that they are protected from hackers as much as possible by employing state-of-the-art security and backup systems. A severe hack can cost a SME its existence. The vastness of IT security and its volatility that increases

at tearing pace can only be surmounted with external help, as illustrated by *Quetta*'s Head of IT (Q1):

And especially in the security area or something like that, do you want to do that? It feels like something changes every week. And we discussed it a lot and also realized that we are actually not in a position to always be up to date with IT.

Moreover, regarding their infrastructure, SMEs should take care of a fast, stable and redundant internet connection themselves. *Kilo* and *Yotta* have contracted a leased line to ensure the required quality of the internet connection. Germany is lagging behind regarding a comprehensive glass fiber supply ([Statista, 2024a](#)) and companies increasingly take care of their internet connection worthy of the 21st century themselves. Furthermore, all of the companies host servers themselves or rent server capacities for their own usage. Nevertheless, the tendency towards cloud applications slowly but steadily decreases the utilization of on-premises servers.

Remote work is not only a buzz word for the new work movement to attract and retain skilled employees, but also a sheer necessity for companies that employ field staff or have a high degree of scattered sites of operation. Therefore, MOBILE WORK TECHNOLOGIES are key to enabling decentralized working practices. First, portable devices such as smartphones, tablets and laptops are the hardware foundation for mobile work. When PCs became increasingly affordable by the end of the 1990s, desktop computers were introduced, predominantly for office workers. Nowadays, among the observed SMEs, there were hardly any job profiles that did not require the usage of a portable device. Combined with the collaboration tools mentioned above, employees depend on computing devices to ensure participation. Second, virtual private networks and virtualization allow employees to access the company's systems from anywhere. Traditionally, employees had to be physically present at a company to use enterprise systems. VPN allows users to remotely access the local domain and therefore detaches the users from the premises of the company. Third, cloud computing also enables remote access to software services. The provider of a cloud software is responsible for the computing hardware and the security of its service, which reduces the purchasing and maintenance costs for SMEs. *Quetta* has adopted a cloud-first stance as described by Q1: "We are now going to the cloud, we do not want any more servers here, nothing more, so that we can actually use everything

properly and everywhere.” Moreover, professional SaaS providers possess considerably more resources and expertise to guarantee the security of their services. This is part of their value proposition and by profiting from economies of scale, it is much more cost-efficient than any SME could accomplish internally. Furthermore, P3 hints at the fact that only through cloud computing, simultaneous document editing is enabled: “Thanks to the cloud ..., it is always possible for us to continue processing a document and always keep it up to date.”

No matter the advantages of cloud computing, not all SMEs of the sample have adopted this new technology. *Kilo*, *Giga* and *Yotta* have thus far declined any major move towards the cloud due to data security concerns. They are united in their skepticism towards US monopolists, particularly Microsoft. The CEOs of these SMEs knowingly abdicate the benefits of cloud technologies in favor of controlling their data, even if this policy decision involves higher costs and lower usability. Interestingly, these decision-makers hold this view against the common attitude among their employees, who would prefer the ease of use of cloud services even at the expense of data security in all three cases. Excerpts from the interviews in *Kilo* and *Quetta* exemplify the dilemma. *Kilo*’s Head of Inside Sales (K2), who is also the IT coordinator, describes his CEO’s attitude as follows:

Yes, [our CEO], for example, is someone who would never give up his data. Hopefully he’ll hear that afterwards too. We have talked about this often, for example when switching to Office 365. Everything somehow goes into the cloud. [Our CEO] is strictly against a cloud. He wants his e-mails to be on his server. If, let’s say, Microsoft gets hacked by some Russian and who reads his e-mails. This is very important to him. Sometimes it costs him more money than putting his data in the cloud. But he wants to have his data with him. Sometimes this is correct thinking, sometimes it complicates things. But the change is more towards the cloud.

Quetta’s CTO (Y3), who is responsible for the company’s IT, expresses his skepticism towards trusting their intellectual property to cloud hosting firms:

So I’ve been looking at these [cloud] topics for a long time. I keep looking at, how do others do it? Where are there, where are they, where are the problems? It’s just proven itself over the years. This is certainly partly due to our structure. So if we had a lot of distributed locations, there would

probably be greater pressure to switch to some kind of cloud solution, I would say. But because we really have most of it here. So in particular, we are a high-tech company. And we live to a large extent from the technology that we develop and promote here. Also from measurement data and things like that. And I just want to have my hand on it. I don't want it to be somewhere at Microsoft in the USA. (Y3)

All of the cases have an ONLINE PRESENCE, both websites and social media accounts. The websites have not been mentioned as an integral part of digital transformation efforts. Just like e-mail, this technology is so prevalent today that it does not seem worth mentioning by the interviewees. Nonetheless, a website is the virtual business card of any company, and all of the observed SMEs maintain an up-to-date version. Social media, in contrast, is much more proactively used. The SMEs have realized that the diffusion of respective platforms presents a significant leverage for both sales and employer branding. For *Zetta*, social media even has a strategic relevance for recruiting, as describes by the CEO (Z2): “So via Facebook, Instagram. There were many, many job inquiries.” In times of skilled labor shortage, the generation of job applications from social media sites is vital. For *Ronna*, social media is a crucial part of their go-to-market strategy for their digital products.

Lastly, the SMEs all employ SPECIAL PURPOSE SOFTWARE to varying degrees. For specific organizational functions, software helps to digitize previously analog tasks and procedures. The SMEs of this study employ computer-aided design software or tools for expense management, human resources management, or financial management, including online banking. The use of software that is designed for special purposes largely depends on the characteristics of a company. However, the mentioned functions exist in almost all manufacturing companies what makes them universal among SMEs in this industry. The more difficult part is to choose an appropriate solution among the myriads of options, an issue that will be addressed in detail later.

All in all, digitization is the very foundation of any digital development of a SME (or any other organization, for that matter). Therefore, a "necessary but insufficient condition for digital innovation is that the new combination relies on digitization, i.e., the encoding of analog information into digital format" (Yoo et al., 2010, p. 725). If basic data is not available in digital format, they are unamendable for further initiatives such as digitalization, digital innovation, or digital business

models. Accordingly, *DIGITIZING DATA* presupposes the initiatives of the following chapters and hence, the proposition for the first measure of this construct is formulated as follows:

Proposition 1a: *The transfer of information and collaboration from the analog to the virtual realm is the technological foundation of digital transformation.*

4.1.2. Digitalizing Processes

When talking about digitization, digitalization or digital transformation in a business context, according to my experience, most people mostly refer to what is coded here as the measure *DIGITALIZING PROCESSES*. In the literature, this stage is called ‘digitalization’ by [Verhoef et al. \(2021\)](#) or ‘process digitalization’ by [Soluk and Kammerlander \(2021\)](#). At its core is the maximization of output with a given input or alternatively minimizing the input for a given output, i.e. the efficiency of processes, by using digital technologies. This chapter introduces the four codes that constitute the measure, namely ENTERPRISE SYSTEMS, SMART MANUFACTURING, INTEROPERABILITY, and BUSINESS INTELLIGENCE. Since this construct focuses on digital technologies, the most common tools will be presented for each code.

All of the SMEs of this study use ENTERPRISE SYSTEMS. This code summarizes software applications that are devised for managing the core functions of a company. Enterprise systems are standardized and customizable software packages "with an integrated architecture, which can be used by organizations as their primary engine for integrating data, processes and information technology, in real time, across internal and external value chains" ([Shang & Seddon, 2002, p. 272](#)).

First and foremost, the enterprise resource planning system is by far the most-mentioned software among the investigated SMEs. It accounts for 30% of all references in the construct **DEPLOYING DIGITAL INITIATIVES**. Nine of the ten companies use an ERP system, some of them for decades already. *Kilo*, for example, introduced their first ERP system as early as 1993. The introduction of an ERP is considered a “milestone” (G1) or the “most decisive step” (Q1) in the digital transformation of a SME.

Zetta is the only SME that has not yet introduced an ERP system. Instead, they only use a CRM system for administrating interactions with the customer. All other processes are still manual. However, Z2 is persuaded to establish an ERP

system soon because he is aware of the limitations that are accompanied by mainly manual work:

So I would like to have more data for myself, for us, for our administration. And it doesn't exist in this form. But I would like to get there with an ERP system that really has inventory management behind it, where we can get more out of it in business terms.

The ERP system is the single most important digital initiative for the incumbent manufacturing SMEs of this study, which is also mirrored in the literature (Robey et al., 2002). It is not just crucial for planning the material and immaterial resources of a company but represents the foundation for many other digital technologies. *Kilo*, *Mega*, *Peta*, *Exa*, *Ronna* and *Quetta* started with a basic ERP system that was later replaced by a more capable system. With the experience of the first introduction, the consecutive projects ran more smoothly. In a nutshell, the ERP system is the admission ticket for a SME's digital transformation.

For the introduction of an ERP system, a SME has to make the elementary decision whether customize the software or whether to alter their processes and organization. Hanelt et al. (2021) describe the latter as an integration mechanism for digital transformation that involves "physical-digital harmonizing by TMT" (Hanelt et al., 2021, p. 1167) by combining "digital technologies with managerial resources, organizational structures [and] new working practices" (Hanelt et al., 2021, p. 1196). All of the SMEs that employ an ERP system have customized it according to their needs. As K2 states: "We have the ERP system. It's completely provided by the producer. ... And they also make the customizations for it. Our ERP system is extremely tailored to [*Kilo*]. There are various functions that no other company could ever need." While representing a company's particularities better than standard software, it comes at the cost of having to manually adapt the customizations at each of the provider's updates. However, the trend towards cloud ERP systems has led to rethinking in *Mega* and *Quetta*. During their current ERP implementation projects, they thoroughly scrutinize every business process as to how it could be realized without a software customization, as described by M1:

And we have a bit of faith in [the ERP system], that there are a lot of clever people behind it who hopefully developed the program on the basis of thousands of companies. And that is why we want to make as few adjustments as possible. The other reason, of course, every adjustment

has to be maintained—we all know this from the IT world. It is not the cost of spending €1,000 a day or more to program a button differently for four hours. That is what will be the case for the next 20 years. With every update that comes from [the ERP system], you have to keep up with it. And we want to be as lean as possible so that we can just click on update and not have to worry about any individual programming.

Another widely used software for the investigated SMEs are customer relationship management systems "that enable organizations to contact customers and collect, store and analyze customer data to provide a comprehensive view of their customers" (Khodakarami & Chan, 2014, p. 27). The goal is to increase the efficiency and effectiveness of sales efforts. *Zetta* is a peculiar case because they do not use an ERP system, but a CRM system, which is very important according to Z1: "Yes, I don't know exactly which year, but at some point the CRM system was introduced. I think that was definitely a milestone." However, a dedicated CRM system only really brings a benefit for SMEs with a large number of customers. Companies with a limited number of relatively stable customers will usually be able to manage their sales with the rudimentary CRM functionalities of their ERP system or without system support altogether, as M1 explains:

For example, a CRM system. We don't have thousands of customers. We have a very small number of customers who we look after very intensively personally. ... And I know them. And we haven't even tried introducing a CRM system, for example. That was once a suggestion, but it was never implemented.

Furthermore, especially for SMEs that realize customer projects (in contrast to manufacturing and selling physical goods), project management software is an essential support. Moreover, depending on the business, other process-related business application software such as product information management systems, supply chain management systems, or requirement management software, can be helpful for manufacturing SMEs.

The digitalization of the production process to achieve SMART MANUFACTURING is one of the core aspects of a manufacturing SME's digital transformation, often referred to as Industry 4.0. The findings of this thesis suggest that it is an important factor, but definitely not the deciding, let alone the only factor for successful digital transformation. Nevertheless, SMART

MANUFACTURING contributes to the digital transformation of manufacturing SMEs with the following technologies.

A technology that is widespread among the investigated SMEs is code scanning. If in the manufacturing process, logistics, or after-sales service, the usage of this technology principally aims at reducing manual errors and speeding up the processes. In *Kilo*, scanning is an important aspect of the operational practice, as described by K1: “Until recently we had these dumb scanners, where you just scan and then everything happens in the background. And now we are increasingly switching to intelligent scanner systems. Yes, and we are doing more and more in that direction.”

For SMEs with a high vertical range of manufacture (which applies to *Exa* and *Ronna*), a manufacturing execution system assists to better supervise and steer production processes. MES usually do not work as stand-alone solutions but are highly integrated with the ERP system to generate insights on a higher commercial level. E2 emphasizes the importance of collecting data first: “With the MES, of course, you have to record data first so that you can get something back. The beginning was always bumpy, but you grow with it, so the more data you record digitally, the better you become.”

Even if production data acquisition can be applied on its own (as in *Giga* and *Quetta*), it is usually set up in conjunction with a MES. PDA further solidifies the actual data that is generated during the production process. A necessary technical condition is that the machines that are involved in the production process are able to generate data. Especially for incumbent companies whose machinery dates back years, sometimes decades, the introduction of PDA is much more complicated as it involves retrofitting existing machines or the purchase of new, data-driven versions. In *Exa*, for example, the existing machinery was upgraded gradually up to the point where the decisive equipment is incorporated in the PDA. As a result, the manager for production planning and control has access to much more detailed and reliable real-time information. E2 resumes as follows:

Of course, with the introduction of MES four or five years ago, that was the next step, where you really had detailed planning with PDA bookings reporting back with actual times, not just in waiting days, but really: I need 73 hours for the order. So that was another step further.

Robotics are on the rise in SMEs. Two of the companies already employ robots in the production process for simple tasks such as welding, inspecting, and assorting (*Kilo* and *Exa*). The CEO of *Kilo* explains the relieving effect of robots for physically exhausting tasks: “If you are now thinking, for example, about the digitalization of production, with the welding robot, you are also doing this to make work easier for the employees.” As with other digital endeavors, large manufacturing companies are more likely to rely on robotics due to the high costs associated with purchasing and programming of the equipment. Moreover, companies with a low degree of vertical integration such as *Mega* or pronounced service orientation such as *Peta* would benefit less from advanced production automation through robotics.

Furthermore, T1 states that for them, the digital twin already plays an important role: “Building Information Modelling. This is the digital twin in construction.” However, *Tera* was the only one to employ this technology, suggesting that this is not yet ready for mass-implementation in SMEs.

Up until this point, many technologies for SMEs’ digital transformation have been described. As standalone entities, each software and each system serve a specific purpose. The SMEs of this study have realized that information in siloes is only of limited use. This is why connecting the individual systems is of crucial importance. The connectivity between software is referred to as INTEROPERABILITY and is defined as “the ability of two or more systems to exchange information and understand that exchanged information” ([Hodapp & Hanelt, 2022, p. 407](#)). In this context, the interconnectivity applies to both systems within and beyond the company boundaries, extending a mere technical interoperability perspective ([Rezaei et al., 2014](#)).

To determine how they create value and understand the mechanisms between input and output, companies can employ process management software. By visualizing the processes and their interconnection points of information and data flows, companies can grasp and improve their value chains. [Fischer et al. \(2020\)](#) even regard business process management as the baseline for digital transformation. Many manufacturing SMEs such as *Kilo*, *Exa* and *Yotta* are certified by the ISO 9001 norm for quality management, which serves as the foundation for a process landscape. The CTO of *Yotta* (Y3) states that “we have a wiki system that we use to map our ISO processes. And which we now also use as a general information tool for [*Yotta*].” The manager for production planning

and control of *Exa* (E2) mentions the important premise that a process management software unfolds its power only if it is designed in a way that the employees benefit from its contents in their daily work and actually use it: “Every layout plan, every process map, organizational chart, everything is actually in this [process management software]. And every employee has their own access to it. And should know it as well as possible. So I think it's really good.”

The second aspect of INTEROPERABILITY is interconnecting a SME's internal systems, software and platforms. Especially in the earlier days of digitalization, SMEs introduced highly specialized software from different producers without considering the embedment in the bigger picture. *Zetta's* CEO (Z2) reinforces the interconnection between internal systems: “[For *Zetta's*] digitalization, we need systems that can communicate with each other. Open systems.” The potential of software is therefore limited to its standalone capabilities. However, by adopting a workflow architecture for tasks, information, and data flows, the potential of software is multiplied: “And this workflow approach that we are currently introducing, especially in the human resources area, will also advance us significantly” (G1). In the investigated SMEs, there is a tendency from smaller, specialized software producers towards more potent software providers that lead their markets. The reason is that established software often offers a range of standard interfaces, whereas niche solutions tend to require manual customization or adaption of interfaces.

The third and last facet of INTEROPERABILITY is the connection to external partners such as customers and suppliers. Technically, the observed SMEs realized this via electronic data interchange interfaces. While connecting internal systems depends on the SME alone, boundary-spanning interfaces are more complex to realize even if there are standard interfaces like EDIFACT (for example employed in *Giga*). Apart from the technical challenge of harmonizing (at least) two different systems, inter-company interfaces require the coordination of firms with a customer-supplier relationship, which inherently implies a power disparity. Usually, the customer specifies the interface that the SME must adhere to; the implementation expense lies with the supplier. Still, the benefit from connecting with major customers can also bring significant benefits to SMEs, especially regarding efficiency and the avoidance of manual errors (*Kilo*):

At that point, customers started sending us orders in digital format. As ASCII codes, as Excel files. And then we started importing them

automatically. That was something we wanted, because you always had to enter huge amounts of data, which was a very high source of errors. And then we received these orders as ASCII codes, or Excel files, and we then automatically imported them into our system and made fewer and fewer errors. (K1)

Moreover, as observed in *Exa*, it can even be a competitive advantage if other market participants are less advanced in this area:

And now we go there and say: Yes, you [the customer] can freely access our data and then you can see for yourself when the delivery date is. You don't need to write us an email. Or we can connect with you and then... We don't check the orders. They are also imported digitally and the order is created digitally. (E1)

Most of the observed companies are aware of the importance of connecting their systems, but none of them has already managed to comprehensively harmonize processes, systems, and partners. The technological hurdles are significant, especially for software that does not provide out-of-the-box interfaces and needs custom programming. All the same, the direction towards INTEROPERABILITY is undeniable given the fact that SMEs increasingly check their lists of standalone software; the next logical step is to connect them.

The ultimate goal of collecting data and connecting systems is to draw conclusions that improve decision-making. BUSINESS INTELLIGENCE is the tangible result of interpreting a company's data to generate insights. To harness the data in a uniform and centralized manner, the SMEs of this study that have already gained experience with BUSINESS INTELLIGENCE (*Tera* and *Exa*) store the data in a data warehouse. A data warehouse is a central repository of data integrated from disparate sources across a company. In *Kilo*, there is an awareness even if it has not yet been implemented: "We would like to reach the point where you have all the data in a data cube, where you can then look at it in different ways so that you can always see where we are at the moment" (K1).

The analysis of data mostly relies on mathematical and statistical calculations. For the human cognition, visualizations are the most digestible and accessible representation of data. *Exa* has built its entire digital architecture around a KPI model, as described by E3:

We have this [software tool], which is a program that you can use to quickly evaluate, summarize and present data. And it is a tool that we can build

ourselves. So we can use it to create our own evaluations. We don't have to rely on anyone externally. And then we can present the topics that we need.

To sum up, *DIGITALIZING PROCESSES* is the logical consequence of *DIGITIZING DATA*, which presupposes *DIGITALIZING PROCESSES*. In the literature (Verhoef et al., 2021), *DIGITALIZING PROCESSES* is mostly associated with the concept of digitalization, versus digitization which commonly refers to *DIGITIZING DATA*. These two measures of **DEPLOYING DIGITAL INITIATIVES** principally take place within an organization and cross its boundaries only in terms of information flows to customers and suppliers. Their principal aim is reducing costs. Accordingly, the proposition for the second measure of this construct is formulated as follows:

Proposition 1b: *Interoperative enterprise software and smart manufacturing enable data-driven business intelligence insights.*

Just as digitization presupposes digitalization, digitalization facilitates further digital developments of a SME. Accordingly, "digitalization creates potent digital affordances that likely have a transformative effect upon the organization of economic activity by supporting radical business model innovation" (Autio et al., 2018, p. 76). The next two chapters describe the digital initiatives that disperse beyond a company's frontiers.

4.1.3. Extending Physical Products and Services

The third measure that the data revealed for the construct **DEPLOYING DIGITAL INITIATIVES** is *EXTENDING PHYSICAL PRODUCTS AND SERVICES*. Being rooted in the manufacturing industry, all of the SMEs in this study offer physical products and complementary services to their customers since the inception of their business operations. Except for *Yotta* whose portfolio inherently contained digital components as part of their functionality since its foundation, all cases originally offered strictly analog physical products. In their digital transformation journey, some of the SMEs of this study have incorporated novel technology into their portfolio. The measure *EXTENDING PHYSICAL PRODUCTS AND SERVICES* therefore emphasizes the adoption of digital technologies in traditional manufacturers' products and services.

First, the most common digital innovation among the observed cases was to extend their existing physical portfolio. By developing **SMART PHYSICAL PRODUCTS**, the companies can still keep relatively close to their established

modus operandi, but at the same time start to enter the realm of digital offerings. *Zetta* complements their product range of sewer cameras by allowing them to be maneuvered via computer. The optical frequency combs of *Yotta* have always been smart by design. The most notable deviation from the original portfolio was observed in *Ronna* which has developed and produced novel products: “Once we started [our digital product], we quickly came to the idea of creating our own products and doing something in that direction” (R3). Making use of IoT technologies such as RFID and sensors, they represent a new line of smart product offerings.

Even if some of the SMEs have not yet enhanced the functionality of their physical products, they have nonetheless considered doing so. The metal products of *Kilo* might be extended by including sensors. The same applies to *Giga*, which additionally contemplates including RFID chips. The SMEs that have not yet incorporated digital technologies into their physical products to make them smart at least demonstrate interest or willingness to do so. However, the manufacturing SMEs of this study are skeptical towards digital product innovation. Nonetheless, the flipside of the coin is that not all physical products need to be digitally enhanced because they serve their purpose well the way they are and will continue to do so for the foreseeable future. Considering this insight, the following aspect is all the more important for incumbent manufacturers whose product range will most likely abide predominantly physical.

Second, as has been described in the systematic literature review, manufacturing companies have increasingly spread beyond mere product offerings and shifted towards servitization, independent of any digital matter. The surge of digital technologies has nevertheless disclosed utterly grander opportunities to add value to products through the rendition of services. Some of the investigated SMEs have already introduced DIGITAL SERVITIZATION. In *Giga*, training videos help clients to correctly use the products. In *Quetta*, the digital servitization voyage is just about to begin, but the plans are concrete. The most significant leap forward has been detected in *Yotta* where services that were originally conducted in person are now partly offered completely digitally, i.e. the installation and configuration of machines. The head of sales of *Yotta* (Y1) exemplifies the case:

One thing that has changed is service, for example. During Covid, we actually switched to doing everything remotely, or trying to do it remotely.

Normally, the devices are sent in wooden boxes, two of them, 400 kilograms each. They arrive at the customer's, they unpack them, a technician drives there and installs them. That was the way it was before. And what's actually very attractive for us is to say: Yes, customer, please unpack them. And then we'll help you plug it in. And we sit here, he sits in his lab and does everything together with a camera. So that's a big change, I think, and it wouldn't work without digital technology.

Notably, the three cases have all maintained their core identity as manufacturers and the data analysis has not revealed any intentions to abandon or outsource the production to solely focus on the provision of services. The digital servitization efforts of the three cases are only minor in comparison to the wide array of technical possibilities. For the upcoming years, virtual and augmented reality offer boundless potential for digital servitization (Gebauer et al., 2021).

Certainly, as has already been explained earlier, the line between *EXTENDING PHYSICAL PRODUCTS AND SERVICES* on the one hand and *INNOVATING THE BUSINESS MODEL* on the other hand is blurred. This applies particularly to digital servitization. The cases of this study suggest that *DIGITAL SERVITIZATION* is not always inextricably linked to changes in the business model but can improve the existing portfolio gradually. This assertion holds true in this study of manufacturing SMEs. Digitally enhanced products or services may require an adaption of parts of the business model to capture their value appropriately. The final measure of this construct, *INNOVATING THE BUSINESS MODEL*, refers to significant changes in how a company creates, delivers, and captures value, rather than the minor adjustments that *EXTENDING PHYSICAL PRODUCTS AND SERVICES* implies. Accordingly, the proposition for the third measure of this construct is formulated as follows:

Proposition 1c: *Incumbent manufacturing SMEs extend their existing physical products with smart functions and foster digital servitization activities.*

4.1.4. Innovating the Business Model

The fourth and last measure of the construct *DEPLOYING DIGITAL INITIATIVES* is *INNOVATING THE BUSINESS MODEL*. This is the most pervasive step of incorporating digital technologies into a SME as it shakes the very foundations of a company. Business model innovation in itself is an endeavor for SMEs that is not to be underestimated, both in its complexity but also in its potential for

sustained value creation (Cucculelli & Bettinelli, 2015). Factoring in the heft of novel technology, innovating the business model becomes all the more challenging. Thus, it comes as no surprise that only four of the SMEs have engaged in digital business model innovation.

First, E-COMMERCE has been adopted (*Peta*) or will be adopted (*Quetta*) by two SMEs. Using the internet for selling products represents a new sales channel that offers significant advantages such as direct access to the end user or the relief of the sales team. While still considered a business model innovation, it is comparably minor as the underlying core logic of a manufacturing SME does not change; rather, this new channel complements the existing commercial activities. Nonetheless, the adoption of e-commerce promises humongous potential also for manufacturing SMEs because it complies with an overall societal megatrend towards decoupling sales from humans as happens in online shopping. Given the prevalence of e-commerce in the overall economy even among SMEs (Bi et al., 2017; Holland & Gutiérrez-Leefmans, 2018), this is a low figure. It can be attributed to the fact that the SMEs of this study primarily target businesses, rather than end customers. The products and services of manufacturing firms tend to be rather complex and therefore require a substantial amount of explanatory support. Such consultation-intensive products and services are difficult to sell through channels that emphasize mass consumption. Nevertheless, e-commerce can be a lever for manufacturing SMEs if they find a suitable business case.

Second, three of the SMEs (*Zetta*, *Ronna* and *Quetta*) have already launched their own SOFTWARE PRODUCTS. These are programs that open new business opportunities that were inaccessible for the traditional products and services. While in *Zetta* the software can only be used in conjunction with the physical product, *Ronna* and *Quetta* have developed solutions that are independent of physical products and therefore represent veritable software products. One of *Ronna*'s software developers (R2) explains the importance of customer customization in their software:

And standard software that I can buy is tailored to everyone. I can buy it, install it, and maybe adapt it a little to my system. The standard software that I buy will work for 90% of the time. But if I buy the [our software] here, then I first need a service to adapt it.

In *Quetta*, they aim for a scalable software product to multiply sales and eventually profits. The company's CEO (Q3) envisions a business model in which their software products are used by a multitude of customers:

The idea would be that we manage to create a software product that can be sold. Because the question is always: do you make software as a product or software as a service, i.e. contract development or some kind of customer-specific software development that is then only used once, as it was developed individually for this customer. Whereas a software product is simply something that can be scaled. And that would actually be the ideal.

Developing software is a challenging endeavor for manufacturing firms that are accustomed to producing tangible products. In therefore involves managerial finesse, a topic that will be deepened later.

Third and last, two SMEs have set up DEDICATED BUSINESS UNITS to foster the digital growth of the company. Large companies rather tend to establish or cooperate with DILs (Holotiuk et al., 2024); however, for SMEs this usually represents a disproportionate investment. New digital entities that operate parallelly to the core business are a suitable alternative (Shahzad et al., 2025). *Ronna* has established an own business unit within the company that develops and sells their digital products and services. *Quetta* has gone even one step further and founded a spin-off with the goal of accelerating the expansion of their software products. Their head of IT (Q1) was a notable driver for this decision:

I was always pestering [the previous CEO] and [the current CEO], saying: Hey guys, we're leaving money on the table in the software sector. We're really, if you'll excuse me, stupid. It can't be right. We're acting so stupidly, we need to step on the gas, we need to do more. And all of this combined has led to us founding a company.

Whereas *Ronna* principally targets existing customers, *Quetta* deliberately aims at addressing new market segments, as explained by the CEO (Q3):

Yes, that was a brave step, I would say. Or still, where you don't know at all whether it will ever be ready for it to actually... But in my view, the only way to find out is to try it and try to develop a business model from these ideas and from these products that we already have. Where you may not even know exactly what it will look like today. But if we just keep treating it like a side issue here at [*Quetta*], and have treated it like that, then nothing

will ever come of it. And so we have now given the whole thing its own platform on which the product or these ideas can develop and somehow turn them into reality. And that was actually the idea behind this spin-off.

All in all, digital business model innovation occurs relatively seldom across the incumbent manufacturing SMEs of this study. And if a SME decides to alter its value creation, delivery, and capture mechanisms, it mostly happens as an incremental evolution within their traditional business logic and industry. However, there are examples in this study that have left their comfort zone to conquer unknown territories by using digital technologies. Accordingly, the proposition for the fourth and final measure of this construct is formulated as follows:

Proposition 1d: *The innovation of value creation, delivery and capture mechanisms involves offering software products and is facilitated by the establishment of dedicated organizational units.*

4.1.5. Interim Summary

Digital transformation involves making use of digital technologies—this trivial insight has led most business managers to include them on their leadership agendas years ago ([Warner & Wäger, 2019](#)). What seems like a hollow phrase in the first instance is a crucial element of understanding the concept's underlying processes. Digital technologies are the enablers of a SME's digital transformation. However, the abundance of possibilities overburdens many SME decision-makers whose main responsibilities are usually centered around other topics such as sales, procurement, finance, human resources, or operations. Moreover, new technologies arise at an exponential rate and the software landscape seemingly evolves at speed of light. For example, blockchain and its relevance for product, service and business model innovation dominated the discourse at the end of the 2010s ([Liang et al., 2021](#)). With the Covid pandemic at the beginning of the 2020s, the adoption of decentralized and paperless work practices became the focus of attention ([Amankwah-Amoah et al., 2021](#)). The release of ChatGPT for public users in November 2022 evoked an unprecedented boom of artificial intelligence based on large language models that might affect all areas of social interaction ([Schwaeke et al., 2024](#)). Within just a few years, many technological advancements with disruptive potential have emerged. Some are here to stay; some vanish without a significant sustained impact on

businesses. In any case, it is up to business leaders to decide how to approach new digital technologies and their adoption in their SME.

In accordance with the theoretical sampling logic based on common antecedents, the observed SMEs had similar circumstances to start with. Nevertheless, they differ notably in **DEPLOYING DIGITAL INITIATIVES**. Table 23 gives a subjective estimation of how the four measures were found among the SMEs, with 0 meaning no activities, 1 meaning few activities, 2 meaning some activities, and 3 meaning many activities. *Ronna* has engaged in digital initiatives in a superior fashion, whereas *Kilo* and *Zetta* have conducted the least. However, this study is not about performance and these raw numbers give no indication whatsoever about how successful a company is, neither in financial nor in digital transformation terms. The table merely offers a quantified comparison to give the reader a summarized impression of the SMEs' digital initiatives journey.

Table 23:

Case Estimation Regarding Deploying Digital Initiatives

Case	Digitizing data	Digitalizing processes	Extending physical products and services	Innovating the business model
<i>Kilo</i>	2	2	1	0
<i>Mega</i>	3	2	1	0
<i>Giga</i>	3	2	1	0
<i>Tera</i>	3	2	2	1
<i>Peta</i>	2	2	1	1
<i>Exa</i>	3	3	0	0
<i>Zetta</i>	1	1	2	1
<i>Yotta</i>	2	2	2	0
<i>Ronna</i>	3	3	2	2
<i>Quetta</i>	3	2	2	2

Note. Own elaboration.

Summing up, the first construct **DEPLOYING DIGITAL INITIATIVES** consists of four measures: *DIGITIZING DATA*, *DIGITALIZING PROCESSES*, *EXTENDING PHYSICAL PRODUCTS AND SERVICES*, and *INNOVATING THE BUSINESS MODEL*. The replication logic that lies at the heart of the Eisenhardt Method postulates that constructs and the relationships between them fit with the evidence in each case ([Eisenhardt, 1989](#)). The construct **DEPLOYING DIGITAL INITIATIVES** is indeed observable in each of the cases. However, not each of the four measures is

represented by all the ten cases. Nevertheless, the construct implies that every SME is theoretically able to engage in the four different realms of digital initiatives. The more a SME transforms digitally, the higher the probability that it will be *DIGITIZING DATA*, *DIGITALIZING PROCESSES*, *EXTENDING PHYSICAL PRODUCTS AND SERVICES*, and *INNOVATING THE BUSINESS MODEL* to some degree.

For SMEs to transform digitally, it is no question *if* they should conduct digital initiatives, but which, why and how. The complexity varies significantly, and so does the timeframe for the implementation. While the SMEs of this study have common antecedents, the extent and type of digital initiatives they have deployed is surprisingly heterogeneous. The common denominator, however, is that they did engage in digital transformation activities. Accordingly, the first proposition is formulated as follows:

Proposition 1: *Incumbent SMEs must deploy digital initiatives to advance their digital transformation.*

The extent to which a SME should engage in each of the fields of digital initiatives, if at all, remains a crucial issue. The next chapter elaborates on the results that the case studies rendered on the matter. Whereas this chapter was about the ‘whats’ of digital transformation, the next chapter is about the ‘whys’.

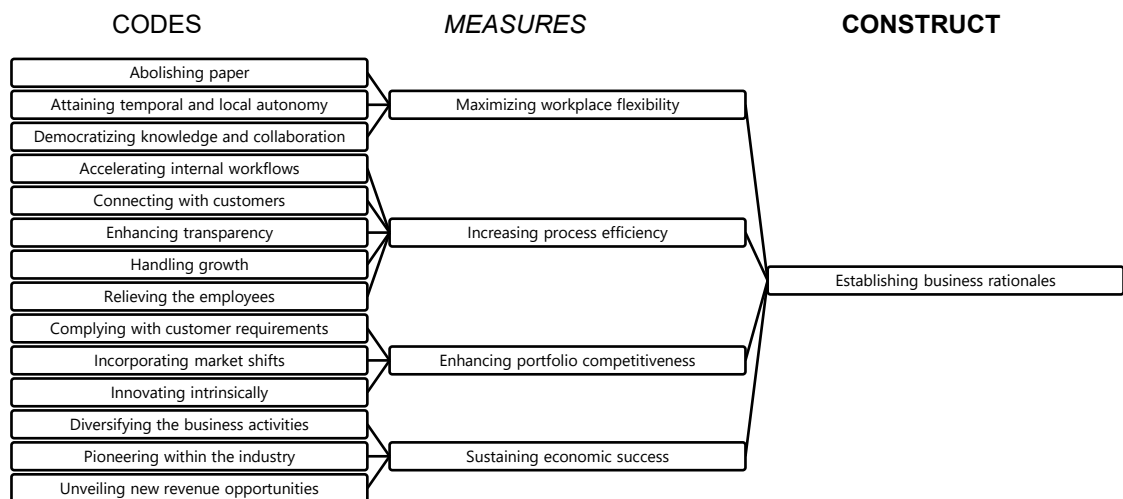
4.2. Establishing Business Rationales: The Commercial Nexus

As evident as it is that digital transformation involves the use of digital technologies, the deeper question of why a company should engage in digital initiatives remains obtuse. A recurring theme among the SMEs of this study can be summarized with a brief statement by Y3: „I would not digitalize for the sake of digitalization”. But what are the actual reasons for transforming digitally? And what does success mean in the context of digital transformation? This chapter elaborates on these crucial aspects.

The data has revealed a second construct, namely **ESTABLISHING BUSINESS RATIONALES**. A business rationale in this thesis refers to the underlying justification for deploying a digital initiative within the overall company logic. It outlines the reasons why the initiative is necessary and how it aligns with the SME’s superordinate goals. Quintessentially, it provides a clear understanding of why the digital initiative ought to be conducted and the specific benefits it will render. In other words, "those companies who can see a clear business case in using Industry 4.0 technology are also those companies in which Industry 4.0 is

more strategically and organizationally supported" (Stentoft et al., 2021, p. 822). The degree to which companies should transform digitally, therefore, depends on the goals they pursue. Success is when they accomplish implementing digital technologies that serve a business rationale. Hence, the prioritization for incorporating digital technologies in a SME does not depend on their sophistication, novelty, or popularity, but solely on their potential to contribute to achieve the company objectives. Accordingly, this second construct represents the commercial nexus for holistic digital transformation.

Figure 11:
Coding Scheme for Establishing Business Rationales



Note. Own elaboration.

This construct is described through four measures that will be explained in the following chapters, namely *MAXIMIZING WORKPLACE FLEXIBILITY*, *INCREASING PROCESS EFFICIENCY*, *ENHANCING PORTFOLIO COMPETITIVENESS*, and *SUSTAINING ECONOMIC SUCCESS*. Figure 11 shows the coding scheme for this construct.

Table 24:

Cross-Case Evidence for Establishing Business Rationales

Measure	Establishing business rationales	Identified in cases	Selection of quotes
Maximizing workplace flexibility	Abolishing paper Attaining temporal and local autonomy Democratizing knowledge and collaboration	<i>Kilo, Mega, Giga, Tera, Peta, Exa, Yotta, Ronna, Quetta</i> Partially: <i>Zetta</i>	"For me, it's basically that everything is becoming digital, everything. Digital filing, you don't have any paper anymore, everything is going back and forth via email, you save it somewhere, you don't really have any letters anymore or anything like that. ... So the whole thing just works online and without paper, let's just put it this way. Everything online and without paper." (P2) "We also had an important meeting. Our IT management was abroad at the time and was able to attend remotely. And we didn't have to stop or pause our project, we were able to connect the IT management and carry on straight away. And that's really what the efficiency of the projects is all about." (G1) "[Our workforce is] also scattered across Germany. So of our five software people, only three are based in the Munich area, the others are based somewhere in Germany. And even those who are based in the Munich area are actually only in the office when hardware interaction is required. In that respect, of course, we are probably closest to the digital nomads, so to speak. And of course, that has developed over the years." (Y3) "And as I said, here you'll always find the latest news from the company or all around. So if something is closed here or there's a Christmas party or anything like a company holiday, it's published here in the news. And then workflows, audits, internal projects, protocols, processes. It's all in here. ... Anyone can do that, anyone can initiate a discussion about an old process. ... So everything that happens with us is actually recorded here." (E2)
Increasing process efficiency	Accelerating internal workflows Connecting with customers Enhancing transparency Handling growth Relieving the employees	<i>Kilo, Mega, Giga, Tera, Peta, Exa, Yotta, Ronna, Quetta</i> Partially: <i>Zetta</i>	"Leaner processes. Simpler, faster processes, easier work, procedures... well, these are processes more or less. So yes, simply that everything becomes a little simpler, a little leaner. That you don't spend all your time doing things that you could have avoided because there is a quicker way." (Z1) "This EDI interface prevents incredible errors in order entry. So if I have a customer who orders 400 [products] a day and I have to enter the 400 items manually, there is a high probability that I will make a typo or copy something incorrectly. Through the EDI interface, we simply arrange things with the customer so that they submit their orders in a specific format so that our system can read them fully automatically." (K2) "Of course, it depends on which area we are referring to. But from a management level, what I understand by digitization is that I can evaluate the company in real time, if possible. Whether that is delivery reliability, a complaint rate, i.e. that I can get a statement about all areas based on numbers. Because from my point of view, digitization is very closely linked to data. And, of course, the basic requirements are data, data collection, data quality, data analysis. And from that I can then derive numbers that I can then work with. And from that you can set goals

Table 24 (cont.)

Enhancing portfolio competitiveness	Complying with customer requirements Incorporating market shifts Innovating intrinsically	Zetta, Yotta, Ronna, Queita Partially: Tera, Giga	again. From that I then derive the numbers that I need. So in the end it's all about transparency." (E3)
			"Something that can grow with us again. That was one of the main reasons why we are now pushing this forward so much. And why it is at the top of the list at the moment. So yes, without a new ERP system we cannot grow any further. It simply limits us in many aspects." (Y3)
Sustaining economic success	Unveiling new revenue opportunities Diversifying the business activities Pioneering within the industry	Zetta, Ronna, Queita Partially: Peta	"Personally... For me, digitization simply saves us unnecessary work. The things that are already obvious, that are already standardized, that a person has to do, but that a machine could also do, digitize them and everything that really, I would say, requires the sensitivity of people. Be it a difficult conversation with a customer or a salary, a salary negotiation or a contract negotiation with a customer. Whatever. That people have more time for such important topics and that these topics that can be standardized, these unnecessary paths, that they are run via software. So that is digitalization for me, and it should ultimately help people and not scare them." (G1)
			"We also have big players as customers, for example, who are also growing very strongly in the field of digitalization, such as [company A] and [company B]. They are already coming along with ideas, and, in some cases, they are also pushing things a bit." (G2) "The whole thing was also a bit connected to looking outwards. What is actually happening on the market right now? What, what is happening at the university? Where is research being carried out right now? Always an exciting topic, isn't it?" (T3) "We are a company that has always lived in technology by developing our products and constantly selling products that have never existed before, where we were forced to develop something new. So, I think that we have always lived in technology by forcing change and constantly reinventing ourselves in order to develop new products. And that has always been a bit of the company's DNA, to simply reinvent ourselves." (Q3) "And we can see that the software sector in particular, yes, that you can make good money with it, quite simply, that if you put your foot on it and develop good software, you will get something out of it, yes. And that it is simply a promising area." (Q1) "And I also think that in this sense ..., because mainly in the automotive sector, in mechanical engineering as an industry, things are sometimes not very mincing. It is also good to have standard products and to have sensible and reasonable foundations in order to grow accordingly and also to have access to industries where you simply didn't have access before because you were looking at things from an automotive perspective." (R3) "Often this can only be done with small, portable inspection cameras. But our industry does not really offer the right software for this. Not a good one. ... And our industry is having an extremely tough time with this, and we have not been able to get it from external companies. It has never worked, although there are lots of promises. But it has never been implemented because it is of course complex. And that is why we said four years ago that we need to develop our own sewer inspection software, go down that path, take that step, that's a big step for a smaller company." (Z2)

Note. Own elaboration.

4.2.1. Maximizing Workplace Flexibility

The first business rationale measure is elevating the flexibility of the workplaces for the employees and the business leaders alike. Modern working environments necessitate collaboration practices based on decentralization and propagation of information. Three aspects have been found to be crucial: ABOLISHING PAPER, DEMOCRATIZING KNOWLEDGE AND COLLABORATION, and ATTAINING TEMPORAL AND LOCAL AUTONOMY. The following paragraphs describe each code in a more detailed fashion.

In a business context, the medium paper is the antipode of anything digital. It therefore comes as no surprise that ABOLISHING PAPER is a commonly shared notion in itself among all SMEs of this study. Getting rid of physical documents, folders and workflows is a self-evident and straightforward entrance to the complex field of digital transformation. If there were a singular common denominator for the digital pathway of SMEs, it would be to abolish the medium paper: “The very first thing I would associate [digital transformation] with is a buzzword like paperless” (E1). Consequently, associated devices such as printers and fax machines are obsolete as well: “Get rid of the fax machine. I find faxes so unnecessary these days. Nobody uses them anymore.” (M3). Evidently, this is an compulsive step towards workplace flexibility. The lack of ubiquity that is inherent to paper documents severely cumpers decentralized working practices. It is notable that participants in non-leading positions, in this case office workers such as M3, P2, or Z1 seem to relate digitality first and foremost to paperless. In their day-to-day work, the switch from paper-based to paperless is much more perceptible than for managers who treat with document-based information less intensively. However, *Mega*’s head of IT (M2) indicates that in some instances, pen and paper still has a right to exist:

Ultimately, everyone has to be able to work efficiently in their situation, that's important. And to do that, they need tools, and whether the tools have to be massively digitalized, always, that's up for debate. Well, sometimes a pencil is just a pencil, and it's good for what it's for. So I don't need a digital thing. We already have one here. [Our CEO M1] has a digital tablet. But I really prefer pen and paper for this case. And for me, in this case, that's enough digitalization at this point.

Some people are accustomed to that way of working and he regards the coercion to utilize digital devices only as counterproductive for the abolition of paper.

One further dimension of ABOLISHING PAPER is the environmental benefit. K1 explicitly mention that ecological sustainability plays an important role in their pursuit of abolishing paper: “So that's why we're going digital and to some extent it's also about environmental issues. So paperless, away from paper.” Moreover, G1 adds that a by eschewing unnecessary flights, the emission of greenhouse gases can be reduced:

And for me, the issue is, yes, away from paper. And the environmental aspect, of course. The issue of sustainability, especially now with the team meetings. I think it's cool that we don't have to get on a plane for every little thing. And, I don't know, Lufthansa Düsseldorf-Munich, these flights are crazy that you can simply reduce such things.

Furthermore, T1 complements the ethical motivations by stating that the grand challenge of humankind, the global warming, can only be solved by accumulating and analyzing enormous amounts of digital data:

I am deeply convinced that the challenge we face as humanity can only be overcome in its entirety by taking this approach. The problems are of a completely different dimension to where we are right now as people. . . . Only if we manage to deal with this large amount of information and then draw intelligent conclusions from it will we succeed in getting this energy issue under control.

In the end, ABOLISHING PAPER is an essential prerequisite not just for *MAXIMIZING WORKPLACE FLEXIBILITY*, but for any other digital initiative. As simple as it sounds, it is nonetheless the foundation for digital transformation. Indeed, it seems to be so self-evident that most theoretical models do not even mention it anymore (Vial, 2019). While this may apply to big corporations and multi-national enterprises, in practice, however, many SMEs still struggle to effectively approach this goal.

As basal as it may be, ABOLISHING PAPER alone does not constitute a complete business rationale for engaging in digital transformation. As Tera's head of HR (T2) describes elegantly: “Shit in, shit out.” She hints at the fact that a poor piece of information on a sheet of paper is equally useless in a digital format. Digital transformation needs more elaboration than just a change in aggregation state in order to surface its value for a SME.

The second aspect of *MAXIMIZING WORKPLACE FLEXIBILITY* is *ATTAINING TEMPORAL AND LOCAL AUTONOMY*. Employees have a desire to be independent from a fixed place and time to work whenever and wherever it deems suitable. This is an important facet of the future of work (Kraus et al., 2023). Remote work has also become mandatory for employer branding to attract the best candidates. Before Covid, remote work was chiefly inexistent among the SMEs of this study. The restrictions during the pandemic forced companies into providing decentralized working practices simply to comply with the strict regulations in Germany and ultimately to keep existing. Even if speculations will always remain disconfirmed, it is likely that without the catalyst of the Covid pandemic, most of the SMEs would still be significantly less temporally and locally independent. In *Peta*, the office worker highly appreciates the possibility to work remotely: “As I said, whether I'm here, working from home or wherever, I always have access to the data. I can work from anywhere. So I definitely find that a relief and definitely an improvement.” Even for a medium-sized firm like *Peta*, internationalization plays a role in retaining and attracting employees, as described by the CEO (P3):

We now have someone who works for us in Mexico. Then someone in Valencia, who moved there at some point, or moved for business reasons. . . . Our [employee] spends a lot of time in Dubai. Then he just works out of Dubai for the month. So everything is possible. We now have various locations. We have another location in [city A], we have just got one in [city B], and in [city C] we have taken over an electrical company. And we now have total networking here. It doesn't matter where the individuals are based, everything works.

Not only is temporary and local autonomy valuable for employees, but also for business leaders. In SMEs where many processes and decision-making are centered around the managers, prolonged recreational absences used to be an exception. For *Kilo*'s CEO (K1), going on vacation for more than just one week was a novum that was rendered possible only through the utilization of digital technologies such as video conferencing and e-mail:

And now, accelerated by Covid, with [Microsoft] Teams and all that, that is a huge advantage for me personally. When I think about it, 20 years ago I could go on vacation for a week. It couldn't have been longer. Now I can go on vacation for three weeks because I can work anywhere and I can

connect. Which is a great thing. And that is only possible through digitalization.

Simultaneously, K1 hints at the potential mischief that permanent availability, even though unintended, might incur:

Then, as I said, dealing with this constant availability. I think that you should start early on, at school, to teach children how to deal with digital media. I had to learn a lot myself and then had to find a different way of doing things. And now it's working quite well. So these are the points, this constant availability and this constant availability of data and so on, that you learn to deal with it. That applies to the company in particular, but also for society in general. I actually see that as the biggest problem, because these depressions and burnouts and all that, in my opinion, digitalization plays a big part in it, because you don't go home at 5 p.m. and then that's it, but have dinner with the family and then: Ah, I'm just going to sit down at the computer for a minute because I have the possibility to do so. And you have to discipline yourself, yes.

Psychological stress caused by the constantly being online might eventually result in depressions or burnouts. He reinforces that learning how to cope with this new way of working is essential for companies. [Mazmanian et al. \(2013, p. 1353\)](#) have termed this the "autonomy paradox" and advise caution especially for knowledge professionals.

Summing up ATTAINING TEMPORAL AND LOCAL AUTONOMY, the detachment from the premises and traditional working hours is a strong factor in achieving workplace flexibility.

Third and last, workplace flexibility involves DEMOCRATIZING KNOWLEDGE AND COLLABORATION. Even if none of the participants has explicitly uttered this motivation, it could be observed in most of the cases. [Rowe and Markus \(2023\)](#) use this term in a slightly different context (i.e. the democratization of computing power). The idea remains the same: Ordinary people get to have a share in digital transformation, with ordinary meaning the ones belonging to lower hierarchical echelons. In *Kilo*, a merited employee could be retained thanks to the possibilities of modern digital tools. His workplace was thus maintained as described by K1:

I mean, of course, thanks to digitalization, it is easier to involve external people in the company. For example, our sales representative [name of the person], came here from Austria and lived and worked here and then

at some point expressed the wish that he wanted to return to Austria. Without the level of digitalization that we had at the time, that would have been impossible, and the employee would have had to leave. But thanks to the digitalization that we have, it was possible for him to be based in Austria and work practically from there.

In *Giga*, the staff meeting that was previously limited to fractions of the workforce due to shortage of space could now be attended by every employee through a video conferencing tool, fostering participation and involvement of the employees: “Recently we had a safety briefing via [Microsoft] Teams, so the field staff can also take part. The staff meeting is now open to everyone. That is another point that has helped us move forward” (G1). In *Exa*, the corporate knowledge is accessible to every employee which is a significant sign of transparency and trust in the workforce. In *Yotta*, collaboration tools play a role in bringing scattered team members together, therefore supporting group dynamics in a positive way:

But during Covid, for example, we introduced a way to have team chat that is still lively. It's optional whether you get involved or not. But every day at 10:00 a.m. you know that this is a Zoom room. Someone is already there, you can chat for a bit, and very often it's about professional topics and really concrete problems and work topics. But often it's just about the weather and weekend plans. (Y1)

All these examples show an honest interest in offering the same opportunities to every employee by sharing knowledge, and therefore power, and present equal chances to be part of the team, no matter their personal circumstances.

All in all, aiming for *MAXIMIZING WORKPLACE FLEXIBILITY* is a goal that all of the SMEs share. Surprisingly, the notion that information must be available in a digital format in order to use it for more complex computational processing was not overtly present. It is, however, a byproduct of workplace flexibility, as it can only be realized with non-physical forms of information. Accordingly, the proposition for the first measure of this construct is formulated as follows:

Proposition 2a: *A digital workplace is characterized by ubiquity and promotes the democratization of knowledge.*

4.2.2. Increasing Process Efficiency

Apart from ABOLISHING PAPER, *INCREASING PROCESS EFFICIENCY* is the aspect that most SMEs associate with digitalization and digital transformation, respectively. Whereas the former is relatively one-dimensional, the latter is a complex endeavor that is constituted by five codes, namely ACCELERATING INTERNAL WORKFLOWS, CONNECTING WITH CUSTOMERS, ENHANCING TRANSPARENCY, HANDLING GROWTH, and RELIEVING THE EMPLOYEES. Each of these codes are described in this chapter to shed light on the most commonly mentioned business rationale.

First, all of the cases observed in this study aim at ACCELERATING INTERNAL WORKFLOWS. Table 25 shows that automation (P1), simplification (M3, G2, Z1, Q2), streamlining (R1), and standardization (R2) play an important role in order to speed up company processes.

Table 25:
Representative Quotes for Accelerating Internal Workflows

Identifier	Quote
M3	So I think that if we continue to digitalize our company, we can simplify many processes and also make them more secure. I think that is our biggest opportunity in this area of the company, that we can simply improve our processes.
G2	And that means that with digitization—and I call that a digitization project—we can use this project to speed up and simplify processes here in-house and, in the best case, make them cheaper.
P1	We would like to automate all manual tasks that can actually be digitized or automated to the extent that employees can focus on what is important, namely the situations that cannot be handled automatically.
R1	I would say that processes are streamlined by using all digital possibilities, i.e. control technology, CPU, perhaps even AI, to automate and streamline processes.
R2	Well, we have standardized a lot since I've been here. We have optimized many processes, especially our ERP system.
Q2	But actually, one thing should help us to rethink certain processes and, in the best case, improve or simplify them, thereby saving a considerable amount of time and effort.

Note. Own elaboration.

Kilo's CEO (K1) adds that all workflows are functional and that the reason for digitalizing them is not because they are dysfunctional, therefore deliberately eschewing the proverbial advice to not fixing what ain't broken:

If you take the incoming invoice process, for example. It works. We pay our incoming invoices on time and as far as I know we don't pay anything twice. At least I assume so! That means the process works. But through digitalization you can make it better, faster, more efficient.

He therefore summarizes what most SMEs experience: They can rely on functional, well-established processes; however, most of them have historical roots and evolved organically, resulting in not-very-lean process landscapes. As part of their digital transformation, SMEs do what they could potentially also do without digital technologies: They reassess their processes to make them more efficient. Most certainly, software tools help to achieve this, but a not insignificant aspect of digital technology is that it can also be seen as a trigger rather than a means for increasing process efficiency.

Second, in order to increase the process efficiency further, SMEs strive for *CONNECTING WITH CUSTOMERS*. This code is closely related to the measure *ENHANCING PORTFOLIO COMPETITIVENESS*. Whereas the latter is centered around the product offering of a firm, the present code touches upon boundary-spanning processes, information exchange and data flows. For example, K2 strives to avoid manual errors by the users. Conventionally, companies exchange documents such as offers or orders as documents, either as paper documents or PDF. These documents are only readable by humans. Digital technologies enable a machine-readable exchange of information that eliminates the hazard of human errors. It furthermore reduces the load of e-mails: "Yes, [the customer] can freely access our data and then [the customer] can see for yourself when the delivery date is. [The customer] does not need to write us an email." (E1). *Giga's* commercial director (G2) is confident that the entire order processing between customers and his company can be digitalized: "So, that gives us the next advantage. And the day after tomorrow we might be able to make this data available in an external online shop or an interface where the entire process runs electronically." In *Yotta*, both the head of sales (Y1) and the CTO (Y3) emphasize the importance of collaborating with customers by stating that "digitalization ... enables us to work more efficiently. To better connect with our customers" (Y1) and that "we work with customers, such as [customer X]. We simply have a lot of interaction with the outside world. I think that's probably where we're most digital" (Y3). Theoretically, the connection to customers could be replicated towards the

suppliers as well. Whereas this is a common functionality for most ERP systems, it was not relevant for the SMEs of this study.

Third, generating data and their aggregate value presents the benefit of ENHANCING TRANSPARENCY. For business leaders, data-based insights assist them in improving their decision-making, as *Kilo*'s key account manager (K3) states when asked about his expectations regarding digital transformation: "Those are my expectations. What we can do is to make better, yes, good quality decisions". In *Peta*, quantifying the business helps the CEO (P3) to better steer the company: "Transparency. Overview. That I can quickly access numbers, data and facts. That I can see what's going on. ... I always have to see and know how, where and what." Furthermore, *Tera*'s CEO (T1) regards their high level of transparency as a distinguishing factor from their competitors:

My assessment is that, compared to our industry, we are in a very good position when it comes to transparency and so on. I think that affects the control side of these instruments that we have, we are in a better position than many others in our industry.

Moreover, transparent data flows and the availability of derived insights contributes to the democratization of knowledge mentioned earlier. *Exa* has established a key performance indicator monitoring system based on data that is generated during the manufacturing process and adjunctive operational and commercial activities. Executives such as E1 use the insights on a daily basis for both quotidian and strategic decisions. "It always used to be a lot of gut feeling. And [our KPI system] now delivers hard facts" (E1). Even if no participant has mentioned it, relying on AI for improving decision-making bears the risk of reinforcing bias ([Lanzolla et al., 2020](#)). Decision-makers must take that into account once the spread of AI reaches SMEs.

Fourth, all of the SMEs of this study have been growing both in terms of revenue and headcount. Actively managing and improving the processes, rather than allowing organic and uncontrolled prevalence, was imperative to HANDLING GROWTH. In *Yotta* it is particularly urgent. Both Y2 and Y3 regard the outdated ERP systems as an inhibitor for further growth: "So it's borderline that we're still using a system like this given the turnover and the number of employees. Ultimately, also because it doesn't provide many things that we simply need these days, in my opinion" (Y2). Similarly, *Quetta* became too big at some point for the ERP system that they used to have: "There was another [ERP system] before

that. We always called it [colloquial name]. And before that there was an even smaller one. We went through a few steps like that. But at some point we always outgrew the system.” (Q1). In *Exa*, not only quantitative growth of revenue or employees became an issue to be tackled, but also qualitative requirements in a new product range:

We're just like, we might have to introduce new systems, because digital introduction was necessary because we said we now have to store quality assurance plans, for example. We didn't have them before. It wasn't needed in the previous area. That means that, of course, with the change to the new product, we also needed new systems and at the same time we had to digitalize again. (E1)

Through digital processes, SMEs can elevate the quality of operations to comply with previously irrelevant standards.

Fifth and last, the employees benefit from *INCREASING PROCESS EFFICIENCY*. Therefore, *RELIEVING THE EMPLOYEES* is an important aspect of this measure in itself. The employees shall focus on tasks that require human intuition, emotion, or negotiating skills instead of wasting time on repetitive routine duties that can be dealt with by a computer. *Yotta's* executive assistant (Y2) emphasizes the impact on the employees:

But ultimately, yes, [digital transformation is] the continuous discussion and the actions that arise from it, how, yes, I would say, digital technologies can be used to make the everyday work of employees easier and more efficient. In particular, with the aim of, yes, I would say, eliminating routine work or avoiding it as much as possible and keeping or reducing friction losses as low as possible, for example in daily communication.

Moreover, disestablishing recurring activities improves the quality of the workplace and therefore augments employee retention, an important goal of *Ronna's* CEO (R3):

And on the other hand, internally, it is more fun at work when the recurring field of activity has to be done by someone and that is digitalization, so that you can focus your energy, your motivation, your ideas on what makes up the value chain for the product. And not the daily doing. Open Excel, save it, open Excel, save it. That is all a useless task. An artificial

intelligence, digitalization can do that. Instead, the ideas that arise in your head have to be the daily doing. And everything else has to be digitized. Driven by the skilled workforce shortage, many SMEs regard process automation and focusing on interesting tasks as a compelling argument for attracting employees. A modern workplace that circumvents repetitive and therefore potentially boring assignments ameliorates the employer brand. In *Kilo*, a robot assists the production personnel:

If you think about the digitalization of production, for example, with the welding robot, you are doing that to make work easier for employees. And also because we are getting fewer and fewer skilled workers these days, of course. Driven by that as well. (K1)

In *Mega*, the CEO (M1) regards efficiency as an outcome of digital initiatives as a desirable factor for employer branding:

So internally, the main focus is to become more efficient. We have a lot to do. The employees are under pressure, and we hope that digitalization will ease the burden. And in the best-case scenario, it even helps us achieve more. This is all in the direction of increasing efficiency. Of course, we also need to become attractive to new employees.

Similarly, *Tera*'s head of automation (T3) is sure that only a digitalized company will be able to attract young, skilled candidates:

And if we are to be seen as an attractive employer in the long term, not just because of the great environment we are in, but also simply because of young people, or who have a completely different way of dealing with cell phones, tablets, computers and so on, or. If we can reach them, or, that means we have, we have managed to bring this awareness to the very highest level in the company over the years.

All in all, increasing process efficiency is at the heart of the digital transformation for the SMEs of this study. For some, it appears to even be a synonym. However, there are more facets to digital transformation. The participants are merely less aware of the further business rationales that underlie their digital initiatives. Accordingly, the proposition for the second measure of this construct is formulated as follows:

Proposition 2b: *Increasing the internal process efficiency depends on standardized and boundary-spanning workflows and enhances transparency, growth trajectories, and employee satisfaction.*

4.2.3. Enhancing Portfolio Competitiveness

Regarding their portfolio, SMEs strive to enhance the competitiveness of their products and services by implementing digital technologies. The reasons for doing so are threefold. They can be driven by the market (INCORPORATING MARKET SHIFTS), provoked by the customer (COMPLYING WITH CUSTOMER REQUIREMENTS), or result from the intrinsic motivation to improve the products and services (INNOVATING INTRINSICALLY).

First, companies do not operate in a vacuum but are surrounded by external stakeholders and conditions. SMEs need to sense developments in their business environment if they want to aim at INCORPORATING MARKET SHIFTS. As summarized in Table 26, relevant actors in the business surroundings include competitors (K2), universities (T3), industry standards (E1), and regulatory policies (Z2).

Table 26:
Representative Quotes for Incorporating Market Shifts

Identifier	Quote
K2	But in the frame area I see it as necessary because the market demands it. And the competition has it just like we do. And if we did not have it, it would certainly make us unattractive.
E1	And so, at the beginning the question was who drove it forward. Well, it was the market. Basically, it was the market that drove us to do it. The new industry gave us the initial impetus to do it at all.
Z2	We have been developing [our digital product] intensively for two and a half years. There will be three modules: A simple module. A module with a standard behind it, so there is a Europe-wide inspection standard that we must implement, that is module two. And we can already fulfill that today. . . And this third module is the sewer route, and we will be working on that for about another two years.

Note. Own elaboration.

In order to maintain their competitiveness, the SMEs have to observe their surroundings closely. Without the direct contact to the market participants and interrelated stakeholders, a SME might miss out opportunities for enhancing their portfolio.

Second, the customers influence the portfolio in a significant way. Their requirements determine the development of products and services. Only by COMPLYING WITH CUSTOMER REQUIREMENTS, SMEs can start or maintain a business relationship with them. SMEs regularly supply bigger corporations (e.g. *Kilo*, *Giga*

and *Exa*) or public authorities (*Zetta*) that have elevated conceptions which they project onto the SMEs' offerings. However, the interview participants do not seem to regard this as obligation or even extortion, but as a chance to deepen and invigorate the ties. *Kilo*'s CEO (K1) even regards it as a unique selling proposition:

So, the first big step was actually this software that we developed for calculating racks and cabinet systems. That was partly part of the marketing, part of the USP. And that was one of the most compelling selling points that we had. Yes, that was a big milestone.

Third and last, the manufacturing SMEs of this study have an intrinsic motivation to enhance the competitiveness of their products and services. During the decades of their existence and INNOVATING INTRINSICALLY, they have relied on product innovation as their foundation to thrive. In that sense, digital technologies have enabled new innovations but nothing fundamentally different to their previous mindset, which often involves a proclivity towards non-technological qualities such as creativity and risk-taking (Castillo-Vergara & García-Pérez-de-Lema, 2021). This is especially visible in *Yotta*, *Ronna* and *Quetta*. In *Yotta*, their products have been smart since the inception of the company. As high-tech laboratory equipment, the optical frequency combs have always incorporated state-of-the-art technology, as described by the head of sales (Y1): "The devices themselves can be controlled remotely. And, but that has always been our goal". In *Ronna*, their IoT products have emerged as a byproduct of internal projects to digitalize the manufacturing and inventory flows within the company. Upon realizing the potential of their innovations, they started to bring them to the market:

So, it was our own initiative. And then relatively early on, the idea arose: there's nothing on the market, so we'll do it ourselves. And then in such a way that we can sell it to other customers and offer it to them. And that was the goal relatively early on. (R3)

And *Quetta*, similar to *Yotta*, considers innovative activities to be part of their corporate identity.

All in all, ENHANCING PORTFOLIO COMPETITIVENESS is an important subset of business rationales to engage in digital activities. Almost all manufacturing SMEs will eventually have digital elements in their products and services. The proliferation of digital technologies will not exempt the portfolio innovation.

Accordingly, the proposition for the third measure of this construct is formulated as follows:

Proposition 2c: *Incumbent manufacturing SMEs engage in digital innovation activities to advance the portfolio competitiveness.*

4.2.4. Sustaining Economic Success

The most ambitious business rationale for digital transformation that a manufacturing SME can pursue is to contribute to sustained economic success. There is, however, not just the market share perspective to maximize the sales figures. Apart from UNVEILING NEW REVENUE OPPORTUNITIES, a SME might also aspire to increase its resilience by DIVERSIFYING THE BUSINESS ACTIVITIES or assuming the role as technological trailblazer by PIONEERING WITHIN THE INDUSTRY. These three codes constitute the last measure of this construct and are described in the following paragraphs.

First, digital transformation can be a vehicle for SMEs to increase sales figures and eventually profits by UNVEILING NEW REVENUE OPPORTUNITIES. *Peta* has opted for a new sales channel, namely e-commerce, to raise the number of units sold: “We sell online, we used to, well, we have, yes, I do not know how much it is now, but I think at least 10% of our sales are purely online” (P3). *Zetta* has complemented their business model with a new value capture mechanism, namely the sale of licenses: “We can already sell these licenses today; we have already made quite a lot of progress and have also made very quick progress” (Z2). *Ronna* has innovated the business model altogether by introducing new products, services and organizational units: “And thanks to the additional products, now the [new product 1] or the [new product 2], the digitalization area or the new technology area is actually growing relatively quickly and strongly.” (R3). And *Quetta* has even founded a spin-off to capitalize on their software product with the aim of scaling its sales. By increasing the sales figures through the economic utilization of digital technologies, the amortization of the implementation is fairly straightforward. Every Euro that is generated as part of new revenue streams directly contributes to financing its initial setup costs. However, digital business models reside outside the comfort zone of manufacturing SMEs and even though the opportunities are manifold and financially promising, few have dared to assume the substantive investments. In

the long run, the technological progress will eventually impact the revenue generation mechanisms of most SMEs in the manufacturing sector.

Second, DIVERSIFYING THE BUSINESS ACTIVITIES contributes to the organizational resilience of a SME, which is an important management imperative in times of ever more frequent economic and technological disruptions (Sabatino, 2016). For sustained economic success, the long-term perspective of how SMEs respond to dramatic changes in their business environment requires strategic flexibility and adaptability (Verreynne et al., 2023). In this context, technological advancements present a particular threat to established business models (Niemimaa et al., 2019). Two SMEs of this study have already diversified their business activities in order to increase their resilience. For *Ronna*, the spillover into non-automotive branches reduces the company's dependence on an industry that is highly competitive on the one hand and faces severe structural discontinuities on the other hand. For *Quetta*, the same applies for the brewery industry: "But that is why this, this open view, that you could build something like that and, and do it, now completely away from this [traditional] business" (Q1). For kicking off the activities in a new industry, the spinoff relies on the stable basis of the established parent company, as described by the CEO (Q3):

From the industry, the brewery industry, where we are known, where we are at home, we can perhaps then go into other industries. . . . Independent of [the parent company], exactly. Using the platform [of the parent company] to start this now. And then becoming independent, that would actually be the goal.

Third and last, SMEs can contribute to their long-term economic success by PIONEERING WITHIN THE INDUSTRY. As there are no more analog vanguards in the digital age, SMEs must make use of digital technologies to achieve a leading role. *Zetta* is on the threshold of releasing software that will make them industry leaders that is accompanied by a novel value capture mechanism, i.e. software licenses. *Ronna* offers smart products that are complemented by a software and corresponding implementation services, reaching far beyond their traditional manufacturing roots. However, they benefit from their established business because their practical approach to software development and deployment, based on their own production process, gives them a competitive edge:

A few competitors, yes. There is a market, yes. It is just that we are somehow at the forefront with as many practical functions as possible,

what you really need on a daily basis. What the customer later on, or the user themselves, what they need. Many software manufacturers are a long way removed from the end user. And [our CEO R3] and, of course, our colleagues in production, they know exactly what the individual needs, what the worker needs on the machine, which functions. And we can then implement this directly in discussions with them and we only must go down the stairs and we're there and see how it is used. So that is why we are very practical. (R2)

Quetta has left the sphere of products and now offers holistic systems with interconnected machines and an automated customers solution. The CEO (Q3) explains how they differentiate from their competitors by deeply incorporating digital technologies in their strategy:

Digitalization is an integral part of our business strategy because without the digital component our systems simply would not represent what they represent on the market today. Because [our company] is not just another company that sells systems, but the entire automation of the systems and the user-friendliness and process-oriented programming also play a major role.

All in all, the overall observation can be summarized that SMEs "with well-established but not very innovative business models pay little attention to the aspect of strategic business development because their day-to-day business is the main priority. This often prevents them from seeing the need to focus on innovation" (Zimmermann, 2024b, p. 2). Accordingly, the proposition for the fourth and final measure of this construct is formulated as follows:

Proposition 2d: *The motivation for long-term economic success through diversification, a pioneering mindset, and growth opportunities trigger digital business model innovation.*

4.2.5. Interim Summary

Many companies have tried to transform digitally and have spent enormous amounts of money along the way. Yet, a significant portion—among them many manufacturing firms—fails (Linde et al., 2021). "A predominant reason for this digital paradox is that investments in digital technologies alone, even though they might lead to technological superiority, do not guarantee success" (Trischler & Li-Ying, 2023). The second construct **ESTABLISHING**

BUSINESS RATIONALES consists of four measures, namely *MAXIMIZING WORKPLACE FLEXIBILITY*, *INCREASING PROCESS EFFICIENCY*, *ENHANCING PORTFOLIO COMPETITIVENESS*, and *SUSTAINING ECONOMIC SUCCESS*. The four aspects are clustered in two areas that differ regarding their focus. The first two measures, *MAXIMIZING WORKPLACE FLEXIBILITY* and *INCREASING PROCESS EFFICIENCY*, deal with internal facets of a SME. In principle, a SME can develop these internal fields without crossing its company boundaries. The outcome is at the most abstract level to reduce costs. Even if a SME does not explicitly express or pursue this objective, working towards these business rationales eventually leads to that positive result. The latter two measures, *ENHANCING PORTFOLIO COMPETITIVENESS* and *SUSTAINING ECONOMIC SUCCESS*, have an external focus. This is not to say that they happen outside the company; rather, they cannot be achieved in isolation from the SME's setting. The competitive environment plays a crucial role, but also technological, societal, and legal circumstances. The ultimate audience for these external business rationales is the customer and in the end, they target at stimulating the growth of the SME.

The first construct **DEPLOYING DIGITAL INITIATIVES** is closely linked to the second construct **ESTABLISHING BUSINESS RATIONALES**. In order not to digitalize for its own sake, each initiative needs thorough grounding in the business activities. Implementing a digital software, tool, system or platform independent from the company's context will dramatically reduce its value for the firm, if not inverting its effect. Each of the four measures of each construct has a complementary counterpart in the other. First, *MAXIMIZING WORKPLACE FLEXIBILITY* entails *DIGITIZING DATA*. Only through digitization is a SME technologically able to make a workplace fully independent of a fixed place or time zone and breaches information and knowledge siloes (i.e. power). Second, *DIGITALIZING PROCESSES* is the accurate consequence of the motivation of *INCREASING PROCESS EFFICIENCY*. Digitalization, however, presupposes digitization; processes can only be digitalized with data in digital format.

The relationships between these two internal pairs are the most commonly observable among SMEs and reducing costs is often seen as their sole purpose, at least explicitly. The explicit mention of reducing costs may take various forms such as decreasing the time for searching for information, increasing speed and simplicity, automation, or standardization. In the end, all of this reduces costs. This notion holds true for digitization and digitalization; however, a company is by

no means digitally transformed if only it digitizes all data and digitalizes all processes.

A SME with an advanced level of digitization and digitalization will more likely and more readily assume the external focus of digital transformation. The business rationale of *ENHANCING PORTFOLIO COMPETITIVENESS* is closely linked to the digital initiative of *EXTENDING PHYSICAL PRODUCTS AND SERVICES* with digital technologies. For manufacturing SMEs whose vision and mission, indeed their very *raison d'être*, are usually centered around tangible items, digital innovation is of crucial importance. Even if not all of the SMEs of this study can be considered experts of *SMART PHYSICAL PRODUCTS* and *DIGITAL SERVITIZATION*, the trend in this direction will certainly not spare any SME of the manufacturing sector in the long term (Jones et al., 2021). Lastly, digital innovation often goes hand in hand with *INNOVATING THE BUSINESS MODEL*. The value creation, delivery, and capture mechanisms of digitally enhanced products and services can be implemented without purposefully altering key elements of the business model (Tera and Yotta); however, digital innovation is predestined to significantly affect—or at least extend—a company's value chain (Zetta, Ronna and Quetta). In the end, digital business model innovation secures the sustained economic success of a SME. The reverse conclusion is that a SME can only achieve sustained economic success by innovating its business model. However, that does not imply that incumbent SMEs need to abandon their autochthonous business altogether, as some authors insinuate; rather, it suggests a shift from products to platforms (Cozzolino et al., 2018). After all, manufacturing is about physical products. Rather, incumbent manufacturing SMEs need to consider extending their established products, services and the related mechanisms for creating, delivering and capturing value from them.

The data has revealed four different sets of business rationales that represent the underlying justification to engage in digital initiatives. They vary regarding their perspective. While *MAXIMIZING WORKPLACE FLEXIBILITY* and *INCREASING PROCESS EFFICIENCY* principally focus on the internal view of the company, *ENHANCING PORTFOLIO COMPETITIVENESS* and *SUSTAINING ECONOMIC SUCCESS* represent the portfolio and business model aspects of a SME that targets external stakeholders such as the customers. However, the four measures are united in their intention to position the incorporation of a digital

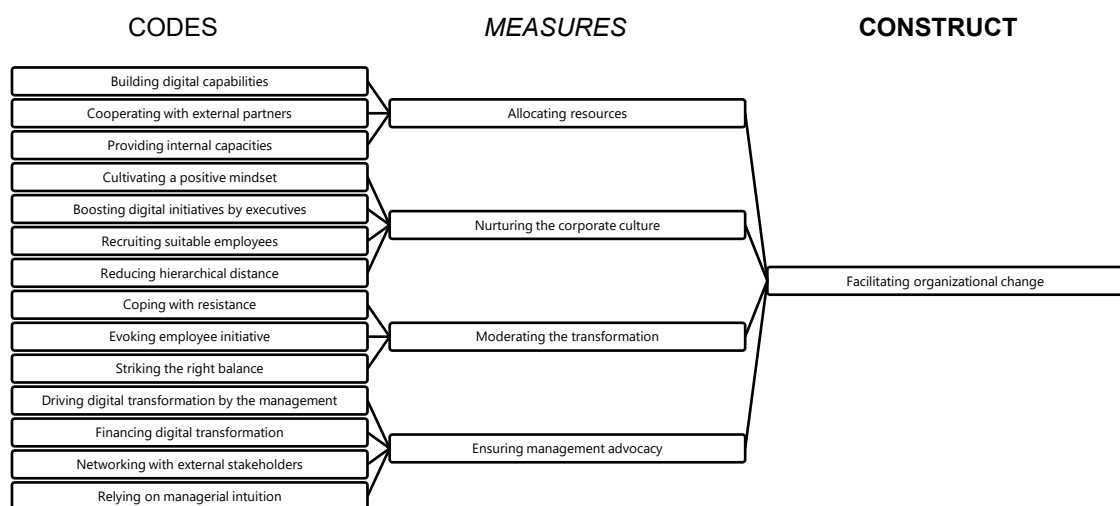
technology within a wider frame. Hence, the second proposition of this thesis is formulated as follows:

Proposition 2: *Incumbent SMEs must base their digital initiatives on business rationales that ensure coherence with the overall company objectives.*

4.3. Facilitating Organizational Change: The Human Nexus

The third construct that has been revealed by the data is **FACILITATING ORGANIZATIONAL CHANGE**. Accordingly, this construct represents the human nexus of holistic digital transformation. Therefore, this construct complements the technological and business perspectives of the previous two constructs by factoring in the humans that represent the most fundamental and valuable asset of a SME. In essence, as *Tera's* CEO (T1) puts it: "People drive digitalization and not digitalization drives people." The data suggests that a SME can actively create favorable conditions that facilitate the change that ineluctably accompany digital transformation. Figure 12 shows the coding scheme for this construct.

Figure 12:
Coding Scheme for Facilitating Organizational Change



Note. Own elaboration.

The construct **FACILITATING ORGANIZATIONAL CHANGE** is defined by four measures, namely *ALLOCATING RESOURCES*, *NURTURING THE CORPORATE CULTURE*, *MODERATING THE TRANSFORMATION*, and *ENSURING MANAGEMENT ADVOCACY*. They are explained in the following sections.

Table 27:

Cross-Case Evidence for Facilitating Organizational Change

Measure	Facilitating organizational change	Identified in cases	Selection of quotes
Allocating resources	Building digital capabilities Providing internal capacities Cooperating with external partners	<i>Mega, Giga, Tera, Peta, Yotta, Ronna, Quetta</i> Partially: <i>Kilo, Exa, Zetta</i>	"We get training paid for if we want it. We can research at any time, we can order literature. None of that is a problem. There is no shortage of such opportunities here. Yes, if there is something to be programmed, someone can be sent to a programming course at short notice. That is no problem at all." (M2) "So my main recommendation would be to give the people responsible for digitization a certain amount of time. Because it is often the case that they do this, do that, digitize that. And then such projects get lost in day-to-day business. The people who are supposed to implement it need time and should also be able to familiarize themselves well. It is my recommendation that they are given the time. And the recommendation is also: do I have the expertise in my company for the projects? So that is extremely critical and should also be checked." (G1) "We have these little aches and pains that everyone has, that we have had for years, that we try to fix and that we actually already know the solution to. But due to the fact that we do not have our own IT, and for me it is only my second priority, it's always a time issue." (K2) "Yes, generally speaking, when we are looking for a solution of some kind, we first try to do it internally, to program it. When at some point we realize that it is either too big or we do not have the expertise, then we want to do it with an external partner and that is where these consultants come into play." (G1)
Nurturing the corporate culture	Cultivating a positive mindset Boosting digital initiatives by executives Recruiting suitable employees Reducing hierarchical distance	<i>Kilo, Mega, Giga, Tera, Peta, Exa, Ronna, Quetta</i> Partially: <i>Zetta, Yotta</i>	"If you see the changes as negative, then maybe it is negative. But I do not see it that way. ... So if you have the will to improve something and learn something new, then everything else will follow." (K3) "We are a small company, we work together very harmoniously, of course there is a little friction now and then, that is normal. But that is what makes it so good. If something does not work or someone asks for something, then we just help at short notice." (M2) "And that is why, for me, the topic of leadership is one of the decisive keys here. And not in a hierarchical sense, but we build, our goal is to build an organism, not a machine. That is a huge difference. And in this organism, leadership does not mean that the best designer becomes the head of design. Rather, leadership has almost a serving character, in which leadership is responsible for ensuring that employees have the framework, everyone has their own framework, to be able to do their job as best as possible. We assume that every employee is the specialist for what they are working on. We cannot say that, I do not know any better. They know that better than the rest of us. But they need a framework for it. And as a manager, I have to anchor that in the framework: How do we deal with new digitization impulses?" (T1)

Table 27 (cont.)

		"It is generally easier for someone to get involved in our structures and to grow within them if they are digitally savvy or simply show the will to do so. So no one assumes that someone who comes will be able to use various programs or create incredible, huge formulas in Excel. But as long as someone shows the will and commitment to learn more, that actually usually brings us more." (K2) "I believe that we have a very flat structure, particularly because—we have become aware of this recently—we are actually very large in the management team, because there are three of us, we can also create a flat structure. So this middle level, which is relatively narrow because a lot is already covered by us. And also because of our company size. And so we have a very, very, very flat structure on an equal footing and a very good connection to the employees in production too." (E3)
Moderating the transformation	Coping with resistance Evoking employee initiative Striking the right balance	<i>Kilo, Mega, Giga, Tera, Peta, Exa, Ronna, Quetta</i> Partially: <i>Zetta, Yotta</i> "So if people simply see the use and the benefit, then they go along with it. So if they realize that I need to do this more, not do that anymore, and can focus more on this and this issue that is always neglected, this is an example, then people are really on board. But of course there are also individual users who say: Okay, why do we have to change that now, it has always worked. And that's how it is at the beginning, when you introduce something, there are teething issues, problems and then: I told you right away that it would not work. So it is a question of attitude, but I think that exists in every company. But at some point you have to try to get people excited about it, or at least get them on board enough so that they say: Okay, that's fine now." (G1) "Talk to the employees, talk to the employees, yes. Like I did before. And ask them what they imagine and involve them too. Maybe I didn't say that in enough detail before, but it's really like this: Whenever a new employee comes, I ask them: How was it at the old company? What did you do there and what have you noticed here that we perhaps don't do like other companies anymore? Or it's really... And in the end, the employees use the digital elements and if they don't use them, then there's no point in introducing them. So, everything that comes from employees is very highly valued. If they come of their own accord and otherwise ask." (M1) "Okay, you have to keep your feet on the ground with certain things. I think the Telekom boss once said: digitize everything, please digitize everything that you can. But there are certain things that you just say should remain with people. So, especially the issue of bots, which are now increasingly coming onto the market, with fewer and fewer personal conversations with suppliers, with customers, with applicants. You have to draw the line somewhere. Digitization, yes, but as I said, with sensitivity. That's what I would call it. So don't digitize blindly. And what's the point in the end anyway? I don't know, the main thing is that it's digitized. So I think we have to find a good middle ground." (G1)
Ensuring management advocacy	Financing digital transformation Networking with external stakeholders Relying on managerial intuition	<i>Kilo, Mega, Giga, Tera, Peta, Exa, Ronna, Quetta</i> Partially: <i>Zetta, Yotta</i> "In my opinion, you invest the time to drive it forward and are prepared to make investments in that direction. Because I think that could be a reason why things aren't moving so quickly for many small and medium-sized companies, because they're busy with their core business every day. And there are 100,000 things every day that are more important right

Table 27 (cont.)

Driving digital transformation by the management	now than maybe dealing with the topic of digitalization. And I think you just have to take the time and make these investments of time and money, even if it hurts." (Q3) "At some point we actually said: Hey, we have a good relationship with all the other competing companies. And then we said: Hey, what kind of system do you use? How do you do it? They tell you a lot. At the entrepreneur and managerial level there are working groups and so on. I think the first thing you should do is ask for information: How do you do it? They tell you. If they don't want to poke your eyes out and get you into trouble, then they'll probably help you a lot." (E1) "That means that the history of digitalization is created by spontaneous ideas, by product ideas that some of us have. As far as I know, there is no roadmap for the whole story, but there are a lot of things, I can tell you now, that nothing has come of it." (R1) "Well, he definitely initiated things during his time to make progress. And you have to say that he had the right instinct. He doesn't deal with many things in detail and then gives others the freedom to take care of the details. And I think we're pulling in the same direction and that's actually been the case since the beginning. And that's why it's a story that I think is now being lived by both generations equally. And I think that's really beneficial. Because I think there's nothing worse than having a generational conflict on a topic like this. And you have to say that he started or initiated it when we were just getting started. We joined in 2015 and in 2016 we actually started discussing the new ERP system. And he was actually always the one who said: We need a new system. Before we even knew which system we were working with. Well, that was, that started back then. And it has been developed and pushed ever since, and you always have the feeling that you are going too slowly. But I think you often don't even notice how much you have already achieved. I think that with this topic, it is one of those topics, you never reach your goal. It just keeps going and there are always areas to be worked on and topics that are still to come. And it is now really, well, I think my father-in-law is taking more and more of a bird's eye view. He already had one before. And now it is always, we are even further away from the actual digitization topics. But he was definitely involved in initiating it and had a good nose for it." (Q3)
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Note. Own elaboration.

4.3.1. Allocating Resources

This study has revealed three core resources that a SME ought to allocate for digital transformation: expertise of the employees and managers (BUILDING DIGITAL CAPABILITIES), sufficient workforce and time (PROVIDING INTERNAL CAPACITIES), and a reliable network of capable service providers (COOPERATING WITH EXTERNAL PARTNERS).

First, adhering to the resource-based view (Barney, 1991; Bharadwaj, 2000), digital capabilities are defined "as the ability of a firm to integrate, build, and reconfigure information technology cum organizational resources and competencies in order to project and respond adequately to the strategic and operational demands of its business environment in a digital age" (Baiyere et al., 2025, p. 8). For individuals, BUILDING DIGITAL CAPABILITIES involves the willingness to continuously learn about the functionality of new technologies to be able to employ them adequately. T2 summarizes elegantly: "A fool with a tool is still a fool." Keeping up to date involves staying curious and SMEs ought to spawn an ongoing inquisitiveness. Training courses regarding technological progress, not matter if internal or external, play an important role. Moreover, the instruction of the users upon the implementation of new tools is quintessential to leverage their usefulness. As emphasized by *Kilo's* CEO (K1), informal capability building is just as important as formal training courses:

With Office, where we switched to Outlook, we also have formal training courses and then the advice: Please use the Internet or something, everything is there. But it is also very informal, where people say: There is the program, try it out, you can't break anything. If it is, then ask and we will support you, yes. So, and you always learn from each other, that one person says: What is that function? Show me! And you learn a lot, also from each other.

Second, PROVIDING INTERNAL CAPACITIES for digital transformation was mentioned throughout the interviews as an indispensable condition. Without sufficient internal resources, digital transformation is slowed down or even hindered. *Quetta's* head of IT (Q1) declares a lack of resources as the most important reason for not advancing more quickly:

Definitely time. Definitely. We simply do not have enough resources to say: Okay, we will put a team together and maybe even do something great!

We simply do not have that. The ideas are there, we have even started. Then something else came up. It is always this thing where one says: yes, we can't split up, we just can't split up. We can only do one thing. . . . Sure, but if we had more workforce, we could deploy initiatives parallelly. Absolutely.

On the one hand, staff is needed to constantly be available for the incorporating digital technologies, conduct training and instructions, support employees, maintain the infrastructure, and proactively develop the understanding of digital transformation. On the other hand, the sparsely available resource time needs to be dedicated to digital endeavors. This applies not only to experts in IT or digitalization departments but to all employees, including owners and managers. *Peta's* CEO (P3) recommends employing dedicated IT specialists: "Yes, if a company of that size allows it, it should definitely have its own IT department in-house". The allocation of temporal resources is one of the most trivial decisions to make for a SME to push their digital transformation. As an alternative to employing formal IT specialists or departments, *Kilo's* head of inside sales (K2) is the IT coordinator even if he has no formal pertinent education. But he was provided the freedom to engage in IT projects by the management and complied with the prerequisite of proactivity and willingness. As a result, even though being a lateral entrant in information technologies, he is now the one of the key players in *Kilo* regarding their digitalization. This observation suggests that IT experts are a valuable but not the only solution for the allocation of resources, thereby also relieving the pain that IT specialists are a rare species that is difficult to be hired by SMEs.

Third and last, even if a SME allocates internal capacities and builds digital capabilities, it will nonetheless reach an invisible yet perceptible barrier in its digital transformation. The resource restraint is usually too severe to be bridged internally. *Yotta's* CTO (Y3) explains their partnership with external specialist firms as follows:

Again, on a case-by-case basis. We cooperate with an [IT company] here that is responsible for IT security. We have a small IT office that helps us with server maintenance. So, on a case-by-case basis. We have two or three consultants who come in when we have any projects.

It is therefore indispensable to build a strong network of stakeholders that embraces external partnerships. Therefore, COOPERATING WITH EXTERNAL

PARTNERS is an essential aspect of all the SMEs in this study. *Peta* and *Quetta* emphasize that trust in the external partners is important:

Three companies made offers. But we felt most comfortable with them. They were the ones who were most attentive to our needs. . . . That was because they looked at what we needed and did not just force something on us; we felt we were in the best hands here. (P3)

We then simply noticed that we were not on the same wavelength at all. We put it down to the fact that they are already bigger and also serve larger companies and we simply do not fit into that pattern. And now we have a system house. They have 50 people, 60 people, they fit. That is something completely different. It is just great, already. (Q1)

Even with the most sophisticated technological expertise, it is still humans collaborating. A trustful relationship is as important with external partners as it is internally to successfully deploy digital initiatives.

All in all, an organization ought to allocate sufficient resources in the form of staff, time, and external partnerships to their digital transformation. Accordingly, the proposition for the first measure of this construct is formulated as follows:

Proposition 3a: *The allocation of resource slack in the form of time, knowledge, and external experts drives digital transformation.*

4.3.2. Nurturing the Corporate Culture

The corporate culture plays an important role in **FACILITATING ORGANIZATIONAL CHANGE**. In fact, the norms and values are a key determinant of success for any profit-oriented entity ([Graham et al., 2022](#)). Business leaders can contribute to the likelihood of successful digital transformation by nurturing the corporate culture that comprises of four elements that will be described in the next section.

First, the SMEs have agreed that **CULTIVATING A POSITIVE MINDSET** towards digital transformation is a crucial enabler. Accordingly, seeing digital transformation as a chance rather than a threat sets a benevolent tone for the organizational change. *Ronna's* CEO (R3) exemplifies this stance:

In the end, everything we have done, even if it did not work or did not work well, has led to what we are today. If we knew beforehand everything we should do differently, we would not be able to come up with some ideas

and would basically just leave valuable ideas, implementations and products lying around.

In other words, "without the right mindset for change, appropriate digital routines, and structural changes, digital transformation efforts will fail" (Volberda et al., 2021, p. 1). The readiness to shed preconceptions and abandon well-trodden, but comfortable paths is equally essential as the openness to travel to new shores. *Giga's* digitalization manager (G1) states that "you have to have a digital mindset, you have to anchor it somewhere in the organization." He therefore regards the establishment of a beneficial mentality as the company's task, as opposed to relying on a pre-established individual existence among the employees.

Second, not all SMEs have middle managers, or executives. In this study, however, they were present in all of the ten cases. These "unsung heroes" (Vuckovic, 2025) are the key actors in BOOSTING DIGITAL INITIATIVES BY EXECUTIVES. The top management team, which in SMEs are often the owners or their family members, lacks the operational range to approach every employee and therefore depends on the executives as the connectors between digital technologies and their effective utilization in daily business operations. *Ronna's* CEO (R3) has established an organizational intermediate layer of executives that allow for more effective development of the company: "That is exactly the [middle] level that we have introduced in the last few months and years. And that gives us the strength to be able to grow accordingly and to permit ourselves time for new ideas and strategies". Indeed, the quality and style of leadership impacts organizational changes of any kind, not just digital transformation. Contrarily, *Kilo's* head of inside sales (K2), who is a middle manager himself, opines that not only executives can be the multipliers of digital initiatives. In his experience, the middle managers not always fulfil the requirements to convincingly stoke the digital fire in their team members: "Because sometimes the interest is not as a team leader, but rather at a higher level, because they want to learn something, or because someone already knows the software from a previous job, for example. . . . So it does not necessarily have to be a team leader or a supervisor or anything else." Yet, K2 recognizes the exigency of someone who assumes the responsibility of multiplying the effect of digital initiatives. For the sake of clarity, this code has deliberately been coded to the measure *NURTURING THE CORPORATE CULTURE* rather than to *ENSURING MANAGEMENT ADVOCACY*. In SMEs, executives usually

have, as the name suggests, more of an executive function and tend not to be involved in the grand trendsetting decisions. This remains a privilege (and liability) of the management, which is often the owners of the owner family. Therefore, the role of an executive and how an organization interprets leadership of middle managers is a cultural matter.

Third, every organization faces the challenge of employee fluctuation to some extent. As discussed earlier, digital transformation can contribute to a reduced internal demand for new employees by increasing productivity and heightening the attractiveness for job applicants by embellishing the employer brand. For staffing vacant positions, SMEs are advised to concentrate on RECRUITING SUITABLE EMPLOYEES. On the one hand, as illustrated by *Tera's* head of HR (T2), preexisting digital expertise can fortify a SME's knowledge base: "The recruiting also regarding people, where we have to see in which positions in the company do we need people who have the appropriate IT affinity and can also deal with digital technology, can handle digitization." Accordingly, the "challenge remains however for SMEs to recruit employees with the requisite skills; this will continue to be a significant barrier towards successful digitalization" (Eller et al., 2020, p. 125). On the other hand, and with reference to *Giga's* digitalization manager (G1), the cultural fit is a determinant for a prolific and long-term cooperation:

Here, too, we look, especially when we hire people, to see whether they fit into the team, whether their character fits, whether they fit our values, whether they are willing to accept our values. This is already taken into account when we hire them, even when we are just starting out as trainees. A lot of attention is paid to this and it is important to the bosses that this is a good fit. And people play a very important role here.

In the literature, Scuotto et al. (2021) highlight that by hiring digitally skilled people, SMEs can elevate their knowledge base to avoid limitedness in future development.

Fourth and lastly, the SMEs commonly regard REDUCING HIERARCHICAL DISTANCE as an impactful contribution to ameliorate the organizational culture and facilitate organizational change. As exemplified by quotes in Table 28, there are a number of benefits such as fast decision-making (K3), short communication channels (P1), and direct connections to the employees (E3). Additionally, E3 adds that a close relation between the management and the employees also

enhances idea generation. Moreover, he mentioned that a narrow middle management layer further contributes to reducing the hierarchical distance between the management and the employees. Although not mentioned explicitly, all quotes are implicitly related to hierarchical distance in the context of digital transformation as this was the interviews' theme. In the end, a minimal hierarchical distance is beneficial to building trust between the management and the employees. Studies in the leadership literature have shown that the trustworthiness of managers is a crucial criterion for cooperation (Long, 2018; Mayer et al., 1995) and is therefore conducive to the organizational change induced by digital transformation. Accordingly, SMEs ought to uphold close interpersonal relations among the management and the employees to facilitate organizational change that is induced by the incorporation of digital technologies. Hence, a low hierarchical distance can be a distinguishing factor compared to more anonymous large enterprises.

Table 28:

Representative Quotes for Reducing Hierarchical Distance

Identifier	Quote
E3	I believe that we have a very flat structure, particularly because - we've become aware of this recently - we're actually very large in management, because there are three of us, we can create a flat structure. The middle level is relatively narrow because we already cover a lot of things. And also because of our company size. And so we have a very, very - I am firmly convinced that we have a very, very flat structure on an equal footing and a very good relationship with the employees in production too. And there is actually a lot of contact. And when there are ideas, they actually come and say so. And we see each other regularly and then people approach us. So we don't have an idea management system or anything like that. We haven't introduced anything like that yet because it isn't necessary. We do get input from the employees when there's a push somewhere or someone has an idea or something like that.
K3	Yes, I think that's a good advantage that <i>Kilo</i> has, is that the communication is not like a pyramid. So it is more horizontal and you can just talk to the managing director or the head of the department in order to, yes, make quick, fast decisions. So that's a bit like... So the decision-making power is not centralized.
P1	This means we have relatively simple communication channels. There are not too many steps in between. We have also decided against setting up staff units or anything like that, and we really want to have a very direct route.

Note. Own elaboration.

Surprisingly, the formal *you* (Sie) was observed in half of the cases, being a strong indicator of hierarchical distance. While formally addressing authorities used to be the standard in previous generations (as in *Giga* and *Zetta*), informal communication has become increasingly common, especially among young people. All the more astounding was the observation in *Mega* where the junior CEOs insist on the formal address. Nevertheless, a trustful relationship between managers and employees with a low level of hierarchical distance can be achieved even with a formal address.

All in all, the prominence of corporate culture for successful digital transformation cannot be stressed enough. Aspects such as effective leadership, optimism, willingness to learn, trust or shared values are of prime importance to nurture a culture that facilitates organizational change. Accordingly, the proposition for the second measure of this construct is formulated as follows:

Proposition 3b: *A positive corporate culture fosters a digital mindset among employees and executives that, in turn, favors organizational change.*

4.3.3. Moderating the Transformation

The third measure for the construct **FACILITATING ORGANIZATIONAL CHANGE** that has been revealed by the data is *MODERATING THE TRANSFORMATION*. The participants agree that any digital initiative ought to be accompanied by moderation efforts on the individual, collective and organizational level. *Tera's* head of automation (T3) emphasizes the crucial importance of an effective moderation:

The exciting thing about the whole thing is of course, and this is exactly the transformation issue, that everything is always good, right, and a system like this is always nice to introduce and you can think about it and implement it in a system landscape and do everything in terms of hardware, right, that's totally great. But if I forget about the transformational aspects, taking people along with me, then I have a really great system, but it just doesn't have any effect.

First, the majority of people is change-averse by their very nature ([Hubbart, 2023](#)). Digital transformation needs to take this basic human trait into account and therefore requires active **COPING WITH RESISTANCE** to embark the employees on the journey. Their rejection of variance in established behaviors is nonetheless not purely obstructive; it can also be seen as an alert system for flawed initiatives

or a corrective for lopsided digital transformation endeavors. One common consideration is the role of age. There was no consensus among the SMEs whether elder people have more difficulties in assuming the digital transformation than younger ones. Some participants opine that it is not age but job tenure that influences the predisposition to embrace change. As *Quetta's* head of HR (Q2) ascertains, "it is difficult to break up this 'we have always done it this way' for sure." More important than age and tenure is the willingness to indulge in new processes and ways of working, which again is a cultural aspect. Moreover, presenting success stories of digital initiatives with positive outcomes significantly contributes to the acceptance of change. They prove that a concept not only works in technological theory but in real life. The employees that are affected by new tools need to see their own benefit. Hinting to the goal of improving the organization as a whole does not yield fruit with those who primarily seek their own convenience. This is not to say that they are egoistic; rather, even in the most collectively oriented organizations, individuals tend to optimize their own area of influence first and foremost. And abolishing unnecessary work or getting rid of repetitive tasks to focus on more precious contributions to the company's success is a powerful argument for managers to convince employees of the benefits of digital transformation. *Giga's* digitalization manager (G1) interprets his position in a way that moderation forms an essential part of it:

For me, digitalization simply saves us unnecessary work. The things that are already obvious, that are standardized, that a person has to do, but that a machine could also do, digitalize them and everything that really, I would say, requires people's sensitivity. . . . So for me, that is digitalization, and it should ultimately help people and not scare them. ... It is my job to get everyone involved in a way that makes them participate and do their part to make it a success.

Furthermore, moderation might sometimes become mediation when there are competing interests within the workforce as is described by *Yotta's* CTO (Y3):

Yes, and then we have different factions. So we have one faction that would prefer to do everything with Microsoft and only trust everything with Exchange Server and, and, and Outlook and the entire Microsoft ecosystem. And then on the other side I have my Linux freaks who basically say: Oh God, Microsoft is the evil. If you roll out Microsoft, I'll quit.

And of course you have to mediate somewhere, I have to mediate somewhere, I'm somewhere in between.

In such situations, the least confrontative solution is to maintain the status quo and give each party their right. However, this thwarts standardization and is a sign of weak leadership. Instead, decision-makers ought to stand by their strategies and not subside too quickly, which will pay dividends for the transformation in the long run. Admittedly, it is always a fine line to walk for managers. Moreover, digital transformation has to be explained well and pick up the employees where they are. Their attitudes, preconceptions and knowledge vary significantly independent of the headcount in a company. *Ronna's* CEO (R3) adds to this perspective that digital initiatives are often associated with an increase in automation, which in turn might reduce the need for human workforce: "And you have to communicate that to people internally. Make it clear, in quotation marks, what is behind it. Also the possibilities, and take away the fear". The notion of job cuts as a result of increasing efficiency might lead to the fear of losing their job, especially for employees at the lower end of sophistication such as office clerks or machine operators. Therefore, it is part of the moderation to find appropriate terminology and formats to communicate the complex phenomenon: "It depends on how you present it to people. And I think you have to address people differently. So you can reach the younger generation quicker and differently than the older generation" (K1). But not only age is a determining factor for target-oriented information, but also job tenure, education, or mindset. The more the managers communicate, the less space there is for potentially false or even harmful speculations. This is true for any organizational development, but for digital transformation which is characterized by a high degree of complexity and widespread nescience in particular. All in all, the decision-makers must prepare for resistance. Even a SME with the most agile mindset, highly skilled workforce and an excellent corporate culture will encounter adversity to change. An essential aspect moderation the digital transformation journey is to be able to cope with resistance and ideally convert the emotionality into positive energy for change.

Second, managers are often too detached from the daily business to be aware of every relevant consideration of digital transformation. What is usually associated with large enterprises is also valid for SMEs. To incorporate the viewpoints of all employees, EVOKING EMPLOYEE INITIATIVE is key. The

consideration of all facets of the respective company can be accomplished by arranging for circumstances that foster the staff involvement. There is no single way of achieving this. The most obvious approach is that CEOs regularly talk to their employees as practiced by M1. The implicit role allocation thereof is, however, that employees play a passive part in the process, whereas the manager is at the steering wheel. A more comprehensive stance is rendered in *Peta* where they try to establish a feedback culture that invites all employees to actively participate in the transformation journey: "We are currently trying to introduce a common culture in the company so that all employees, let's say, are welcome to participate in the improvement process" (P1). This approach implies a level playing field for members of the staff, executives, and CEOs. All SMEs of this study agreed that incentive programs do not conduce a beneficial interaction between the actors of digital transformation, as exemplified by *Tera's* CEO (T1):

That's again connected to the management philosophy, about... running the business through incentives, I'm absolutely against it. Because as soon as you reward something, competition arises, frustration arises, and they should... My expectation is that someone brings in an idea to benefit the bigger picture. And if they don't do that, I can't change it. Then they're somehow not really a good fit for us anyway. If they just do that, if I get something for it. You want it, I'll give it to you. So that's not the culture, not at all, that we want to create.

Such methods spur individualism, if not to say egoism, and simultaneously foil a wholesome culture of collective development. Furthermore, employee initiative will only be achieved and maintained if they are able to perceive concrete results that result from their suggestions. In *Zetta*, it could be observed how employees are demotivated to be engaged by a lack of consideration by the CEO. The management assistant (Z1) describes these situations as follows:

Yes, it's usually like this: when I have an idea, I go to the [CEO, Z2] with the idea and discuss it with him. . . . He usually says he thinks it's good. Let's see. . . . Yes, and then it sits there for a few years.

In the long run, it is doubtful if *Zetta* will continue to generate ideas from staff members. Companies will yield significantly worse results if they push digital transformation over the employees' heads. Not just will they flatline the beneficial effects of digital initiatives but might go astray altogether. Especially for SMEs, their inherent resource constraints necessitate the employees' initiative and

cherish it as a valuable source of both effectiveness and efficiency of digital transformation endeavors.

Third and last, digital transformation moderators ought to aim at STRIKING THE RIGHT BALANCE of the organizational change. The literature has shown that many SMEs are digitally underdeveloped. However, the flip side of the coin is digital auxesis when a company overrates its own transformative capacity. Thus, it is a thin line between altering too many aspects at a time and not doing enough. The most important common denominator among the SMEs of this study is that not everything needs to be digitalized. As K1 puts it, “sometimes you digitize yourself to death in a certain way.” Occasionally, this implies resisting the temptation of digitizing tools or digitalizing processes that work perfectly fine in an analog way. To find and maintain an equilibrium of change and permanence is as difficult as it is necessary. If the employees feel overwhelmed with an abundance of changes, the digital initiatives forfeit their desired purpose. If a SME becomes cragfast in complacency, it might fail to keep up with technological advancements and the development of the competition. In essence, a SME needs to strive for digital ambidexterity, balancing exploitation and exploration activities (Ortiz de Guinea & Raymond, 2020; Raisch & Birkinshaw, 2008). From a financial perspective, a SME needs to allocate sufficient resources to perpetuate the operative activities. The income from the daily business transactions sustains the possibility to engage in improvement endeavors such as digital initiatives. *Mega*’s CEO (M1) professes his own business gnosis since he started working in the family company:

I noticed that digitization is very time-consuming and not everything works at once and you also have to earn money somewhere. And you must never forget: You can do as much administrative work as you want. If you don't sell any projects from the start, ... then I can spend two years working on digitalization, but then I won't have a single customer order.

Digital ambidexterity also means equilibrating efficiency and flexibility (Park et al., 2020). The observed SMEs have predominantly opted for an unconventional approach: They have tried to improve efficiency through the exploration of new technologies. Another key facet of STRIKING THE RIGHT BALANCE is to permanently reside on the middle ground between over-digitalizing and under-digitalizing. Table 29 summarizes the viewpoints from different cases to illustrate the point.

Table 29:***Representative Quotes for Striking the Right Balance***

Identifier	Quote
K2	Digitalize to a healthy extent. I don't think it's any use to me if I have employees who, to put it bluntly, always sit at a typewriter and suddenly have to work on the virtual desk. Because the employees won't make this leap. So it's better to take small steps one after the other than to change everything all at once. Because... The problem with digitalization or a process change is often not that the person changing the process doesn't understand it, but rather that the people who have to work with it can't keep up with learning new things. And that could be demotivating.
M2	Well, you can actually digitize everything by force and thereby make things that, let's say, work well worse. That is entirely possible, that would be the risk.
E1	Some, there will be many here, who would say that we are doing far too much. I don't think that many people are saying that we are doing too little. Rather, many people will say that we are doing far too much. And so the question is, when you say: should they do more? I don't think so. It's more like, we should maybe even slow down a bit in some places. Or try out the existing system completely until everyone is safe with it again, before we add the next one.
Y3	Well, I wouldn't digitize something just for the sake of it being digitized. It has to offer some added value, otherwise I don't need it.

Note. Own elaboration.

All in all, a proactive and wise moderation of the transformative events that are inherently induced by the implementation of digital technologies is one of the four key facets to facilitate organizational change. Accordingly, the proposition for the third measure of this construct is formulated as follows:

Proposition 3c: *Digital transformation requires active moderation to cope with resistance, evoke employee initiative, and constantly equilibrate exploration and exploitation activities.*

4.3.4. Ensuring Management Advocacy

The fourth, final and presumably most significant measure for the construct **FACILITATING ORGANIZATIONAL CHANGE** that surfaced from the data analysis is termed *ENSURING MANAGEMENT ADVOCACY*. The common notion, as wisely encapsulated by Tera's CEO (T1), is that digital transformation "is not delegable" and therefore necessitates the direct support and involvement of the managers, who are usually the owners of a SME. Only the proprietors who are liable for the success or failure of a company can potentially evaluate and integrate all relevant aspects of such complex interrelations. Even if the general strategy and a digital

strategy are not explicitly verbalized, SME managers follow an agenda that represents their vision of the company's future. It is them who must consolidate the variety of determinants of the firm's further development and incorporate digital technologies in the overall business strategy (Park & Mithas, 2020). Moreover, the managers' intrinsic motivation to achieve the best solutions for the SME is inherently superior to any employee because their existence is tied to the company. In that sense, the management's advocacy is not an optional negligibility but a mandatory prerequisite that manifests itself in four embodiments in the data.

First, the management must procure the monetary resources for FINANCING DIGITAL TRANSFORMATION. Any way you look at it, digital initiatives are expensive in the first place. Hardware, software, installation, licenses, maintenance, consulting, or training, just to name a few, are costly undertakings. The implementation of an ERP system is one of the most complex digital endeavors for any company and in the case of a SME, it can easily cost the equivalent of one year's entire net profits, as illustrated by *Peta's* CEO:

So we have now quite consciously decided for an ERP system, for example. We never thought that you could spend so much money on ERP and that we would ever spend so much money on it. But the strategy here is that we want to optimize processes. . . . So we believe that it will pay off in two, three, four, five years. (P3)

Hence, SMEs must be prepared to spend significant amounts of money on digital initiatives. Simultaneously, she mentions another important aspect, namely realistic expectations regarding amortization. For traditional investments such as production equipment, SME managers are used to payoff periods of no more than one or two years. For digital initiatives, however, it is not uncommon to calculate up to ten years. In *Giga*, the mindset is comparable:

Yes, and of course, certain things cost money. What are you prepared to invest? With a sense of proportion, of course. But if you say: OK, we want that, but it can only cost €5,000. And nobody can do magic. So certain things have to be seen as an investment, especially in digitization. And you shouldn't count on an amortization of two years or one year, but simply on 5 to 10 years. (G1)

Furthermore, while the benefits of a new production machine can be measured relatively easily (less input for the same output or more output for the same input),

it is much more difficult to estimate the positive effects of a digital initiative, which further hinders an accurate assessment of the amortization.

A way of reducing the expenses for external services such as programming or consultancy is to allocate more internal resources to deploying digital initiatives as demonstrated by *Ronna*. Comparing the hourly rates, own employees cost significantly less than outsourced service providers:

We are definitely cheaper this way because we are basically our own employees. If I take the hourly rate alone, say an internal programmer costs €70, an external worker who is really good at what he does and can cope with our level (I think you could say that), you are at €120 or €130. Plus someone internally has to supervise him. So are we really cheaper there? We do trials and offers regularly. We are definitely cheaper internally. Because we are flexible and have the confidence in ourselves and just do things. And then of course you burn your fingers somewhere because something doesn't work again, but that is part of the inventive spirit, the person who pushes themselves to the limit knows their limits. Anyone who doesn't push themselves to the limit before that has no idea what is possible. (R3)

However, internalizing the resources increases the fixed costs for the respective employees' wages and many SMEs tend to aim for minimalizing their fixed expenses.

In essence, *Giga's* digitalization manager (G1) has summarized the financial considerations on the point: "Digitalization is not expensive if you digitalize the right things. It's more expensive not to digitalize." Considering the notable financial effort, it becomes even more important to deploy the right initiatives grounded on business rationales and create organizational conditions that elevate the probability of successful outcomes. After all, it is a mindset question if a management wants to seriously embark on the journey. If they really do, they will not be able to circumvent sizeable investments.

Second, managers can amplify their understanding of digital transformation by NETWORKING WITH EXTERNAL STAKEHOLDERS who are in comparable circumstances—indeed, the wheel does not have to be reinvented. In *Mega* and *Peta*, the owners participate in exchange formats for SME leaders:

So what they're both doing, [one of the managing directors] is currently participating in events on the topic of digitization. I think in Bavaria or

somewhere. They're taking part in them and trying to sophisticate their education and of course pass something on to us. (M3)

Well, we always get advice from other entrepreneurs, we go on further training courses. So we're always looking to see what's happening, what's new. (P3)

These events allow for in-depth conversations with peers about the problems and possible solutions. After all, most SMEs face similar obstacles. Moreover, trade fairs or conferences offer the opportunity to enlarge the managers' expertise about digital topics that are relevant for their respective industries. *Zetta's* CEO (Z2) capitalizes on the compact knowledge transfer formats during these events that are usually difficult to obtain in day-to-day business:

Conferences, specialist conferences. These things are discussed there and then you hear: Oh, I heard recently, three months ago, that we are already at 98%. Then you are at a specialist conference. A lot comes out of lectures too. There are 50, 100 participants. Questions are asked, you feel, you get it straight away, that it is not 98%.

Even competitors might be an informative source of inspiration as in *Exa*. Most certainly, there are no other companies that are as comparable to a SME's situation as other firms from the same sector. Generally speaking, networking fosters out-of-the-box thinking of managers. By assuming new and alternative perspectives by peers, managers can look beyond their established paradigm. Moreover, it invigorates their digital awareness ([Garzoni et al., 2020](#)). Constantly remaining in their comfort zone might possibly lead to missing both opportunities and threats triggered by digital technologies. Managers ought to contrast and reflect their noneconomic goals for continuous adaption of organizational moves to the changing business environment ([Kammerlander & Ganter, 2015](#)).

Third, the data has revealed surprising findings regarding the strategic aspects of digital transformation. In the literature, many authors have already pointed towards the notion that digital transformation is "fundamentally not about technology but about strategy" ([Rogers, 2016, p. 239](#)) and that although the phenomenon "is technically all about technology, the more important issue is how companies make their way through this strange new digital world in which they find themselves. Ultimately digital transformation is as much about strategizing as it is about technology" ([Volberda et al., 2021, p. 1](#)). Foundational in this respect was the insight that IT strategy should no longer be treated as a mere entourage

to the business strategy, but be an essential part of it, fusing to digital business strategy, defined as an "*organizational strategy formulated and executed by leveraging digital resources to create differential value*" (Bharadwaj et al., 2013a, p. 472). The confluence of business and IT strategy is not only happening in practice, but also in theory (Drnevlch & Croson, 2013). Other authors rather promote information systems (IS) strategy as a field on its own (Teubner & Stockhinger, 2020) or question the practicability of such a vast digital business strategy (Matt et al., 2015), but there seems to be common agreement that if companies are to succeed in the digital age, they must act strategically. Contrarily, the data of this study has shown the value of RELYING ON MANAGERIAL INTUITION. Except for *Tera*, none of the SMEs has formulated a digital strategy, digital business strategy, or digital transformation strategy. *Ronna's* CEO (R3) has even actively decided against long-term plans because that would counteract their most valuable virtues, which are flexibility and speed in the practical application: "So our strength does not lie in specifying what we need at length. Our strength lies in implementation. I think this saying sums it up quite well: Before someone enunciates 'tree', we are already up there." Some respondents even had difficulties in understanding⁵ the interview questions regarding the strategizing aspects of digital transformation. In general, the familiarity with strategy was underdeveloped. Hence, the question arises how these companies were able to reach as far in their digital transformation as they evidently have. The answer lies in the characteristics of these companies. SMEs are usually significantly less formalized than big corporations. Moreover, only the owners are responsible and accountable for the weal and woe of a SME, removing the imperative of elaborating and communicating a formal strategy. If, as stated above, establishing business rationales means considering the superordinate goals of the company, the company or the managers have to enunciate them in the first place. But this does not necessarily have to happen verbally or in writing but might exist just as thoughts based on experience and thus intuition. Consequently, even if not openly visible or officially stated, a strategy is informally present in most companies in the owners' minds. Literally referring to the mind rather than to a written or oral strategy, *Mega's* head of IT states: "This means

⁵ Offering an alternative view, I as the interviewer was not able to steer the conversation in a way that the participants would be able to comprehend the topic.

that it doesn't make sense to introduce anything without keeping the bigger picture in mind" (M2). The exception was *Tera* where a digital business strategy is present both formally and informally. The firm has elaborated a management framework that explicitly involves digital transformation as one of twelve strategic governing factors, as described by the head of automation (T3):

And from my point of view that was actually the point in time when this strategy component came straight into IT again. Well, we quickly, suddenly, had completely different topics to deal with. We stopped talking about day-to-day IT and what was bad again and who had a problem. Instead, we quickly switched to a mode where we got to the point where we had to do something about it so that we are well positioned for the longer term. What are the next steps, how can we become even more stable, how can we derive greater benefit from it? And that's how it developed, ultimately to the point where we founded [the automation business unit].

The omnipresent consciousness of digitality as a central aspect of strategic management in *Tera* has resulted in a much more sophisticated dealing with digital transformation both within the management team and the staff.

Fourth and last, DRIVING DIGITAL TRANSFORMATION BY THE MANAGEMENT is the bedrock of the organizational change that is instigated by the incorporation of technology. Incumbent manufacturing SMEs tend to be centered around their owners and proprietary families, some of them for decades or even centuries. The influence of the top management is so significant that without their proactivity, the digital transformation will be extenuated, in case it even took off in the first place. *Yotta*, for example, is not generally lagging behind, but still Y2 feels like the company has to combat against the founding CTO's adherence to seasoned technologies:

My personal opinion is that it is because the [CTO] has been building up the company for 20 years. And that he often thinks that it worked that way and that certain things are not needed because it has worked in a similar way for the last ten years and that such technologies have never been needed. (Y2)

Seven out of the ten cases are family firms. Based on the literature ([Soluk & Kammerlander, 2021](#)), the generational setup in family firms significantly affects their digital pathway. Among the observed companies, in just one case did the

predecessor generation hinder the digital transformation. In *Exa*, only when the succeeding generation took over in 2015, the aversity towards computers and other digital devices ceded. The deputy head of project management has experienced the transition first-hand and recalls the process as follows:

Exactly, because of the change in there and... the senior standard was still so afraid of viruses, afraid of... only turning on the PC twice a day. One for everyone, and then not connecting it to the network. Or rather, we didn't have any, no server or anything like that. And when you see that you worked on a PC somewhere and everyone looked at it a little bit during the day. Until most people, yes, sent more emails, that was... Then it is as it is now, it is enormous. So that means that we have developed massively, because it was simply, but it was accompanied by the change in the generation. Everyone says: What are you doing? At the time we also said: Okay, if the seniors want it that way, then we'll just do it. But that was actually the change, the digitalized change only came with the generation change. (E1)

Contrarily, *Giga* benefits from a commercial director who is actively involved in the transformation. Leading the company in third generation, his personal affinity for information technologies drives his ambition to digitally develop the company. The appointment of a digitalization manager who directly reports to the management is quite uncommon for SMEs and underscores the priority the management gives to the topic. The digitalization manager (G1) owes his position to the commercial director and recognizes the positive benefits on *Giga*'s digital transformation:

And the bosses, you have to say, are very much behind it. They don't block things, on the contrary. They push things forward. You can see that now with the new department that has been founded. A lot is happening there and our boss has also been involved in IT departments in previous companies. So he already has an affinity for it and has already done a lot and gained experience. And I think one of his biggest projects was the introduction of the ERP system. I would say he is also very enthusiastic about IT. So he is fully behind it. So he is not someone who says: Okay, we have to be careful... Of course, everything in moderation. Security comes first. But the boss naturally wants to move his company forward.

That's why he is very involved in digitization and is always very interested in the topics.

In *Mega* and *Quetta*, the patriarchs were even promotive of digital transformation. The reason why they did not expedite the development was not a lack of willingness, but of knowledge. *Mega*'s head of IT (M2) remembers how his previous employer, also a manufacturing SME, struggled to manage the generational transition and now appreciates how the owners have handled the handover:

It's the right path. Definitely. A lot has happened in the last two years since I started here. I saw things that were important to me, including the handover of management from the old generation to the new. That happened step by step, so to speak, and I actually feel good. That's not something to be taken for granted. I've also experienced things that didn't work out in other ways.

Summing up the generational aspects within the SME management, the age of the owners alone cannot explain differences in the intensity that digital transformation is driven. Similarly, the years active do not seem to influence the digital transformation journey in a significant way. A factor that does, however, have an impact on digital development of a SME is the number of top managers. Table 30 summarizes the top management characteristics of the ten cases. As has been described above, incumbent SMEs are often centered around the owning managers who play an active role in the daily business and thus, they tend to be the bottleneck for non-operational activities. More top managers

Table 30:

Top Management Characteristics

Case	Number of top managers	Years active of the current leaders	Top management mindset
<i>Kilo</i>	3	30	Supportive
<i>Mega</i>	2	7	Proactive
<i>Giga</i>	2	32	Proactive
<i>Tera</i>	5	31/1	Proactive
<i>Peta</i>	2	13	Supportive
<i>Exa</i>	3	8	Supportive
<i>Zetta</i>	1	14	Conservative
<i>Yotta</i>	2	22	Supportive
<i>Ronna</i>	2	3	Pioneering
<i>Quetta</i>	6	8	Proactive

Note. Own elaboration.

appear to increase the chances of digital initiatives because the business responsibilities can be dispensed among several people. Thus, a relevant determinant is the capacity the management is capable of dedicating to the digital transformation.

To ensure management advocacy, SME owners must exert their influence and act as a role model by actively driving the digital transformation. In the end, it is a question of their mindset. Skills can be acquired; capacities can be allocated. SME owners need to become leaders of digital transformation rather than managers of digital transformation in order to positively sway the organizational change (Alvesson & Spicer, 2012). The employees need to perceive an earnest willingness to innovate not only technology, but thoughts, emotions, and the underlying assumptions about how the SME does business. Given this need for a change of the employees' mindsets, SME owners need to be the first ones to adopt a new way of thinking. Accordingly, the proposition for the fourth and final measure of this construct is formulated as follows:

Proposition 3d: *The top management's dedication to be actively involved in the organizational change crucially affects its success and depends on their willingness to provide the financial means, network with peers, and include digital transformation in their vision for the company.*

4.3.5. Interim Summary

The salable and established terms such as *digitization*, *digitalization*, *digital innovation*, and *digital business model innovation* (and many others from the digital realm) carry the scent of technology, algorithms, and machines—by and large the scent of artificiality. But while computers follow mathematical, physical, and statistical rules, humans do not. Many digital initiatives do not redeem the often significant financial and non-financial investments of their companies because they factor out the vital influence of humans and the organization itself. And here lies the crucial distinction between the technology-oriented terms such as *digitization* and the change-oriented conception of *digital transformation*. In effect, for "a firm to transform itself for today's digital world, embracing new technologies is necessary but not sufficient on its own. Simply selecting and implementing the right digital technologies (the so-called 'technology fallacy') is unlikely to lead to success" (Volberda et al., 2021, p. 4). For digital initiatives in incumbent manufacturing SMEs to materialize, they must

consider the not always logical reasoning and mostly not *homo oeconomicus* behavior of their employees and management alike. Hence, **FACILITATING ORGANIZATIONAL CHANGE** becomes the catalyst for successful digital transformation. For there is not (yet) a way of running a company purely by robots and artificial intelligence, the third and last proposition of this thesis is formulated as follows:

Proposition 3: *Incumbent SMEs must facilitate organizational change to create beneficial conditions for digital transformation.*

5. Discussion

I started this thesis upon observing that many incumbent manufacturing SMEs struggle with their digital transformation. Prior work predominantly focuses on large enterprises (Chan et al., 2019). High-quality academic studies on SMEs are scarce and mostly concentrate on certain aspects of digital transformation such as performance implications, Industry 4.0, or business models. This research was targeted at practitioners to help them succeed in the digital transformation of their SMEs. By studying ten cases with common antecedents, I abductively developed a practical theory for the digital transformation of incumbent manufacturing SMEs as holistic organizational change: The *triple nexus*. Its core features are three interrelated constructs that, if combined and executed properly, will render the digital transformation of a manufacturing SME a desirable, achievable and beneficial endeavor.

Table 31 presents the propositions of the emergent theory. In sum, the propositions represent the core features that distinguish a successful digital transformation in incumbent manufacturing SMEs.

The contributions of an academic study should be useful and original (Corley & Gioia, 2011). With this study, I contribute to both dimensions in a meaningful way. The originality is assured by the revelatory nature of the theory—there was no holistic theory for the digital transformation of manufacturing SMEs prior to this thesis. Regarding its utility, this theory is both scientifically and practically useful. Even though this research originated from a real-world managerial challenge and this thesis is part of a practice-oriented doctoral program, it is not only targeted towards practitioners. Any academic ought to strive for adding to the scientific body of knowledge (N. Scott, 2025). The new theory was firmly embedded in academic literature and conducted with conceptual and empirical rigor. By explicitly elaborating the theoretical elements (*whats, hows, whys, and when-where-whos*), it covers all building blocks that constitute a theory (Whetten, 1989). The level of abstraction is relatively high but does not confine accessibility, which means that the insights are applicable for practical problem-solving as well as contributions to the academic discourse. The remainder of this chapter consists of six sections: Three for the contributions to theory, one for the practical contributions, one for policy implications, and one for methods contributions.

Table 31:*Summary of the Propositions*

Number	Proposition
1	Incumbent SMEs must deploy digital initiatives to advance their digital transformation. 1a) The transfer of information and collaboration from the analog to the virtual realm is the technological foundation of digital transformation. 1b) Interoperative enterprise software and smart manufacturing enable data-driven business intelligence insights. 1c) Incumbent manufacturing SMEs extend their existing physical products with smart functions and foster digital servitization activities. 1d) The innovation of value creation, delivery and capture mechanisms involves offering software products and is facilitated by the establishment of dedicated organizational units.
2	Incumbent SMEs must base their digital initiatives on business rationales that ensure coherence with the overall company objectives. 2a) A digital workplace is characterized by ubiquity and promotes the democratization of knowledge. 2b) Increasing the internal process efficiency depends on standardized and boundary-spanning workflows and enhances transparency, growth trajectories, and employee satisfaction. 2c) Incumbent manufacturing SMEs engage in digital innovation activities to advance the portfolio competitiveness. 2d) The motivation for long-term economic success through diversification, a pioneering mindset, and growth opportunities trigger digital business model innovation.
3	Incumbent SMEs must facilitate organizational change to create beneficial conditions for digital transformation. 3a) The allocation of resource slack in the form of time, knowledge, and external experts drives digital transformation. 3b) A positive corporate culture fosters a digital mindset among employees and executives that, in turn, favors organizational change. 3c) Digital transformation requires active moderation to cope with resistance, evoke employee initiative, and constantly equilibrate exploration and exploitation activities. 3d) The top management's dedication to be actively involved in the organizational change crucially affects its success and depends on their willingness to provide the financial means, network with peers, and include digital transformation in their vision for the company.

Note. Own elaboration.

5.1. The Triple Nexus: A New Theoretical Model for SME Management

My primary contribution is the first holistic theory of SME digital transformation to date: The triple nexus. Accordingly, this contribution answers the research question that had been formulated as follows:

How can incumbent manufacturing SMEs successfully shape the organizational change that is induced by the incorporation of digital technologies?

As has been demonstrated, the digital transformation, both generally and specifically relating to incumbent manufacturing SMEs, is surrounded by an aura of inconsistency and ambiguity. Past research predominantly focuses on certain aspects of digital transformation while omitting the big picture. Therefore, I fill the gap that I determined in the systematic literature review ([Sandberg & Alvesson, 2011](#)). Accordingly, the literature on SME management is enhanced regarding a topic of utmost relevance. The theory clarifies how incumbent manufacturing SMEs can successfully shape the organizational change that is induced by the incorporation of digital technologies. For academics, the theory serves as a point of departure for further research. The propositions and the measures of the constructs are devised as a researchable framework. To the best of my knowledge, this is the first empirical study that consolidates the heterogeneous and sometimes even controversial aspects of incumbent manufacturing SMEs' digital transformation and provides a holistic theory of how they can successfully shape it. This contribution condenses the quintessence of the three constructs and their relationships among them while simultaneously placing them firmly within the extant literature.

First, the technological nexus of digital transformation is what the phenomenon is most commonly associated with: **DEPLOYING DIGITAL INITIATIVES**. The research question presupposes that digital transformation involves the incorporation of digital technologies, and this nexus represents this notion. Previous literature predominantly describes digital transformation as a staged process with phases that differ in complexity. Moreover, they explicitly or implicitly contain a fixed chronological order. The data confirms that manufacturing SMEs' digital transformation occurs in phases. Contrary to the literature, however, the digital transformation of manufacturing SMEs does not necessarily have to start with digitization or digitalization; it can start with digital innovation which can then lead to digital business model innovation. Highly-cited digital transformation papers such as [Eller et al. \(2020\)](#), [Soluk and Kammerlander \(2021\)](#) or [Verhoef et](#)

al. (2021) assume that digital transformation occurs in phases that build on each other. The results of this study, however, suggest that a SME can start its digital transformation even without a paperless office and fully automated processes. This falsification of prior work is most notably visible in *Zetta* where they have extended physical products and services and also innovated their business model with almost no data digitization and process digitalization in place. This view challenges the widespread assumption of sequential steps and posits a perspective that allows for more than one point of departure for digital transformation. That said, the most common chronological trajectory remains—in this specific order—digitizing information, digitalizing processes, extending physical products and services, and digitally innovating the business model.

So what is then, one may ask, the difference between these four digital initiatives on the one hand and digital transformation on the other hand? Or are they just synonyms with different viewing angles? Because digital technology is the activator for new ways of working, organizing, or gaining money, digital transformation is often reduced to its technological component (Volberda et al., 2021). Manufacturing firms in particular tend to regard the implementation of digital technologies as a quasi-mechanical endeavor, meaning the erroneous assumption that incorporating software and devices will definitively lead to the desired result.

In information systems research (Vial, 2019), but also in other fields such as marketing (Verhoef et al., 2021), digital transformation is reduced to a business model perspective. However, there is much more to the phenomenon than changes in the value creation, delivery, and capture paths. This view underestimates the impact that the implementation of digitization or digitalization initiatives have on a SME. The abolishment of paper or the implementation of a ERP system may in itself lead to transformative reactions of an organization. Accordingly, the digital initiatives of the technological nexus are all different aspects of digital transformation, rather than conceptually separate entities.

Nevertheless, the four digital initiatives that I have defined in the theory do differ in their severity. In particular, the transition from digital initiatives with a primarily internal focus to digital initiatives that are directed externally involves a paradigm shift in a SME. This transition might well be more drastic than leaving the analog realm in the first place. Piccoli et al. (2024) compare the IT-enabled organization with the digital organization and find crucial differences not only for

the technologies involved, but also for the associated mindset in a company. In this study, I could only detect this discerning transition in one case (*Ronna*). The SMEs that have not yet passed the threshold from internal to external are not alone as this is a common observation for small compared to medium and large companies (Balakrishnan & Das, 2020). While the theoretical observation by Piccoli et al. (2024) allows a crucial academic insight that might apply for big companies, the data suggest that it is not relevant for the digital transformation of SMEs. Moreover, as time advances, there will be new trends and technologies. Nevertheless, I expect this theory to be stable regarding new technologies because the technological nexus, the digital initiatives that a company deploys, are expandable by new developments without altering the constructs and their relationships.

The commercial nexus of digital transformation represents the second construct of the theory, namely **ESTABLISHING BUSINESS RATIONALES**. The research question involves the notion of success without further defining what is meant by that. Most studies associate success with financial or economic performance (Etienne Fabian et al., 2024; Neirotti & Raguseo, 2017). My theory assumes a less output-related perspective apart from key performance indicators such as revenue growth or profits. Digital transformation success can therefore also mean non-monetary achievements. I have found that a significant factor for the success of digital initiatives is their placement on a foundation to serve a business purpose. Whereas the internal perspective focuses on flexibility and efficiency, which eventually reduce costs, the external perspective addresses the competitiveness and financial success, representing a growth stimulus.

I reckon that the internal perspective of digitizing data and digitalizing processes will sooner or later disappear from theoretical and practical models on the digital transformation of SMEs. Not that they are irrelevant—on the contrary, they are the bedrock of long-term success (Meier et al., 2025). However, they will become obsolete because all companies will have passed these stages within a few decades. As of now, they are still decisive for most SMEs, but with a clear decreasing tendency. The practical realization of digitality among SMEs lags behind academia and big company practice. For the long-term economic success of SMEs, the external perspective will be more relevant than the internal (Neirotti & Raguseo, 2017). My theory mirrors this insight. If an incumbent manufacturing

SME is to thrive in the long run, they will not be able to circumvent digital innovation and digital business model innovation.

Lastly, the human nexus of digital transformation is represented by the third construct that has been revealed by the data, namely **FACILITATING ORGANIZATIONAL CHANGE**. The research question asked how this organizational change that is induced by the incorporation of digital technologies can be shaped successfully. This construct answers his how-question by deconstructing how organizational change ought to be shaped in incumbent manufacturing SMEs. It consists of four measures that have no inherent order or hierarchy; rather, they need to be given equally high priority. This thesis posits a perspective of holistic organizational change on digital transformation. Hence, this construct is what sets the findings apart from other theories. This is not to say that the content is entirely novel. On the contrary, individual elements have been studied extensively. However, my framework is the first that specifically assumes a holistic view of how digital transformation of incumbent manufacturing SMEs can be successfully designed as organizational change. I have distilled five recurring themes regarding the transformational facets of digital transformation from the extant literature. The following paragraphs relate my theory to these notions from the literature.

First, dynamic capabilities are a common lens through which digital transformation is viewed ([Matarazzo et al., 2021](#); [Soluk & Kammerlander, 2021](#)). I follow the definition by [Teece \(2018\)](#) that "dynamic capabilities, which are underpinned by organizational routines and managerial skills, are the firm's ability to integrate, build, and reconfigure internal competences to address, or in some cases to bring about, changes in the business environment" ([Teece, 2018, p. 40](#)). Dynamics capabilities are especially important in responding to digital disruptions ([Karimi & Walter, 2015](#)). In high-velocity markets or rapid technological advancements, they help companies to rectify their product development or strategic decision-making ([Eisenhardt & Martin, 2000](#)). The further a company develops its digital initiatives (digitization, digitalization, digital innovation, and digital business model innovation), the more do dynamic capabilities replace conventional operational capabilities ([Soluk & Kammerlander, 2021](#)). Therefore, I had also anticipated to find dynamic capabilities high on the priority list of digital transformation by incumbent manufacturing SMEs. However, this was not confirmed by the case evidence. As a possible explanation, due to the relative

immaculacy of the case companies regarding the external perspective of digital transformation, they have not yet seen the necessity to develop dynamic capabilities which are, by definition, triggered by external circumstances. Alternatively, SMEs are more dynamic and flexible in comparison to big corporations which sheds a different light on their capabilities—they might be dynamic by design. My findings are therefore in line with [Hanelt et al. \(2021\)](#) who assume that the importance of dynamic capabilities in their conventional sense will vanish because firms steadily adopt digital operational capabilities. Moreover, my findings have shown that SMEs need to develop individual digital capabilities. The individual knowledge to apply digital technologies in a business context has become a success factor for SMEs ([Scuotto et al., 2021](#)). Accordingly, "SME managers need to support and train employees to obtain the necessary digitalization skills" ([Eller et al., 2020, p. 125](#)). Finally, the notion of improvisation has reoccurred among the SMEs. In these companies, flexibility is more highly valued than in big companies that need reliable rules to warrant functionality. Especially in turbulent environments (which digital technologies spur ever more often), improvisational capabilities are an important asset for a company ([Pavlou & El Sawy, 2010](#)). Rather than trying to adopt the capabilities of corporations, SMEs ought to value their idiosyncratic qualities.

Second, the organizational design and structure are influenced by digital technologies ([Kretschmer & Khashabi, 2020](#)). In the wake of digital transformation, companies tend to move towards malleable organizational designs ([Hanelt et al., 2021](#)). This kind of configuration of the formal organizational arrangements allows for easy changes with the goal of aligning swiftly to environmental opportunities and threats that are brought about by digital technologies. It requires capabilities for organizational flexibility to achieve this ([D. K. Nguyen et al., 2023](#)). Similarly, to dynamic capabilities, the literature is informed by a predominant view on big companies. They are more inert by default compared to SMEs due their sheer size. Therefore, the structural convertibility of SMEs is an asset that is of high value for implementing new technologies. Digital initiatives in SMEs do not need to set a behemoth into motion, but a comparably manageable number of people. However, none of the case companies explicitly aimed for less rigid organizational designs. In summary, malleable organizational designs are important for digital transformation, but SMEs do not need to introduce them as they possess them inherently.

Third, strategy appears to be a crucial factor for digital transformation (Bharadwaj et al., 2013b; Mithas et al., 2013). The literature differentiates between information technology strategy (Teubner & Stockhinger, 2020), digital business strategy (Bharadwaj et al., 2013a), digital transformation strategy (Chanias et al., 2019), and digital strategy (Adner et al., 2019). While they all apply a different lens on corporate strategy in the digital age, they have one common denominator: The groundbreaking implications of digital technologies on the business shall be planned well in advance. For the purpose of SMEs, this is the relevant aspect of strategy. The exact conceptual specification is insignificant because SMEs tend to be less formalized in general, but regarding strategy in particular. Following the distinction from the literature, the interview guideline that was specifically based on Hanelt et al. (2021) included one question regarding digital business strategy and digital transformation strategy each. The difficulty that many interviewees had with replying confirms the relative irrelevance for SMEs. Most surprisingly, even digitally mature SMEs seem to rely on managerial intuition rather than formal strategies. And if there are strategic considerations at all, they are usually not written down, but in the owners' heads, and subsumed under an overall business plan. Nevertheless, strategic digital contemplations have the potential to raise a SME's on a higher level, given the omnipresence and heft of the phenomenon (Menz et al., 2021). In sum, "developing a digital strategy ... provides a common understanding of digital transformation as a profound business change that goes beyond mere technology introduction" (Meier et al., 2025, pp. 9–10). The benefit for a SME of overcoming a short-term strategic mindset is not just a more professional and prescient business vision, but also a common vocabulary for undergoing the transformation.

Fourth, leadership plays an important role (Avolio et al., 2014; Cortellazzo et al., 2019). For SMEs, leadership takes two different shapes. On the one hand, middle managers (or executives) multiply or hinder the effectiveness of digital initiatives. The perceived leader competency in implementing change and trust in the leaders are two important factors for the success of digital initiatives that directly address the SME management (Stouten et al., 2018). On the other hand, the business owners represent the top management team that is responsible for the overall leadership of the company. The top management is arguably the most forceful driver for digital transformation. Larger organizations increasingly employ

dedicated managers, often as CDOs (Fitzgerald et al., 2014), to impel and coordinate the digital transformation (Firk et al., 2021). The installment of a CDO is associated with an improvement in firm performance (Singh et al., 2020). Additionally, "this role can also be filled by a firms' key employees who have developed e-skills and possess significant digital knowledge ... and who work not only in the IT department but also in other areas" (Zoppelletto et al., 2023, p. 12). In SMEs, however, this is a lot less common. Among the sample companies, only *Giga* had a dedicated CDO, who was then also in charge of their ecological sustainability. In essence, the enforcement (and therefore the responsibility) for digital initiatives can formally be delegated, but the accountability for digital transformation cannot. In order to do so, managers need to possess the appropriate abilities. A lack of managerial skills hinders the digital transformation (Eller et al., 2020). Furthermore, paternalism can hinder the digital transformation of a family-led SME. Soluk and Kammerlander (2021) have found that powerful patriarchs can be convinced by cash opportunities of digital initiatives. Among the SMEs of this study, a financial incentive to acquiesce to digital initiatives was not observed. In the cases where a senior family member obstructed the digital transformation of the company, the common remedy was his (or her) removal. However, in none of the SMEs was the hindrance of the patriarch the reason for stepping down; rather, in all of the family SMEs, the generational transition followed other motives, mainly age. All in all, "organizations are well-advised not to disregard people orientation when going digital as this leadership behavior buffers the potential downsides of digital transformation-oriented leadership behavior, which is mandatory to stay competitive in the digital era" (Weber et al., 2022, p. 225). Hence, it is the leaders' responsibility to perform the balancing act between technology, business, and people.

Fifth and lastly, the literature regarding the role of corporate culture for digital transformation success is still underdeveloped (Butt et al., 2024). More broadly, the influence of culture on organizational development and change is still mostly neglected in the majority of profit-oriented companies (Cacioppe & Edwards, 2005). All the more surprising, the crucial importance of culture is reflected in my framework as a notable measure for facilitating organizational change. The development of a digital mindset (Westergren et al., 2024) among all employees significantly promotes the transformation of the organization. This mentality also implies the view that change is not the exception but the rule

(Neeley & Leonardi, 2022). The employees' resistance towards digital transformation presents a critical barrier (Soluk & Kammerlander, 2021). This attitude alleviates the handling of resistance that is inherent to organizational change, be it sparked by digital technology or any other trigger. Even more, resistance can be a resource rather than an inhibitor for change (Ford et al., 2008). Resistance can be early indicators of inconsistencies or flaws in the initiatives that are to be implemented (Cable & Bartunek, 2024). It is the change actor's responsibility, in the case the SME management, to render resistance functional. In this context, a software's perceived usefulness is arguably crucial for its acceptance by the users (F. D. Davis, 1989). To demonstrate the usefulness to the user, it is indispensable to show them success stories of its early implementation (Soluk & Kammerlander, 2021). Without concrete and practical examples and, more importantly, direct contact with the software, it will stay a nebulous conundrum. This applies even more for digital initiatives that have a more profound impact on an organization such as digital business models (Soh et al., 2023). Resolving interpersonal tensions is a solid way to detect potential deficiencies in the endeavor. All in all, a corporate culture that welcomes change is at the heart of digital transformation. Apart from general cultural exigences for successful business conduct (Graham et al., 2022), owners, managers and employees have a shared awareness of the inherent ephemerality of digital transformation. Such a corporate culture views contradictions, failures and exploration as a virtue rather than problems. In the end, digital transformation requires a mindset that tolerates ambiguity by design.

All in all, the three perspectives on digital transformation are complementary. The research question of this thesis was formulated as follows: *How can incumbent SMEs successfully shape the organizational change that is induced by the incorporation of digital technologies?* A SME's digital transformation will only be successful if all three elements, the three constructs, are present and executed in a beneficial manner. Each nexus addresses one part of the research question. First, the incorporation of digital technologies is treated by the technological nexus by deploying digital initiatives. Second, the notion of success is based on the commercial nexus that exhorts to establish business rationales. Third, the human nexus accounts for the facilitation of organizational change.

5.2. Permanent Beta: Towards Continuous Organizational Change

The effects of information technology on organizational life have been studied for decades (Markus & Robey, 1988). This thesis posits that digital transformation is primarily a process of *organizational change* and therefore, I contribute to the extant body of knowledge in this research stream. In my emergent theory, I elaborated the construct that represents the human nexus of digital transformation: **FACILITATING ORGANIZATIONAL CHANGE**, which is comprised of the measures *ALLOCATING RESOURCES*, *NURTURING THE CORPORATE CULTURE*, *MODERATING THE TRANSFORMATION*, and *ENSURING MANAGEMENT ADVOCACY*. In the previous section, this construct has been described and how it relates to the extant literature. This section builds on these contributions and develops the implications regarding organizational change further.

First, digital transformation carries the scent of disruption (Christensen et al., 2015) or revolution (French & Shim, 2016). The notion of radicality that is often associated with the phenomenon has spurred the anxiety before its realization. However, the trepidation is unwarranted. SMEs do not need to engage in eradicated changes to transform digitally. Insights from the literature on organizational change suggest that "repeated incremental changes over time can eventually result in transformation" (Markus & Rowe, 2023, p. 331). Hence, the fear of overthrowing a company in its entirety through digital technology shall be jettisoned in favor of a prudent and pragmatic approach. Accordingly, digital transformation alters the nature of organizational change. Previously, change occurred episodically and was characterized by the sequence unfreeze-change-refreeze (Weick & Quinn, 1999). In today's corporate reality, digital transformation "leads to a shift towards continuous change" (Hanelt et al., 2021, p. 1178) that follows a freeze-rebalance-unfreeze logic. For SME leaders, this transition implies a paradigm shift in their perception of developing their company. Temporary phases of consolidation will be less frequent and shorter or dissipate altogether. Overall, all the manufacturing SMEs of this study have adapted that reinvented themselves, which in the end might lead to even better results than disruptive approaches (Furr & Shipilov, 2019). This new mentality of embracing the inevitability of change might come as a challenge for many manufacturing SMEs because in my experience that applies to Germany, they traditionally tend to be rather conservative. Physical products and services have been relatively stable for decades, if not centuries. Through digital technologies, companies will

have to change continuously regarding their portfolio, processes, structure and other core aspects of their business. Borrowing a term from agile software development and digital services ([van Oorschot et al., 2023](#)), companies remain in state of *permanent beta*—the change is never finished. There is no blueprint for this trajectory; however, a new mindset that acknowledges the condition of perpetual *panta rhei* is prerequisite.

Second, the nature of digital transformation has recently received increased attention in the IS literature ([Kaganer et al., 2023](#); [Markus & Rowe, 2023](#); [Piccoli et al., 2024](#); [Rowe & Markus, 2023](#); [Wessel et al., 2021](#)). This discourse broaches the issue of *the end state of digital transformation*. A final stable state is a defining feature of a transformation; without the aspiration for a final form, a change would be an evolution. Accordingly, a digital transformation is a one-time occurrence: A defined old state is left behind and a new steady state is reached. Following [Piccoli et al. \(2024\)](#), the transformation can result in a lasting stable condition of equilibrium or a transitory state to even further metamorphosis. This view is opposed to the findings of this study that suggest a permanent state of continuous organizational change. [Piccoli et al. \(2024\)](#) assume that companies can reach a defined steady state of *being* a digital organization, whereas I suggest that the transformation is all about *becoming* an ever-more digital firm. Furthermore, two significant questions arise. First, will every company eventually *be* a digital organization with a particular digital architecture and specific design principles? The results of this study suggest that all SMEs will have to transform digitally to thrive in the digital age just like all companies have adopted the use of electricity. However, I advance the view that there will be a multitude of intermediate steps towards being a digital organization. Moreover, I doubt that there will be this one definitive state a firm can reach. The technological advancements are too dynamic and their variety too extensive to achieve a stable condition. Second, what happens upon the completion of the transformation process? The authors present an answer to that question and predict a new kind of transformation that is based on a novel type of technology, for example the "quantum transformation" ([Piccoli et al., 2024, p. 13](#)). I recognize the theoretical and intellectual value of this discourse in IS research, but I fail to appreciate its value for the management discipline in general and for investigating SMEs in particular. Rather, the data suggest viewing digital transformation in manufacturing SMEs as an evolving process of becoming.

Hence, evolution is the more appropriate metaphor rather than transformation. During this process, the strengths of the past need to be transferred to the present without abandoning the qualities that distinguished a company for decades or centuries. In all of the case companies, it is an incremental, long-term organizational change rather than a sudden and fundamental reinvention of the firm. The notion of disruption (Christensen et al., 2015) or revolution (French & Shim, 2016) dominates much of the perception of digital transformation. This perception is reinforced by the commonplace experience that new players such as Netflix, Uber or Spotify have reinvented entire industries and simultaneously upending the business models of established companies within just a few years (Rayna & Striukova, 2016). For manufacturing SMEs, however, such radical market-driven distortions are almost entirely irrelevant. Physical products simply cannot be replaced by digital offerings—not now and not in the future.

Third and lastly, this dissertation amends the *multi-dimensional framework of digital transformation* by Hanelt et al. (2021) in terms of applicability for manufacturing SMEs. Surprisingly, even though the research design was tightly aligned with their model and theoretical perspective, neither of their two aggregated thematic patterns of digital transformation could be confirmed for manufacturing SMEs (i.e., towards malleable organizational designs and digital business ecosystems). Regarding the first pattern, I attribute this discrepancy to the idiosyncrasies of SMEs. In comparison to big companies, organizational structures in SMEs are more malleable per se. What is otherwise considered a decisive disadvantage regarding other dimensions such as resource slack (Cenamor et al., 2019) or strategic orientation (Kumar et al., 2012) is an advantage in organizational flexibility. Hence, the "liability of smallness" (Coco et al., 2024, p. 131) turns into an *asset of smallness*. Information technologies inevitably induce change in companies which requires restructuring of these organizations (Orlikowski & Robey, 1991) but SMEs can confidently tackle this challenge. Regarding the second pattern, the relevance of digital business ecosystems in the digital age has been investigated for companies of all sizes (Cennamo et al., 2020) and also specifically for SMEs (Pelletier & Cloutier, 2019). Surprisingly, digital business ecosystems have not played a major role in the case companies of this research. I attribute this to the fact that these SMEs have predominantly focused on the internal perspective thus far. Hence, digital business ecosystems will presumably become more relevant for SMEs as they

move from an internal to an external perspective of digital transformation by innovating their portfolio and business models. Nevertheless, peer networks can be helpful during any stage. SME leaders ought to engage in "external knowledge sourcing strategies to overcome inertia" (Coco et al., 2024, p. 131). All in all, the theoretical model by Hanelt et al. (2021) fitted the research design well as it views digital transformation through the lens of organizational change even though different patterns of organizational change were observed.

Summing up this contribution, incumbent manufacturing SMEs (and presumably many other types of companies of all sizes and industries as well) will move towards a state of continuous organizational change. Digital transformation is a firm's iterative and individual journey of becoming an increasingly digital organization.

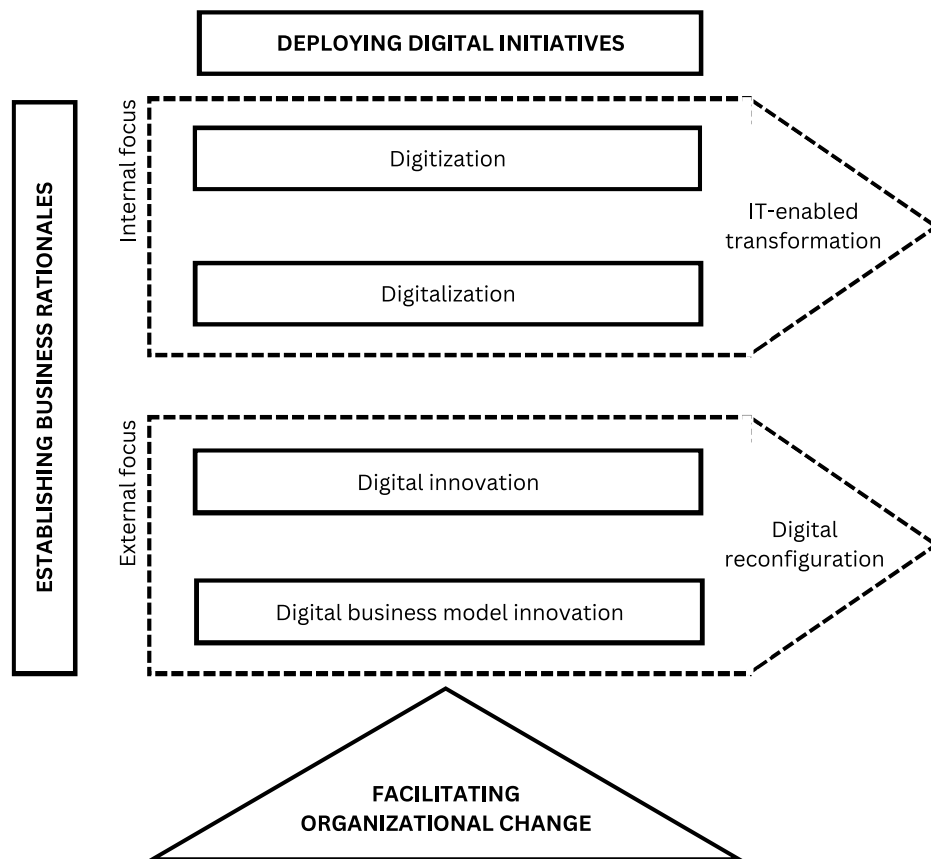
5.3. The Conceptual Concinnity of Digital Transformation

With this study, I also offer an *unambiguous terminology* for the terms surrounding digital transformation. Therefore, I contribute to the disentanglement of the "digital transformation conundrum" (Markus & Rowe, 2023, p. 328) by synergizing the diverging and sometimes contradictory terms in management and information systems research (Carroll et al., 2023). Hence, this contribution integrates the heterogeneous and partly controversial academic literature. Figure 13, which is a modification of my theoretical framework for the purpose of visualizing this contribution, shows the pertinent concepts that, in sum, lead to digital transformation.

First, I offer clarification regarding the *terminological ambiguity of the digital transformation phases* (alternatively steps or stages, depending on the authors). In the literature, there is no universal theory for the sequence or order of digital phases. Soluk and Kammerlander (2021) describe three stages, namely process *digitalization*, product/service *digitalization*, and business model *digitalization*. Verhoef et al. (2021) call their phases *digitization*, *digitalization*, and *digital transformation*. Further related concepts are *digital innovation* (Yoo et al., 2012), *digital servitization* (Kohtamäki et al., 2019; Tian et al., 2022), and *digital business model innovation* (Trischler & Li-Ying, 2023) that all play a role in digital transformation, in one way or another.

Figure 13:

Subsets of Digital Transformation



Note. Own elaboration.

The first measure of **DEPLOYING DIGITAL INITIATIVES** is *DIGITIZING DATA*. [Soluk and Kammerlander \(2021\)](#) subsume digitization activities under a stage they call 'process digitalization', which implies transferring analog information to bits and bytes. Apart from that, their stages are, in terms of conceptual content, consistent with the digital initiatives that are posited in this thesis. A possible explanation is that in German (both authors are German), there is no distinction between digitization and digitalization. Moreover, digitization and digitalization initiatives are often connected to one another, and both focus on the internal perspective of an organization, adding to the notion of merging both concepts. However, the data of this study suggest that keeping digitization and digitalization separate adds to the construct clarity because they are based on different business rationales, namely *MAXIMIZING WORKPLACE FLEXIBILITY* and *INCREASING PROCESS*

EFFICIENCY, respectively. Therefore, *DIGITIZING DATA* and *DIGITALIZING PROCESSES* are two different measures of **DEPLOYING DIGITAL INITIATIVES**.

The pertinent literature, heterogeneous as it may be, suggests that digital transformation occurs in chronological phases. The first phase (digitization) is followed by a second phase (digitalization) that depends on the first one. The findings confirm this notion. Apart from that, however, the results of this study contradict the idea that there are further chronological phases. The "adage of walking before you run" (Eller et al., 2020, p. 120), referring to completing the stages of digitization and digitalization before moving on to higher echelons of digital transformation, could not be observed throughout all cases. Specifically, *Zetta* is significantly underdeveloped regarding digitization and digitalization, the internal dimensions of digital transformation. Yet, they have digitally extended their traditional portfolio and developed their own software, resulting in a nontrivial adaption of their business model, showing a relatively considerable maturity from the external perspective.

Nevertheless, while digitalizing the processes of a company is by no means a mandatory prerequisite for digital innovation and digital business model innovation, it facilitates them. By introducing information technology tools, SMEs can gain digital experience that in turn lowers the threshold for more complex initiatives. "While companies can manage aspects of digitization and digitalization primarily by using information systems, they need to rely on holistic approaches when coping with digital transformation" (Fischer et al., 2020, p. 2). This integral perspective involves more dimensions and requires advanced management capabilities.

As has been mentioned above, the vague demarcation between the two measures *EXTENDING PHYSICAL PRODUCTS AND SERVICES* and *INNOVATING THE BUSINESS MODEL* does not always allow for unambiguous classification of digital initiatives. This is, however, a rather theoretical consideration. In practice, innovating the portfolio fuels the innovation of the business model. A SME that digitally enhances its products or its services will most likely innovate its business model no long after, and the other way around. In a way, they are two sides of the same coin. But in manufacturing SMEs, the products will always come first.

Summing up the clarification regarding the terminological ambiguity of the phases, I suggest digital transformation to be the umbrella term for the overall process. The process consists of four subprocesses, namely digitization,

digitalization, digital innovation, and digital business model innovation. The four phases each involve specific technologies and ought to be grounded in idiosyncratic business rationales. Accordingly, they are conceptually self-contained with clear demarcation of their logical boundaries.

Second, the emergent theory contributes to the ongoing discussion about the *ontology of digital transformation* in information systems research. I add to the current discourse that I mentioned above regarding the nature of digital transformation (Kaganer et al., 2023; Markus & Rowe, 2023; Piccoli et al., 2024; Rowe & Markus, 2023; Wessel et al., 2021). This thesis gives evidence that a distinction between information technologies and digital technologies is not beneficial in the context of SMEs. The fact that this discourse has not yet spilled over into management research substantiates the potential problem of feasibility. Even if the distinction between IT-enabled transformation and digital transformation—based on the presumed ontological dichotomy of information technology and digital technology (Piccoli et al., 2022; Wessel et al., 2021)—is impedimental for the practicability of my theoretical framework, it is nevertheless partly visible. The two measures for **DEPLOYING DIGITAL INITIATIVES** with an internal focus—*DIGITIZING DATA* and *DIGITALIZING PROCESSES*—tend to lead to IT-enabled transformation. However, the two measures with an external focus—*EXTENDING PHYSICAL PRODUCTS AND SERVICES* and *INNOVATING THE BUSINESS MODEL*—do not per se lead to the digital transformation of a company in the sense of this thesis. Furthermore, the pervasiveness of digital technology in the sense of Piccoli et al. (2024) into conventional information technology makes it impossible to separate them. For example, modern ERP systems, which are considered conventional information technology, heavily rely on digital technologies such as artificial intelligence, cloud computing and big data analytics (Saraswat & Choudhari, 2025). Even though Piccoli et al. (2024) assure that "firms engaged in multi-year transformation journeys may intermediately display traits of both" (Piccoli et al., 2024, p. 8), it seemed neither possible nor expedient to separate digital technologies from information technologies and their corresponding transformative consequences. The results of this study suggest that this theoretical distinction based on the kind of technology that stems from IS research is irrelevant for manufacturing SMEs.

Nevertheless, clustering the measures adds value to the discussion because the first two—*DIGITIZING DATA* and *DIGITALIZING PROCESSES*—reduce

costs, whereas the latter two—*EXTENDING PHYSICAL PRODUCTS AND SERVICES* and *INNOVATING THE BUSINESS MODEL*—stimulate growth. Accordingly, each of the two pairs has its own result, which reinforces their bond. However, I advocate against tying the differentiation to technology (information technology vs digital technology). Rather, digital initiatives seem an expedient entity to manifest their affiliation to each cluster. For the two digital initiatives with an internal focus—*DIGITIZING DATA* and *DIGITALIZING PROCESSES*—there is already an established term, which is IT-enabled transformation. As an addition to the discourse, I suggest the term *digital reconfiguration* for referring to the portfolio and business model related changes that are enabled by digital technologies.

Lastly, from a semantic viewpoint, I respectfully disagree with the usage of terms such as *digital transformation projects* (Carroll et al., 2023) for incorporating new systems, devices, software or other technology. Moreover, digital transformation is not something a company can actively *implement* (Fischer et al., 2020) or *purchase* (Paul et al., 2024). What a company can actively implement or spend money on are digital technologies. Such terms insinuate that implementing digital technology will automatically result in a transformation. According to the emergent theory, this is not the case. I suggest using the term *digital initiative* for projects that focus on technology, for example the introduction of a new system. In the sense of this research, if someone were to conduct a *digital transformation project*, they would take a holistic view and focus on strengthening the human nexus to facilitate organizational change and simultaneously establish a business rationale for this project.

Putting this contribution in a nutshell, I suggest a harmonized terminology for digital transformation and the concepts associated with it. This vocabulary bring conceptual concinnity that will benefit the academic discourse.

5.4. Orchestrating Digital Transformation in SME Practice

Management research is only meaningful when it reaches its audience: Managers (Pfeffer & Sutton, 1999). Any study in this academic field ought to ensure that "both the lost in translation and lost before translation problems" (Shapiro et al., 2007, p. 252) do not occur. The term 'translation' is not used in a linguistic sense here but as a cognitive gap between academia to practice. Lost in translation refers to the problem in knowledge transfer when practitioners find relevant academic work difficult to locate and understand (van de Ven & Johnson,

2006), whereas lost before translation addresses the knowledge production issue with management research being regarded as irrelevant or unimportant to its practical audience (Shapiro et al., 2007). This thesis takes both translation problems into account. On the one hand, the theoretical model and these practical implications are formulated in a way that the target audience, SME managers, can comprehend (Bartunek & Rynes, 2010). The high level of parsimony plays an important role in achieving this goal. On the other hand, the fact that the research question originates from a real-life management problem rather than being conceived in an ivory tower ensures its practical relevance (Rynes et al., 2001). The research aim of this study was to build a rigorous theoretical framework that is targeted towards practitioners to help them succeed in the digital transformation of their SMEs in the manufacturing sector. With this contribution, I shall address the need for an actionable theory.

There is no shortage of practical frameworks for digital transformation. However, they predominantly focus on big corporations like the renowned digital transformation roadmap for billion-dollar organizations (Westerman et al., 2011). The results of this study reinforce the extant literature (Neirotti & Raguseo, 2017) that SMEs merit their own conceptualizations for successful digital transformation. Usually, scientific research does not find its way into practice (N. Scott, 2025). Theoretically and academically impeccable theories like the model of technological embeddedness and organizational change by Volkoff et al. (2007) ostensibly illustrate the problem: Some academic work is just too complex and complicated for use in practice. This section consists of four practical implications and demonstrates how SME managers can use the emergent framework as a practical theory that complies with high academic standards and simultaneously accounts for the need of pragmatism and applicability of their everyday business life.

First, SME leaders ought to devise their digital transformation holistically by permanently considering the triple nexus of technology, business, and people. If not, digital initiatives will remain a technological dead end without any real impact on the organization. A SME that facilitates organizational change and conducts digital initiatives without establishing corresponding business rationales will fail to achieve financial benefits. A SME that formulates business rationales for digital transformation and prepares the company for the organizational change but does not conduct digital initiatives will not yield satisfactory returns. And a

SME that conducts digital initiatives and grounds them on business rationales but does not set up the organization to embrace change will struggle to benefit from the investments. Only the skillful combination of the technological, commercial, and human nexus will render digital transformation of incumbent SMEs in the manufacturing sector successful. In other words, the triple nexus of successful digital transformation is the intersection of the three constructs. Accordingly, the answer to the research question in a single sentence is that incumbent manufacturing SMEs must base their digital initiatives on business rationales while facilitating organizational change to successfully shape their digital transformation in a holistic manner. Many incumbent SMEs still struggle to adapt to the digitally changing environment (Zimmermann, 2021). The new theory can help SMEs to digitally transform to use the framework as inspiration. The practical value is high due to a suitable degree of complexity for SME leaders who do not frequently consult academic literature. Managers can therefore better understand the scope and importance of their digital transformation, which in turn helps them to proactively shape the process rather than merely undergo it passively. Unbalanced approaches will deteriorate the quality of the transformation significantly. Presumably, most SME leaders put their business in the first place by default. Accordingly, they are exhorted to get acquainted with the digital technologies that are relevant for the company and prepare the organization for organizational change.

Second, the theory offers *practical guidance for SME managers* by answering the questions of what they should do (deploying digital initiatives), how they should do it (facilitating organizational change) and why they should do it (establishing business rationales). The most common application of the theory will likely be that a SME leader knows which purpose (i.e. business rationale) he pursues but struggles to determine which kind of technology might be helpful and how the digital initiative will be effective. Moreover, the theory places emphasis on the external dimension of digital transformation, which is in many manufacturing SMEs still underdeveloped. Digital initiatives are often only internally oriented, resulting in an incomplete or one-sided effort. Furthermore, SME leader can determine the organizational factors they lack in order to make their digital initiatives more successful. For example, a SME might realize through the theory that digital initiatives have failed because they have neglected the importance of nurturing the corporate culture. Simultaneously, the theory offers

suggestions how to improve on that dimension, for example by reducing the hierarchical distance between leaders and employees. All of the ten cases of this study have transformed digitally to varying degrees. Each of the SMEs is characterized by a standout feature that other firms could learn from. Table 32 summarizes the role model traits for the ten cases as a triple nexus best-of collection. A combination of these ten characteristics would hypothetically create a SME that is perfectly digitally transformed by the standards of this thesis. It is impossible to know if such a manufacturing SME that combines all of these characteristics exists. This list is a thought experiment to encourage SME leaders to engage with digital transformation just like other SMEs have done already.

Table 32:
Standout Features of Each SME

Case	Standout feature
<i>Kilo</i>	Positive corporate culture
<i>Mega</i>	Abolishing paper with a paperless manufacturing department
<i>Giga</i>	Appointment of a digitalization manager (similar to a CDO)
<i>Tera</i>	Organizing structure which strategically includes digital transformation
<i>Peta</i>	Allocation of abundant digital resources
<i>Exa</i>	Smart manufacturing with a high level of data transparency
<i>Zetta</i>	Physical products enhanced by a software
<i>Yotta</i>	Digital independence
<i>Ronna</i>	Highly engaged top management
<i>Quetta</i>	Digital spin-off with a novel business model

Note. Own elaboration.

Third, SME managers ought to establish a *new collective mindset of continuous change* in their companies. The awareness of the perpetuality of change is the foundation to embrace the ever-evolving technological landscape. As has been described above, any organization will remain in a state of permanent beta. Long periods of relative stableness will diminish or cease to exist altogether. In lieu thereof will firms constantly need to adapt to the increasingly volatile and fast-moving environment. On a side note, this does not only apply for the field of technology but also to political, environmental and societal developments. The overall rhythm of doing business has been accelerating and organizational change has become an unescapable facet of entrepreneurial reality. All of the case companies have adopted an embracing posture towards change. The attitude alone does not guarantee a successful digital transformation but sets the stage. Resistance of employees, but also of managers, is almost

certain—it is a deeply human reaction grounded in the evolution of our species. It is also one of the principal reasons for the failure of change processes (Del Pardo Val & Martínez Fuentes, 2003). However, resistance is per se neither good nor bad but it needs to be recognized and treated actively (Coch & French, 1948; Warrick, 2023). Leaders can ease the resistance by "assuring followers that the essence of the organizational identity will remain unchanged" (Venus et al., 2019, p. 667). In sum, SMEs need to interpret change as "ongoing, evolving, and cumulative" (Weick & Quinn, 1999, p. 375). By accepting change and resistance as an elementary part of the new normal of organizational life, they will forfeit their negative connotation and be seen as a source of inspiration (Cable & Bartunek, 2024). For many, this will mean a paradigm shift—but without any doubt a rewarding one.

Fourth and last, business development and digital transformation will be increasingly entangled. Bharadwaj et al. (2013a) have established this view on a strategic level, but SME leaders should prepare for digital permeation of all facets of their company. After all, "digital technology is no longer in the cordoned-off domain of IT; it is being applied to almost every part of a company's value chain" (Furr & Shipilov, 2019, p. 97). Especially in the manufacturing sector, products and services will sooner or later have digital components. The more digitally transformed a SME is, the more competitive it will be. Accordingly, engaging in digital transformation is a matter of survival since neglecting it means denying a global development that is unstoppable. There is no doubt *if* this will happen, but *when*. Essentially, it is a matter of time and business leaders are well advised to act before they are obliged to react.

All in all, the practical contribution of this thesis is significant. The parsimony and comprehensibility of the emergent theory lower the hurdle for SME managers to practically engage with the insights. The theoretical framework can serve as a basis for long-term organizational development as it incorporates crucial aspects of a company's overall success.

5.5. Placing SMEs in the Focus of Policymakers

This research also has policy implications. German policymakers at all political levels—from municipalities to the federal government—should generally strengthen the position of SMEs. Due to limited resources in comparison to big companies, they face increased difficulties in allocating the necessary slack

resources for their digital transformation. Even if the governments on federal and on state level regularly issue SME-specific grants ([Zimmermann, 2024a](#)), they ought to be more easily accessible, offer higher promotions and be generally more promoted to raise awareness of their existence. Among the case companies, funding programs have only played a minor role due to unawareness of such opportunities, confirming the need for a political booster. Moreover, the public information technology infrastructure, especially the fiber-based network ([Statista, 2024a](#)), is substandard in the European context, which must rapidly be resolved. Furthermore, various participants of the study called policymakers in Brussels to enact an European alternative to the market leaders for standard turnkey business applications. Companies on this continent are quasi forced to use US software. This not only raises data protection concerns but also weakens the competitive strength of the European community. The Dutch parliament has also realized this imbalance and has approved countermeasures ([Sterling, 2025, March 19](#)). Other countries—or better the entire European Union—ought to follow this path to end the dependence on foreign software providers.

5.6. Providing Novel Insights Through Reflexive Interpretation

This section consists of two methods contributions. They offer novel perspectives on the phenomenon by combining a multiple-case study research design with an methodology of reflexive interpretation.

My primary methods contribution is a novel approach to investigate digital transformation. To the best of my knowledge, this is the first study that consequently applies a *reflexive interpretation methodology* ([Alvesson & Sköldberg, 2018](#)) to investigate digital transformation. Indeed, the methodological lens that was applied here is one of this study's defining features. Accordingly, this approach has led to several research decisions that markedly governed—and enhanced—this study.

First, the primary data was collected not only from managers or IT specialists but also from *ordinary* employees who, for the most part, are consumers of digital technologies. In fact, as has been elaborated above, digital initiatives become void if they do not fall on fertile ground, i.e. employees who bring them into action. Comparable empirical qualitative studies tend to focus on decision-makers and experts ([Matarazzo et al., 2021](#); [Müller et al., 2018](#); [Soluk & Kammerlander, 2021](#); [Warner & Wäger, 2019](#)). In SMEs, they usually do not

form an active part in designing the transformation but are subject to all its consequences—for better or for worse. This results in an imbalance of power between the designers and the affected people of digital transformation. The involvement of both camps in the interviews addresses issues of representation and restores the authority equilibrium. Consequently, it results in a more critical and democratic theory ([Alvesson & Deetz, 2000](#)).

Second, the Eisenhardt Method has been applied in a strictly interpretive fashion. The Method involves some core characteristics that document its positivist heritage such as making constructs quantifiable through measures ([Ravenswood, 2011](#)). While staying within the confines of the Method's defining features, this study explores digital transformation as interpretatively as the Method allows for. The subjectivist epistemology shines through all sections of this research project. While this might sacrifice some of the ad-hoc operationalizability of the theoretical model and its constructs, it strengthens the weight of the meaning that lies behind the data, rather than aiming at quantifying qualitative data, i.e. counting cases or occurrences. Moreover, this methodological choice might come at the expense of generalizability. Nevertheless, the benefit of looking behind the curtains and thoroughly interpreting the meaning of the data outshines these positivist preconceptions and results in a theory that closely fits the empirical data.

I also add to *theory building through multiple cases* by amplifying the conceptualization of a case. The approach is similar to [Tidhar and Eisenhardt \(2020\)](#). The typical setup relies on longitudinal data with a process perspective. In this study, I combined cross-sectional data with a process focus. Longitudinal records were implicitly included in the data through historical accounts of the respondents. While omitting longitudinal data was not a deliberate choice but is a structural condition of the time limitation, the combination of cross-sectional data while remaining a process focus delivered valuable insights.

This chapter discussed the findings by mapping out the contributions that this research makes to theory, practice, policy, and methods. All in all, the emergent theory makes useful and original contributions to manifold audiences.

6. Conclusion

This final chapter concludes the thesis by elaborating the boundary conditions of the theory, indicating limitations and future research avenues, and presenting a personal reflection of the research journey.

6.1. Boundary Conditions

As in all theory-building research, the generalizability of this theory is not boundless, even if I adhered to all the quality criteria that I defined in the research design chapter of this thesis. The Eisenhardt Method is particularly explicit about establishing precise boundary conditions and represents one of its defining features (Eisenhardt, 2021). Boundary "conditions place limitations on the propositions generated from a theoretical model. These temporal and contextual factors set the boundaries of generalizability, and as such constitute the range of the theory" (Whetten, 1989, p. 492). Hence, the boundary conditions define the scope of a theory and indicate the settings in which it is likely to hold true (Eisenhardt, 2021). In other words, boundary conditions are key to understanding the extent of generalizability of a theory regarding where, when and to whom it applies (Whetten, 1989). Metaphorically, these theoretical limitations are a fuzzy line rather than a sharp delineation (Busse et al., 2017). Especially for practice-oriented theories as the present one, rigorous boundary conditions provide more nuanced guidance for managers (Gonzalez-Mulé & Aguinis, 2018). This section presents four potential boundary conditions of the emergent theory.

First, from a geographical point of view, the emergent theory is unlikely to apply outside of Germany. The political, economic, social, technological, ecological, and legal circumstances in other countries might alter the applicability of the framework and other implications of this dissertation significantly. Hence, the setting of a company presents a boundary condition for the practical application. The paper about the digital strategy 2025 by the [Federal Ministry for Economic Affairs and Energy \(2016\)](#) shows for example how many aspects may change in the global environment of a country within only a few years.

Second, I expect the theory not to hold true for types of firms other than incumbent manufacturing SMEs. The age, sector and size of a company are crucial determinants of the theory's applicability. Firm characteristics such as Industry 4.0 are irrelevant for other industries. Similarly, the framework is unlikely

to apply in an entrepreneurial or start-up context. Equally, it will probably be inapplicable for firms that are bigger than SMEs.

Third, the rapid change of technologies might render the results obsolete at some point in the future. Accordingly, the applicability of the theory could be limited by technological advancements. Even if it is unclear when that will be the case, it is sure to happen. Nevertheless, I expect the theory to be relatively technology-stable. The digital initiatives are not tied to defined technologies but refer to specific domains within a company that remain even with the technological development (data, processes, products and services, and the business model).

Fourth, I assume that the emergent theory is only valid for times of economic prosperity or, at least, no explicit crisis within a manufacturing SME. When a company is on a financial decline or faces other vital complications, the managers will usually steer their attention towards the solution of these problems rather than proactively driving their digital transformation. In such a context, engaging in digital transformation activities will likely be regarded as a luxury that will be postponed to economically favorable times.

6.2. Limitations and Future Research Avenues

The previous section outlined the theoretical limitations for the generalizability of the emergent theory. This section continues by exhibiting the limitations of the research itself and indicates future research avenues.

First and foremost, collecting longitudinal data would enhance the model by observing the phenomenon digital transformation how it evolves over time, therefore accounting adequately for its processual nature (van de Ven & Huber, 1990). The resource constraints of this project did not allow for such a research design and thus, cross-sectional data was used. Methodologically, longitudinal data would complement the research and I encourage researchers to conduct strong process studies of digital transformation in manufacturing SMEs. This applies specifically with regard to the ever-evolving nature of digital transformation. The observed companies are in the midst of the process of digital becoming. Yet this contemplation illustrates the methodological quandary: Is there a right moment to conduct a study on this process phenomenon to grasp it in its entirety? Assuming that the process is iterative and continuous, the best moment is always *now*.

Second, intricacies lie within the data collection and analysis. On the one hand, a study conducted by a single researcher bears the risk of researcher bias. However, reflexive interpretation ([Alvesson & Skoldberg, 2018](#)) mitigates its effects by applying different perspectives the data collection, analysis, and interpretation. On the other hand, informant bias was mitigated in various ways ([J. P. Davis & Eisenhardt, 2011](#)). By assuring confidentiality and pseudonymization, the interview participants were encouraged to speak openly and critically. Furthermore, I followed the interview guidelines to achieve comparable courses of conversation. Moreover, the triangulation of the interviews with secondary data and on-site observations allowed me to detect anomalies that only one source of evidence would not have unearthed. Nevertheless, researchers should aim to reproduce the theoretical model with alternative research designs. For this project, I had to make decisions; and every decision in favor of one choice implies a decision against another option that might be equally valid. For example, conducting the study with more informants and a bigger set of secondary data could enhance the quality of the model. Ideally, this is done by multiple researchers with diverse professional and academic backgrounds. In addition, basing the research on a different theoretical framework would yield precious comparative insights.

Third, one weakness lies in the research approach itself. Even if case study research is commonly accepted and widely applied ([Gehman et al., 2018](#)), there are some potential inherent flaws like overwhelming complexity or a missing balance between idiosyncrasy and generalization ([Eisenhardt, 1989](#)). However, elements of storytelling can hone the quality and readability of the thesis ([Dyer & Wilkins, 1991](#); [Pentland, 1999](#)). Moreover, staunch positivists or constructivist hardliners might criticize the philosophical assumptions of this dissertation. Combining realist ontology and constructivist epistemology is uncommon outside of critical realist research projects. A straight-forward mainstream quantitative or qualitative methodology might bear less risk for the acceptance. The positivist heritage of the Method ([Eisenhardt, 2021](#)) is still visible, most notably in the aim to make the theory measurable. Die-hard constructivists will contest the notion that a social theory can be operationalized through objective measures. In sum, altering the philosophical assumptions would present a valuable comparison to my results. With my pronounced constructivist view, I respectfully disagree with

Eisenhardt and assume that a different researcher with a divergent world view could end up with a different theory ([Gehman et al., 2018](#)).

Fourth, as has been explained as a boundary condition of the emergent theory, the generalizability is limited by the context in which the research took place. However, this topic is not only relevant for manufacturing SMEs in Southern Germany but for myriads of SMEs from all industries all over the globe. The intricacies of the contextual conditions are so relevant that I reckon that every industry and every country merit their own study. I certainly encourage future researchers to investigate the digital transformation of SMEs wherever they can—it is a relevant and timely matter everywhere.

Fifth, this study consolidates the heterogeneous scientific landscape with empirical evidence to build a holistic theory. As such, it inevitably often stays on a meta level, sacrificing details at points where some readers might desire more food for thought, which is also a criticism of theorizing from multiple-case studies ([Dyer & Wilkins, 1991](#)). Hence, the level of detail might limit the usefulness of the theory in certain applications. For each topic, however, papers from highly ranked journals and leading academics have been referenced for further involvement in a certain topic.

Sixth, I have not studied performance implications of digital transformation. In the end, SMEs need to generate money to be economically sustainable. I posit that digital transformation can have highly positive effects for the financial stability of a firm. Since all profit-oriented SMEs are impelled to generate income, future research should zoom in on the financial benefit of digital technology.

Seventh, future research should try to empirically validate my theory both quantitatively and qualitatively. That is the main purpose for formulating the propositions ([Whetten, 1989](#)). The three constructs are clearly defined and operationalizable via their measures and codes for deductive theory testing.

Eighth, this study treated information and digital technology uniformly even though some academics endorse a distinction ([Piccoli et al., 2022](#)). I assume that in the context of SMEs, this subtleness is inadequate. However, I leave it to future research to falsify my assumption and differentiate between information technology and digital technology.

Ninth, researchers are encouraged to explore the territory beyond digital business model innovation. As of today, altering the value creation, delivery, and capture mechanisms is the most pervasive digital endeavor a SMEs can engage

in. Most certainly, the future will surprise us with exciting and unexpected technological developments that future researchers should embrace.

Tenth and lastly, I have used the journal ranking as an exclusion criterion in the literature review. Articles that were published in journals with an AJG ranking below 3 were not taken into consideration to focus on highly influential work and reduce the literature sample to a manageable size. However, this procedure is not in line with the Declaration on Research Assessment (DORA). This framework "recognizes the need to improve the ways the outputs of scientific research are evaluated" (Aguinis et al., 2020, p. 147) and foregrounds the inadequacy of journal metrics for assessing the quality of a research output. To mitigate the effect of excluding lower-ranked articles, I remained attentive to less renowned journals throughout the research process and included suitable literature where expedient.

6.3. Personal Reflection

A research project in the vein of reflexive interpretation (Alvesson & Sköldberg, 2018) would be incomplete without a personal reflection. This thesis is rooted in a real-world problem, namely the observation that many incumbent manufacturing SMEs struggle to transform digitally. Conducting the research and building my theory of digital transformation as holistic organizational change has not only contributed to academia, practice, policy, and methods. By dealing profoundly with the topic, I have been able to learn a lot for my professional life, both through the interaction with the case companies and through immersing in the data that originated from them. Research and practice were inextricably linked throughout this study as I represent both realms. During all phases of this study, I cross-checked the findings with the business reality of the manufacturing SME I work for. This was no deliberate choice; it is inherent to conducting a research program part-time and, as such, inevitable. What might constitute a flaw from some perspectives (first and foremost a positivist stance which detaches the researcher from the research) is turned into a methodical strength. At no point, the research has served its own purpose but strived towards a practical avail. Therefore, the research-practice gap (Shapiro et al., 2007) was inherently obviated.

Moreover, the research strategy of theorizing from multi-case evidence is essentially an endeavor of abstraction (Eisenhardt, 2021). The abductive logic

matches my personality as I generally tend to search for patterns and try to fit singular observations into the big picture. My inclination to organize and structure *things* was helpful in this regard, even if it bears the risk of rearranging what was already there rather than generating new insights—a trap I did not blunder into.

Furthermore, I could live up to my high ethical standards and my critical stance, especially regarding human interactions. Social science is never carried out in a void but always in a context (Alvesson & Skoldberg, 2018). Accordingly, my actions inevitably have consequences that I tried to be aware of. The same applies for scrutinizing the interactions between the participants. Hence, I carefully addressed matters of representation, power, and authority throughout the research project. And on a side note, even if generative artificial intelligence has seen an immense boost in all domains of life during the lifetime of this research project (Schwaeke et al., 2024), every word has been penned by hand.

On a last note, thinking about thinking (Thomas et al., 2022) is quite palpable in this thesis. On the one hand, it is a personal tendency to cognitively stroll around in meta-terrains. On the other hand, my philosophical assumptions and the methodological approach are unconventional in business and management studies, which increases the necessity to comprehensively illustrate what lies beneath the surface. If I had tried to fit into the predominantly positivist conventions of the field (Gehman et al., 2018), this endeavor would have been doomed to failure as it would have clashed with my personal convictions. Every researcher is biased—if they admit it, is another question. I recognize my bias as the person I am, having been socialized under circumstances that shape my ideas until today, and conducting this research from a unique perspective. By applying a reflexive methodology, the emergent theory nevertheless makes a claim to a useful generalizability within its boundary conditions. Hence, this thesis is not only characterized by a theory-method fit (Gehman et al., 2018) but by a theory-method-researcher fit.

Ultimately, I was able to find a good balance between theory and practice, between academic rigor and pragmatism, between intellectuality and practicability. I had a "big idea" (Kilduff, 2006, p. 252) and I am optimistic that this thesis will prove as valuable for researchers and practitioners as it was for me.

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Appendix A: Ethics Approval

This is an excerpt of the ethics approval as an evidence of approval. It shows the top half of the first page of the ethics approval.

The digital evolution of incumbent SMEs: Towards a holistic theory

Ethics Review ID: ER20878869

Workflow Status: Application Approved

Type of Ethics Review Template: Very low risk human participants studies

Primary Researcher / Principal Investigator

Manuel Diepolder
(Sheffield Business School)

Converis Project Application:

Q1. Is this project ii) Doctoral research

Director of Studies

Roy Woodhead
(Sheffield Business School)

Q3b. External Investigator Details: Prof. Dr. David Wagner, DBA program leader, Munich Business School

Q4. Proposed Start Date of Data Collection: 05/09/2021

Q5. Proposed End Date of Data Collection : 09/01/2022

Q6. Will the research involve any of the following

Thesis chapter(s)	Research study	Ethics review reference	Approval date
Research Design	The Triple Nexus: Digital Transformation of Manufacturing SMEs as Holistic Organizational Change	ER20878869	17/05/2021

Appendix B:

Interview Guideline for the Semi-Structured Interviews

Introduction

- Do you see digital transformation as a threat or an opportunity for your firm?
 - How do you estimate the digital maturity of your company? Why?
 - What were the crucial steps of digitalization until you reached the current maturity?
 - Which influence did the Covid pandemic have on your digital transformation?
 - Who is the main driver behind digital initiatives?
-

Mechanisms

- Does your company have a digital business strategy? If yes, could you describe it?
 - How does your company create digital innovation?
 - How are the employees trained with digital capabilities?
 - How does the top management team support the company's digital transformation?
 - Do employees or customers interact with computers? If yes, how?
 - How do you guarantee that the company's potential is fully unlocked?
 - To what degree is your company technologically flexible?
 - Does the top management team harmonize new forms of organizing cross-functionally?
 - Is there a digital transformation strategy, a practical roadmap to put digitalization into action?
-

Conclusion

- Which are the most important results you expect for your company from digitalization?
 - Who determines these goals?
 - Have you always reached them? If not, why not?
 - What benefits do you envisage in the short, medium, and long term and how long before you expect to experience them?
 - Similarly, what negative side effects do you envisage in the short, medium, and long term?
 - What key recommendations would you suggest for the digital transformation of SMEs?
 - If you started all over again, what would you do differently? And why?
-

Appendix C: Language Considerations for Data Analysis

Approach	Pro	Con
1 - Apply German codes to German data	- Maintains the original meaning of the language	- Not allowed by Sheffield Hallam University - Difficult for the further analysis, synthesis and theory building, which will be in English
2 - Apply English codes to German data	- Pragmatic approach - Minimum loss of meaning in the coding process - Recommended by specialists for NVivo CAQDAS - Recommended by Johnny Saldaña	- Data and codes are not in the same language
3 - Translate the interviews from German to English and then apply English codes, while applying English codes to the German archival data	- Pragmatic approach in between the poles of "translating all data" and "not translating any data at all"	- Less time-consuming than translating all data - Loss of some meaning in the translation process of the interviews
4 - Translate all data from German to English	- This would be the standard approach for the international setup of my study	- Loss of meaning in the translation process - Very time-consuming - Necessary for all data sources, also archival records
5 - Code the English case histories	- Pragmatic approach - Triangulation of all data sources is in place - Best practice by J. B. Li and Piezunka (2020)	- Not the original data, but a first interpretation (the case histories) is coded and might lose meaning

Appendix D: Case Histories

Kilo

The primary data that was generated for *Kilo* consisted of three interviews with a *Key Account Manager*, the *Head of Inside Sales* and one of the two CEOs.

The *Head of Inside Sales* is responsible for all internal IT topics even if he has never formally undergone an IT education. He grew into that informal position because of his personal affinity and the departure of the former informal IT appointee. Now his opinion is taken into consideration also for strategic IT decisions but mainly he drives the implementation of digitalization actions.

The *Key Account Manager* started at the company six months prior to the interview.

The *CEO* views digitalization as an opportunity rather than a restraint, but he refers mainly to digitization of processes rather than digital transformation on a company-wide level. The *Head of Inside Sales* also believes that it is a chance, mainly due to the high availability of the IT systems.

For the sake of transparency, I have visited the company several times not only for the interviews, but also as a business partner in my day job. This provides me with an even deeper understanding of the company.

The company started very early on in 1990 and has already digitalized significantly. The first tools were written by company members themselves to facilitate quotidian tasks to automate technical calculations. This was also used as a USP in their marketing.

In 1993/1994, they introduced an ERP system to reduce manual errors. The ERP system was upgraded in 2004, which they still used in 2023. The partner takes complete responsibility for the ERP system, which is highly customized.

With that upgrade, barcode scanners were implemented to reduce manual errors.

Around that time, the company started to interchange electronic data with customers, such as orders, and process them automatically. The main goal was to reduce errors. Some customers can even check the warehouse stock. Numerous big customers require electronic data interfaces, so this is an external driver. There is a high dependency on the external partner for the interface, but there is no alternative due to his decade-long industry experience.

The next milestone was e-mail in around 2004.

For the *Head of Inside Sales*, the most important and risky project was to relocate the servers to an external data center. Without that, the switch to home office would have been much more difficult. The second most important was the introduction of a document management system in 2014. Interestingly, none of these two have explicitly been mentioned by the *CEO*.

In 2017, a customer relationship management system was introduced, which was mentioned by the *Key Account Manager*. However, none of the interviewees mentioned it as a milestone, which is surprising.

Video conferencing systems that were introduced during the pandemic were a great leap forward for the *CEO* personally because it augmented his autonomy and possibility of going on vacation. Even before, e-mailing changed the way he worked, both in a positive and in a negative way. On the positive side, he was more independent, but on the negative side, he had to learn how to cope with the permanent availability.

As of 2023, the company introduced a process management system to dynamically visualize and structure processes, including a document management system.

Apart from the milestones, the company steadily improved with minor, but numerous digitalization initiatives over the decades.

The *CEO* estimates the digital maturity as 8 or 9 out of 10. He is aware of all the possibilities that exist which they have not captured yet.

The *Head of Inside Sales* is sure that the company was forced to digitalize in 2012 to 2024 because of the different subsidiaries. He estimates a high digital maturity compared to similar companies. He attributes this to the management placing high importance on the topic, even if it is old school sometimes, especially regarding cloud computing. Sometimes this is a restraint for the development.

The *Key Account Manager* estimates that the digital maturity of the company is quite high considering its size. With all the changes in recent years, the *Key Account Manager* feels that the pace has been slightly too high. With the individual tools, the data exchange between them has been neglected. For him personally, the improvements could even be faster, but he seems to be an exception.

The company is sometimes held back in its digitalization efforts because the employees are comfortable and do not want to change habits. The *CEO* prefers not to displease the employees and advances rather slowly, especially with elder employees. In the family business's constellation, the mother plays a special role because she still handles accounting processes that are essentially non-digital. For younger employees, the *CEO* sees less of a problem because they are more open-minded. After reconsidering, the *CEO* does not see age as a crucial factor for the willingness or ability to work digitally. Rather, they must see their own benefit, which he believes is the leaders' task to present changes in a persuasive way. And younger employees are easier to convince because they are more digitally accustomed. The *Head of Inside Sales* adds to that view that younger people are not per se more skilled with digital tools. Rather, the willingness is decisive, which he repeats several times throughout the interview. Also, the private engagement with digital devices is important. The perspective of the *Key Account Manager* is that younger employees tend to be more open towards digital innovations not because of their age, but because of lower job tenures, on average, and therefore less prone to stick to year-long habits.

Interestingly, an employee in the marketing department judged that the company should digitalize more according to Kununu. This is contrary to what the *CEO* thinks.

The *Key Account Manager* believes that for all changes in a business context, people have fears even if they know the changes might be beneficial or necessary. So, resistance is not directed towards digitalization, but towards change. The *Key Account Manager* himself is open towards new software. He sees the advantage of new tools to do his work better. He even integrated new methods regarding big data analytics on his own initiative without being delegated that task by the management. The simple reason is that he likes handling big data.

Moreover, the company lacks time resources to digitalize further even if there had been a necessity. Both the *CEO* and the head of internal sales mention that. The head of internal sales laments several times throughout the interview that they do not have an internal IT department.

Kilo changed the external partner because they lost trust in the previous one, mainly due to a lack of innovativeness and proactiveness. For a SME with no or a few internal IT resources, the choice of a good partner is crucial.

The company does not follow a strategic digital transformation path. Digitalization actions are usually talked about during regular functional meetings such as sales, inside sales or strategy meetings that take place every 3 to 4 months. But appears to be always problem-centered, i.e. what is missing. The drivers are external such as GDPR or tax authority regulations. Actions are rather taken by chance than by design. At the same time, political and administrative regulations hinder the digitalization, such as customs handling. Sometimes, even customers refuse to change existing processes and therefore impede digitalization efforts. Generally speaking, the company is led quite strategically, just not with a focus on digital transformation.

Later in the interview, the *CEO* insists that digitalization actions are taken proactively to become more efficient.

The *Head of Inside Sales* talks about an IT strategy plan, which is very detailed and rather an action plan with upcoming projects than a strategy plan. The plans are available as secondary archival data and an analysis reveals its project character. The rather operational focus (not strategic) is reinforced by the fact that the plan is updated every two weeks with the external partner, which would be a unrealistically short interval for strategic projects. The prioritization of the projects is decided by the production managing director. The *CEO* wants to be informed, but not directly involved. A small circle of deciders is crucial to advance and not get stuck in too many opinions.

The prioritization mechanisms of the company seem to work. Some nice-to-have projects (such as structuring the file server) have been present for years but not been realized because of being not important enough.

The *Key Account Manager* is not aware of any digital transformation strategy.

The main drivers are the *CEO* and the production managing director, whom he refers to as IT consultant. The production managing director is referred to as quasi-*Head of IT* by the head of internal sales. Moreover, the *Head of Inside Sales* also initialized many improvements. The inside sales manager, however, sees himself as one of the main drivers, together with the *CEO*, with the production managing director assuming a more process-oriented perspective. As a third perspective, the *Key Account Manager* sees the *Head of Inside Sales* as the main driver, together with the production managing director. He also mentions customers as a major force that triggers digitalization.

The *CEO* laments that seldom, suggestions for changes are initialized (let alone realized) by employees who are on a lower hierarchical level. Not even employees in management positions do so. The *CEO* attributes this to a lack of processual thinking. The *Key Account Manager*, however, believes that often employees bring up the necessity for changes.

The company tries to stay up to date mainly through conversations with friends and business partners. Moreover, they rely on previous knowledge. This is complemented by their external IT partner, who try to keep the company updated. IT-centered trade fairs are attended infrequently.

The *CEO* believes that small companies have a disadvantage in comparison to bigger companies regarding the reliability of the IT systems. The company does not have any internal IT specialist, just some IT affine persons that are allocated in other departments.

There are formal internal training courses, both in person and e-learning. With internal courses, they follow a train-the-trainer concept so that internal key users serve as a multiplier. Also, the *CEO* likes to conduct internal trainings. But most of the qualifications happen informally. There are no external training courses.

New employees like the *Key Account Manager* received training from the *CEO*, the head of sales and other colleagues. Moreover, he received written instructions for certain software.

The *Head of Inside Sales* confirms that the *CEO* has never neglected the budget for sensible digitalization actions. As long as it generates some kind of benefit, which does not necessarily have to be monetary, he approves of it.

The *CEO* has a hands-on mentality and helps with any task in the company, if necessary. Interacting on eye level with the employees makes him a credible leader. He would never alter a process that he does not understand. He relies very much on feedback from the employees. That way, the employees stay motivated and flexible. That minimizes the resistance by the staff for digitalization efforts.

There are quite a few critical employee evaluations on Kununu, however. The management is partly described as not being respectful and with a lack of honesty and trust. Moreover, one person states that digitalization should be enhanced.

The excerpt of the ISO 9001 quality manual contains many processual and quality goals, but no mention of digitalization.

The *Key Account Manager* reinforces the value of the flat hierarchy in the company. Decision can be made very quickly with the *CEO* or other managers. The power of decision is not centralized. The atmosphere I sensed at the headquarters confirms this notion.

The atmosphere is warm-hearted in the offices. In the production, it seems colder, which is not unusual for manufacturing firms.

Apart from the standard devices such as notebooks, tablets and smartphones, the company uses scanners. Moreover, they use a camera system to monitor goods movements and determine lost goods. They use the footage to prove that the shipment was complete at the time it leaves the facilities and avoid costs of additional goodwill shipments. However, they are extremely costly. In one of the facilities, the company uses a welding robot.

The *CEO* believes that the company does not use its full potential. The field of digital transformation is too huge to be fully grasped by his company.

The head of internal sales confirms that stance.

To use the full potential of the company, the *Key Account Manager* sees a need for an internal programmer or data analysis expert. Moreover, he thinks that all the necessary tools and structures are in place. The bottleneck is the lack of time that the employees can spend on getting to know the tools up to their full potential.

The *CEO* sees his company as technologically flexible. But not just because they want to, but also because of sheer necessity due to external developments like the pandemic.

At the same time, the dependency on IT systems has risen significantly. Without the IT systems in place in one of the subsidiaries, almost nobody can work.

According to the head of internal sales, the company adapts quickly to a changing competitive environment. They are technologically flexible, but often under constraint with the pressure from customers.

The company had restraints of their internet speed, which are now solved with a new provider and new fiber connection.

The *Key Account Manager* mentions that in comparison to big corporations that he had previously worked for, digital innovations were significantly harder to detect and slower to implement.

Kilo does not have an inhouse IT department.

The organizational aspect of digital transformation has made it easier to employ people from other places such as home office. But this was just minor adjustments, no big change in the organizational structure or hierarchies. With their IT infrastructure, home office was technically possible then the pandemic hit without delay.

Generally speaking, *Kilo* is rather unstructured and, with the words of the *Head of Inside Sales*, very chaotic. Roles and responsibilities are not clearly defined. The *Head of Inside Sales* is a good example. He became the IT appointee by chance. Sometimes, that unstructuredness hinders the company, but sometimes

it is beneficial in the form of high flexibility. For the digital transformation, the degree of engagement highly depends on the team leaders. Until the external pressure is high enough, some teams do not see the necessity to reenforce their digitalization. Some team leaders do not show a lot of interest in digitalization. In that case, team members assume the role as key users. The *Key Account Manager* believes that many team leaders are not aware of the chances of digitalization.

Regarding products, they are still fully analog. Customers have the possibility to use complementary configuration software free of charge. The *CEO* has an idea for a fully digital product but has not yet pursued that goal with urgency.

The *Key Account Manager* admits that in such a price sensitive market, product innovations are hard to realize. From his sales perspective, we would highly recommend services that add value to an otherwise purely mechanical product. However, he feels reluctance towards this kind of innovation among his management. In his opinion, the company only produces what it has been producing for years without evaluating alternatives or neighboring product groups. There also seems to be a sense of complacency with the current competitive situation of the company and not enough pressure from the market or the customers.

The main goal of digitalization for the *CEO* is to make life easier. Temporally and locally independent access to data is crucial for him. Moreover, transparency is important. Furthermore, legal compliance is important. In addition, environmental aspects matter. Finally, skilled labor shortage plays a role. Monetary considerations to reduce costs or workforce were declined. The importance of ergonomically good workplaces is mentioned.

According to the *CEO*, these goals are part of the quality management. They also serve to make life for everyone easier. A specific digitalization goal is to build a digital warehouse. That goal has existed for a decade but has not yet been realized.

For the *Head of Inside Sales*, the main goals are simplification, cost reduction and availability. These were spontaneous goals and are not concerted with the management.

The *Key Account Manager* sees two main goals. First, to make processes simpler and more efficient. Second and more importantly, faster and better decisions must be the main outcome of digitalization. He supposes that these goals are universal to the organization, but he is not certain about that.

One negative side effect of digitalization is data security. The *CEO* places enormous importance on IT security. The company relies on their external partner. For the *CEO*, it is extremely important where the company's data is stored. He rather had all data stored on premises, but they have gone the step towards data centers located in Germany. He is upset by the fact that there are no serious European e-mail providers. He believes that providers from the USA do not obey data regulations as they should. For the *CEO*, the lack of European alternatives is a political negligence. According to the *Head of Inside Sales*, the *CEO* would rather increase the costs rather than storing e-mail data in the cloud.

Moreover, permanent availability and digital media competence is an issue that should already be addressed in school. Digitalization influences burnout rates, according to the *CEO*.

The head of internal sales laments that through digitalization (on a societal level), the reliability of the spoken word has dissolved. Everything must be documented and archived in order to be valid.

The *Key Account Manager* regards the initial costs of digital transformation actions as negative. However, he is aware that more efficiency will follow later. Moreover, he sees the negative stance of some employees as a risk to cause dissatisfaction.

On a societal level, the *Key Account Manager* fears that SMEs might vanish in favor of big corporations that can survive due to their size or location advantages in a globalized economy.

The *CEO* recommends that SME take digitalization and data security seriously. Moreover, SME should place the focus on the employees that they learn to cope with the permanent availability.

The head of internal sales recommends not over-digitalizing. The steps should be digestible for the employees. If not, they will not be able to keep up with the pace and become demotivated.

The *Key Account Manager* recommends not to be afraid. If a company wants to digitalize and improve, they will be able to do so. Especially senior managers might be afraid to unmasked regarding their lack of digital competency so that they prefer not to digitalize in order not to be embarrassed. That can only be overcome by changing the mindset.

It is important to plan the ERP introduction thoroughly. Apart from that, the *CEO* is very satisfied with the company's digitalization.

For the *Head of Inside Sales*, everything has been successful since his start at the company.

Mega

The primary data that was generated for *Mega* consisted of three interviews with one of the CEOs, the *Head of IT*, and an *Office Worker*.

The *CEO* has been in the company for six years. The atmosphere of the interview was dense, and I had the feeling that I could not quite get through to the *CEO*. The *CEO* generally regards the digital transformation as an opportunity for the company because they sell IT hardware. The more companies transform digitally, the more revenue they can generate with their products. For the internal perspective, he also sees their digital transformation as an opportunity. The skilled labor shortage is a main reason for them to become more efficient.

The *Head of IT* has been in the company for two years. The *Head of IT* believes that there lies an opportunity, but also a thread in digital transformation. A thread is that processes might be worsened, even with the intention to improve it. Still, he thinks that it is important to constantly analyze processes to improve the

quality. To strike the right balance is the responsibility of quality management. It differs from situation to situation. It is impossible to go from 0 to 100.

The *Office Worker* has been in the company for 5 ½ years, starting with an apprenticeship. The *Office Worker* regards the digitalization, both in the company and in private, as a chance.

The digital transformation had already started before the two brothers led the company. Their father has always been at the forefront of the latest technology. In the 1980s, they introduced personal computers as one of the first companies in Germany.

In 1998, the first ERP system was introduced. Before that, everything was manually programmed.

Around 2005, a document management system was implemented. However, the *CEO* wants to replace it soon.

Between 2010 and 2012, the production was fully digitalized.

In 2019, all employees were equipped with notebooks instead of desktop computers.

In 2020, two dedicated video conferencing meeting rooms were established.

In 2022, a new ERP system was introduced. But rather than using a cloud version, their philosophy is to host it on premise. The responsible person is the other *CEO*, his brother. He is assisted by a part-time project manager and key users from each department.

The perspective of the *Office Worker* on digitalization milestones is limited to her observation that less invoices are sent by post and that the website has been modernized, but nothing groundbreaking.

The *CEO* regards their digital maturity between 7 and 8 out of 10. Not all processes are highly automated, no robots are in place for manufacturing, no artificial intelligence is used. But within the range of standard digitalization, the company is quite digital. Almost no paper is used, according to the *CEO*. Later in the interview, he admits that some processes still function in an old fashion, i.e. printing invoices just to scan them directly with the goal to archive them in the document management system, rather than just changing the process to fully digital steps.

The *Head of IT* judges the digital maturity after implementing the new ERP system as 7 or 8 out of 10, with 10 being all that would be sensible for the company, not all that is technologically possible.

The *Office Worker* estimates the digital maturity as 7 out of 10. But she has never worked in another company.

The whole company seems to be highly digitalized. Visitors are greeted personally on a screen in the entrance, for example. The company was tidy and not a lot of paper was visible on a first glance. Even in the production, all steps are documented and instructed digitally on screens at each of the 15 workstations.

There is no written digital transformation strategy. According to the *CEO*, it is communicated verbally, which he deems to be sufficient. He places more emphasis on actually realizing digitalization actions, not just writing them down theoretically in the ISO 9001 quality manual.

There are currently no electronic data interfaces towards customers because the batch sizes are too small.

The *Head of IT* is not aware of any digital business strategy. But since he is interested in how the top management strategically plans the coming years, he will proactively try to gain that information in his upcoming appraisal interview. He is just aware on a very high level that the company wants to diversity its portfolio.

According to the *CEO*, it is the two CEOs and the head of sales (who is also an authorized representative) who drive the digital transformation. He refers to them as early adopters or scouts. He explicitly does not mention the *Head of IT*. His roles are administrative and operational, but apparently not so much managerial.

The company has established an innovation circle in while the sales and R&D departments are represented. Accordingly, it has a product and customer-centric perspective to determine sales opportunities. The *Head of IT* confirms that this committee originates from quality management, and he is not aware of any digitalization focus in this board. Similarly, the *Office Worker* confirms the customer-centric approach of this innovation circle and negates the existence of any general innovation format.

The *Office Worker* believes that the two CEOs are the main drivers of the digitalization. The simple reason is that they are young. But also the employees initiate digitalization initiatives by suggesting them to the CEOs.

Otherwise, digital improvements are discussed personally and informally. In the end, the CEOs decide if an action will be taken or not. He sees a chance of only 20-30% that neither of the CEOs or the head of sales do not see a potential for improvement by themselves.

The *Head of IT* sees the two CEOs as the main drivers of digital transformation. Furthermore, the department leaders also contribute to developing new ideas. Generally speaking, the company is constantly innovative due to its small size.

Trainings are mainly conducted from employees to employees. Key users have the responsibility to train the users. Moreover, written instructions are used.

The *Head of IT* emphasizes that the employees have the possibility to attend external trainings at no cost or can order literature. They are also flexible regarding spontaneous training needs to send someone on a training on short notice. The acceptance of the training possibilities is moderate and depends on the current workload of the respective employee. The *Head of IT* describes the organizational culture as harmonic. The employees help each other, which reduces the need of formal trainings. The informal exchange is often quicker and easier.

According to the *Head of IT*, the employees accept new tool very quickly if they facilitate their daily business.

The decision for or against any digitalization action is principally based on a profitability calculation. Big decisions such as if the ERP system will be upgraded or not are taken by the management. Even if the management involved the users in the decision-making process, the final decision was taken by the management.

The *Head of IT* attributes credibility to the management. They have complied with their promises to update the ERP and DMS. He has fun at work with this constellation where things are realized in a constant pace. Moreover, he likes that in such a small company, he is involved diversified topics.

The prioritization of digitalization actions is dominated by day-to-day necessities rather than guided by strategic decisions.

The *Head of IT* is happy that the generational switch has worked out well. He has experiences when it turned out otherwise. The previous generation grants the new generation a lot of freedom to take their own decisions. More generally speaking, he is satisfied with the direction in which the company has been developing even though he does not have detailed insights.

The *Office Worker* sees the two CEOs as exemplars for the digital transformation. Both are highly digitalized in their personal mode of operation. Furthermore, she recognized that one of the CEOs participates in a program for future digital leaders and associated that with his ability to mold the company's digital pathway.

The employees are actively incorporated in the decision for new tools. The final decision in the case of the new ERP system was taken by the CEOs, but the employees seemingly felt part of the decision-making process. The *Office Worker* stated that she is in favor of being engaged by the management.

The company used all kinds of different devices because that is their core business. They experiment a lot with hardware. So naturally, employees frequently interact with computer systems.

The *CEO* claims that they do not implement any changes that are not supported by the users. He supposes that in that case, a new tool or process would not be accepted and therefore not be used.

The *Head of IT* is skeptical if it is even necessary to digitalize certain processes that also work in an analog way. Digitalization must be the means to an end, not the means itself. Every employee needs the tools to do their job as efficiently as possible and it does not matter if these tools are digital or analog. He repeats that stance several times in the course of the interview. He believes that the company so far strikes a good balance between cost and benefit in their digital transformation.

Shortly before the launch of the new ERP system, the stress level is high among certain teams. It is tiring to realize such a big project along the daily business.

The *Office Worker* confirms that the company offers many training courses, both external and internal. The internal trainings are not only offered by supervisors or managers, but also by employees who have gained expertise in a certain topic.

Moreover, she feels that there is a stable foundation for digital transformation but still sees potential for improvement in many processes.

The strict economic assessment prevents the company from exploring software possibilities. For hardware, which is their core business, they do so.

The IT architecture is handled by the internal IT team. They do not have an external partner for that. This is a legacy from the past because the company used to be a system house itself.

According to the *Head of IT*, the external ERP partner is not ideal. The training of the users is very good, but they are not as cooperative and fair as he would like them to be. My interpretation is that there is a severe lack of trust towards the external ERP partner.

The ERP system that is about to be implemented is not optimized for operation on premises. The *Head of IT* implicitly laments that the management has decided against the native operation in the cloud.

The *Office Worker* thinks that the company is flexible towards the customers, for example with customer-specific adaptations. Moreover, most of the workforce is described as being flexible, even if the colleagues do not always agree for certain processes.

The IT team is four persons, which equals around 10% of the workforce. This is an exceptionally high rate for a SME. However, they also have service responsibilities towards the customers and are therefore not fully available for internal projects.

With the new ERP system, the *CEO* wants to make as few customizations as possible. He rather changes the organization around the ERP system. This applies mainly to processes. The *Head of IT* believes the exact opposite. He sees the ERP system as a tool that must adapt to the company's needs. He is aware of the discrepancy between him and the management. He is also aware of the fact that updates are easier with less customizations. In his role as *Head of IT*, he is more involved in the technical realization than in conceptual considerations. Between the lines, I hear that he is not completely convinced with the management's choice of the new ERP system, even if he claims that he and his team are indifferent.

This stance has two reasons. First, the *CEO* relies on the quality of the ERP system. Second, updates are much more difficult and costly the more customizations are implemented.

The team structures have not been changed due to the digital transformation.

According to the *Head of IT*, roles and responsibilities will not change due to digital transformation, just the way people work.

The *Head of IT* believes that every employee should only be able to operate with the tools that they need to fulfill their personal tasks.

The *Office Worker* has noted that the team size has grown, but that is not directly related to the digital transformation. As part of this growth, the company has established a middle management level.

Talking about the skilled workforce shortage, the *Office Worker* mentions that she noted on the website about job vacancies. This is an indicator for a lack of internal communication because the employees were not informed about the vacancy before it went online.

The *Office Worker* expresses a wish for streamlined processes among the employees. She regards that as a responsibility of the CEOs but has never addressed that issue. She has high hopes for the new ERP system to resolve these kind of issues. If it does not materialize, she would escalate it to the CEO. The conversational atmosphere is very open.

The CEO has not thought about digital business model innovations.

The *Head of IT* believes that nobody in the company sees the big picture; not because they are unable or unwilling to do so but because it is not possible. Rather, their digital transformation is directed by challenges that occur in the daily business along the way.

The *Office Worker* is not aware of any digital transformation strategy.

For the CEO, efficiency is the key outcome for digitalization. He mentions that numerous times throughout the interview. The reason is that he wants to relieve the employees who are all used to capacity. Moreover, he wants the company to be attractive for potential employees.

For the *Head of IT*, digitalization means to work with digital tools as often and as good as possible, with the least stress possible. Moreover, it serves to generate performance indicators to initiate improvements. His view on digitalization is almost exclusively tool-centric.

For the *Office Worker*, the goal is to facilitate processes. Ideally, all processes are automated so that she just must press a button to initialize a process.

The *Head of IT* believes that a problem of digitalization is that it means something different to every employee and that everybody needs something different to digitalize their work.

Another problem he sees are legal requirements that need to be fulfilled, for example secure electronic filing.

The *Office Worker* fears the dependency from the digital infrastructure, predominantly the internet. Contrarily, she is not concerned about data protection, even if she only refers to her private realm.

The CEO's central recommendation is to talk to the employees. Especially for new employees, he tries to incorporate their knowledge from the previous employer. Hold in high esteem what comes from the employees. And if nothing comes from them, proactively talk to them.

The *Head of IT* recommends that the tools must always fit to the existing processes, not the other way around. Furthermore, the degree of digitalization must suit a company and constantly develop. But he believes that there are no general rules that apply to all SMEs because they are so different. However, his view is coined by his tool-centric perspective.

The *Office Worker* recommends disestablishing the fax machines. Moreover, she recommends conducting external trainings for the employees and end users.

The *CEO* recommends not to pursue too many digitalization projects at once. A company must still earn money at the same time and digitalization projects take up a lot of resources.

In general, he is very satisfied with the digital transformation since his inception. Not only have they realized significant projects but also grown in headcount, revenue, and profit. It seems to be an example of well-designed ambidexterity.

The *Head of IT* would not do anything differently by hindsight. The same applies for the *Office Worker*.

Giga

The primary data that was generated for *Giga* consisted of two interviews with the *Digitalization Manager* and one of the two CEOs.

The *Digitalization Manager* reports directly to the *Commercial Director*. He perceives himself as CDO or inhouse-consultant. The *Digitalization Manager* is member of a digitalization council for the Chamber of Industry and Commerce. The *Digitalization Manager* sees the digital transformation as a chance. This is reinforced by the fact that he currently pursues a Master's degree in 'Digital Management and Business Consulting'. In this degree, the *Digitalization Manager* has learned that strategy and organizational change play an important role in the digital transformation, not just technology. However, the *Digitalization Manager* reinforces that not everything must be digitalized but only where it makes sense. Especially human interactions must be preserved in a non-digital form. Digitalization should not be an end in itself but only a means to an end.

Giga uses an ERP system since 2005 that is capable of handling most of the processes. According to the *Digitalization Manager*, this was the most important milestone. The ERP system permits customizations that the company can partly program internally. The ERP costs are relatively low with the solution they use. For whichever process cannot be handled by the ERP system, the company has established isolated applications.

In 2013, a plant data collection system was introduced, which also includes capacity planning.

In 2020, a video conferencing application was introduced to facilitate meetings with customers, internal meetings, trainings, safety instructions, or even townhall meetings with all members of the staff. It also reduces costs for consultants who do not need to travel to the company every time anymore.

As of 2022, a product information management system is being established. However, it will not be Linux-based but have an interface to the ERP system.

Moreover, as of 2022, the human resources department is introducing a workflow management to streamline processes.

The *Digitalization Manager* estimates the digital maturity to be 6-7 out of 10. He is aware of all the challenges that still lie ahead.

Giga uses many applications based on Linux due to security considerations. This applies also for the ERP system. This stance can mainly be ascribed to the *Commercial Director*. However, the *Digitalization Manager* is skeptical towards that approach because the majority of commercial software offers only Microsoft-based interfaces. For new software tools, it implies individual programming every time in order to make them compatible with the Linux ERP system. The company has previously decided against certain tools that might have been beneficial because of a missing Linux interface. The company does use Microsoft products, but only the most basic tools such as [Microsoft] Teams or Office. The *Digitalization Manager* states that they have still not found their definitive approach.

Talking about IT security, the *Commercial Director* recounts to recent hacking incidents in the region. He expresses the thought that Russia could pay Microsoft to reveal data or that Office 365 should be banned in Europe due to data security regulations, his extremely critical stance towards Microsoft is clearly observable.

The *Digitalization Manager* has thought about adding value to their analog products by providing additional information for the final customers. They could access that information via smartphone and a permanent branding on the product. Supposedly, he refers to some kind of QR code. The additional information could be safety instructions or user videos.

Another added value for the customers would be to provide delivery dates with high accuracy by tracking the product during the production process, for example via a supply chain management software.

The *Commercial Director* mentions that the company introduced a virtual showroom to explain their products. It is supposed to replace a trade fair booth.

The company's products are purely analog so far. In the future, sensors could monitor the state of the product while in use and therefore generate additional benefit for the customer. Even if nothing has been realized so far, the *Commercial Director* is clearly up to date as far as value-adding ideas for their products are concerned.

According to the *Commercial Director*, a benefit for their customers is that they will be able to deliver product data and marketing materials in a systematic manner. This will be realized via the product information management system. On the website, the service is already presented to the public.

The departments allocate their digital requests directly to the digitalization department. The digitalization department is responsible for defining the priorities and the upcoming projects. Customer projects always have higher priority than internal projects. They have an awareness that they have yet to fully establish the structures. For the prioritization process, they also consider formal management methods. Important aspects for prioritization are security and the cost-value-ratio.

The desired process is that a request from the department first arrives at the IT department, which then gives a first assessment regarding technology and strategy. The *Digitalization Manager* is not sure if there are commonly accepted

guidelines for the digital transformation strategy that the IT department can take as a basis for their evaluation. The evaluation is based mainly on the three decades of experience that the *Head of IT* has within the company. Moreover, the *Head of IT* works quite closely with the *Commercial Director*. Ideas that are purely of a technological nature and do not need any commercial evaluation are then directly realized. Second, the ideas that pass that stage arrive at the digitalization department, which conducts a commercial and organizational analysis. Potential benefits such as an increase in transparency or a reduction of stress among the workforce play a role, too. Furthermore, the *Digitalization Manager* ensures that the chosen tool is offered by an economically stable company so that long-term support is secured. Third, if an idea passes that stage, it will be discussed in a workshop with a key user, department head, *Head of IT* and the directors. Only then, a decision will be made by the directors for every digitalization project. The rationale of why a project must be realized is crucial to them. But also, subjective values such as employee happiness may influence the decision. Overall, the company places significant importance and effort to the analysis phase of a project.

Major customers which are highly digitalized corporations are also drivers of digitalization, especially regarding the branding of the products. Moreover, they have already established EDIFACT interfaces with major customers. The *Commercial Director* confirms that the digitalization that originates from the customers, which are in turn highly professional enterprises, is very important.

Other drivers, even if only indirectly, are *Giga's* competitors.

The *Commercial Director* considers himself a driver of digital innovation in the company. Not so much regarding the products, but rather regarding processes in the administration and communication.

Several months upon introducing a new software and the main training, there is a refreshing training for the users. The users, or at least the key user, can get in contact with the system house directly without taking the detour over the IT department or the *Digitalization Manager*. Especially for the *Digitalization Manager*, it is not productive to have him included in daily business so that he can focus on the digital transformation on a larger scale.

The *Digitalization Manager* involves users early in change processes because he believes that will then be easier to implement new tools and procedures. The employees shall feel involved in these changes in order to be motivated. He is convinced that the solution will be better if users are involved early on.

The *Digitalization Manager* emphasizes that the age is not a determinant of a person's willingness or ability to digitalize. Rather, it is their openness and having fun improving processes. Moreover, the employees must be shown which benefits a change brings for them individually in their personal work. According to the *Digitalization Manager*, it is the company's responsibility to persuade the users and not the responsibility of the users. The mindset of the employees plays a significant role, too. That is why the company is quite restrictive in their recruitment process and explicitly searches for new employees who are willing to accept the company's values. The cultural fit must be given.

According to the *Digitalization Manager*, the directors strongly encourage and even push the digital transformation. The *Commercial Director* has previous experience in IT and has a strong affinity for digitalization topics. For example, he introduced the ERP system. But security always plays a crucial role for him.

The *Commercial Director* also initiates new initiatives or brings up new ideas for digitalization. Being asked about the digitalization in sales, the *Digitalization Manager* refuses an answer, indicating that the *Commercial Director* is the better interlocutor for that question. That indicates that he attributes high competency to his boss. I can feel that the *Digitalization Manager* is highly convinced that the company is well-led and that the directors are beneficial for the digital transformation of the company.

Generally, the *Commercial Director* is very open towards new ideas, according to the *Digitalization Manager*. The two directors are both very open and also demand that from the employees, be it towards new machines, software, or colleagues. They do not always succeed, but mostly they do. Regarding the digital transformation, the *Digitalization Manager* regards it as his job to onboard every employee to that journey.

The *Digitalization Manager* is aware of the possibilities that bots offer for automating processes and generate new business opportunities. However, he is skeptical about how bots can be implemented without sacrificing important aspects of human interaction.

When implementing new software, the key user is involved in the process early on. They are able to work with early-stage demos in order to get acquainted with the new tool. When going live, the key user already knows how to use a software and teaches the team members.

The *Digitalization Manager* states that Germany is not anymore a location advantage for a company. The digital infrastructure and public administration is not on par with other countries in Europe.

Giga has established a new department named 'digitalization and sustainability'. It is detached from the IT department and focuses on commercial and organizational aspects of digitalization. The IT department consists of two experts plus one apprentice. The IT department is headed by an expert of their external service provider who dedicates almost all of his working hours to the company. This is an unusual constellation but seems to work well for the company.

The mere existence of the digitalization and sustainability department shows how much emphasis the company puts on its digital transformation. Apart from the *Digitalization Manager*, there is also an IT specialist in the team. The *Commercial Director* argues that the company has reached a size where two team members can constantly be occupied. He believes that there is always room for improvement to make things faster and more well-rounded. For new digitalization ideas, he does not want to depend on coincidence if someone is available for conducting an improvement, but always have someone available.

Not all analog interactions should be abolished. A hybrid mix of digital and analog interactions is crucial for the *Digitalization Manager*.

The *Digitalization Manager* is not aware of any digital transformation strategy. He believes that if there was one, security issues would be top priority. For the *Digitalization Manager*, the key is to find a good balance between security and productivity.

Giga cooperates regularly with external consultants. They are either system houses or directly the software producers who help the company to define new processes or customized workflows. Their main partner is the one for the ERP system, but if they cannot offer a certain solution, the company is open for alternatives. For the choice of partners, regionality, trust, fairness, quality, and cultural fit play a crucial role.

Giga has described a vision how the IT structure should look like in five to ten years. It refers mainly to the organizational structure and the headcount in the corresponding departments.

The *Digitalization Manager* pursues the goal to get rid of unnecessary work. Standardized tasks must be automated so that humans gain more time for important tasks that only humans can accomplish, such as salary negotiations or customer negotiations.

Another positive side effect is ecological sustainability, for example by using less paper or conducting meetings online that previously involved travelling. That, in turn, can improve the work-life-balance of the employees by saving time and reducing stress.

For the *Commercial Director*, rationalization is an important result of digitalization. Moreover, he wants to reduce costs.

No negative side effects of digitalization were mentioned.

The *Digitalization Manager* recommends that CEOs grant sufficient time to the persons who are in charge of the digital transformation. They should not be involved in daily business. The *Commercial Director* confirms that clearly because he regards it as critical to conduct IT or rationalization projects casually.

Furthermore, he recommends having the expertise with the persons who are responsible for the digital transformation.

Moreover, the persons in charge for the digital transformation needs courage for realizing changes.

Finally, he raises awareness that digital transformation does not come for free and that company leaders must be willing to invest. Accordingly, the amortization for these investment decisions should be calculated on a time horizon of five to ten years, not shorter. However, it is more expensive not to digitalize.

The *Commercial Director* insists that it is crucial to inform and involve the employees early in a change process wherever people or the organization is concerned. He explicitly mentions elder employees' fear of losing their job due to rationalization or automation.

Furthermore, the *Commercial Director* recommends to not believe everything that consultants tell. He has made the experience more than once that more was promised than could be delivered.

The *Digitalization Manager* would have started earlier. Moreover, he would have introduced the management methods to evaluate and prioritize projects effectively earlier rather than just digitalizing project by project without a view of the big picture.

Tera

The *CEO* chose the interviewees to be the *Head of HR* and the *Head of Automation*, apart from himself. The interview was conducted with all interviewees together.

According to the *Head of Automation*, the digital maturity is good with room for improvement. According to the *CEO*, the company is doing very well compared to their industry. Compared to what is technologically possible, there is a lot of room for improvement. The *Head of HR* estimates the digital maturity for her department as 40%.

The *Head of Automation* highlights that IT and digitalization have been allocated to the management level for maximum priority. This means that the management has the awareness that these topics are crucial for a sustained economic success. In the operational structure (which is based on a common management model), it is visualized that 'digitalization' is allocated as a management duty.

Within their organization structure (which they call Open Systems Model), many ideas arise among the employees and are escalated bottom-up until their realization.

But not all ideas are realized due to a lack of resources. Once an idea surfaces, it will be reconciled with the existing demand. Then, the potential effects on processes and the existing IT landscape will be evaluated. Only then, an idea will be subject to realization.

There are no awards or bonuses for ideas. This would foil the systemic approach. Someone shall yield an idea because want to benefit the company, not to gain an individual advantage. This would not be the culture that the company wants to establish.

Via the intranet, every employee can access strategic projects and be up to date what the management plans.

The employees are entitled to engage in the strategic projects and can therefore contribute actively to the development of the company. Each strategic project has a godparent from the management circle and must contribute to any of the strategic spheres. The prioritization of the project backlog is conducted at the end of every year by the management circle.

The *CEO* is deeply convinced that digital transformation means 10% digital and 90% transformation. In other words, 10% technology and 90% humans. Even within the company, there are many examples who see it the other way around. The *CEO* is certain that digitalization projects fail where this stance is

predominant. The key for him is to design the organization properly, to set up a framework in which digitalization can thrive. The employees, the humans must be taken along. If the *CEO* just tells people to work differently, more digitally, he will not succeed. The *Head of Automation* confirms this view. The *Head of HR* adds that this is not only important for digitalization matters, but also generally for every kind of measure that is implemented by the management.

The *CEO* chose the *Head of HR* to be part of the interview to demonstrate that for him, people and organization are crucial to digital transformation.

With around 100 employees, the company was very process-oriented. They had a high employee fluctuation because many thought that the individual does not matter anymore. By that time, they introduced systemic leadership with all executives in the company and shaped a project and process-oriented organization. They wanted to streamline the actions of all employees and create a workplace culture as a performance-oriented community. The complexity of the new projects requires interdisciplinary cooperation among the teams. The ultimate goal is to mold a systemic company. The project and process-oriented organization is supposed to strike the right balance between standardization and flexibility. The *CEO* describes an analogy where the company shall be an organism rather than a machine.

The *Head of HR* mentions the importance of attracting digitally affine candidates. Employer attractiveness is one of the twelve key aspects of their management system. The *Head of Automation* confirms that attracting young candidates who have grown up with digital devices is decisive.

Furthermore, the users must know what a tool is for and what purpose it has. If the managers fail to explain why a tool is needed, it might even be counterproductive, and the employees might adopt a defensive demeanor.

For the *CEO*, the mindset of the employees is very important for a successful digitalization.

Moreover, for the *CEO*, leadership is a crucial key for a successful digitalization. Leadership is one of the twelve key aspects of their management system. They interpret leadership as servant leadership and every executive must internalize there guiding principles of leadership. The *Head of Automation* adds that the value of a tool is significantly higher if the executives support them.

Digital transformation is one of the twelve key aspects of their management system. The management is aware of the fact that digital transformation is related to many other strategic spheres. When advancing in strategic endeavors, the managers usually consider the effects on the digital transformation as well. The *Head of Automation* adds that if the company is to advance in any of the strategic spheres, digitalization plays an important role.

The *CEO* recognizes that an organization is subject to constant change. All learning and development happen in loops.

According to the *Head of Automation*, no company can nowadays exist without a decent IT infrastructure. No employee can be productive without a reasonable IT

backbone. If a new tool is introduced, it is important to accommodate it within the existing IT landscape.

Furthermore, the *Head of Automation* adds that they have established a good IT landscape with suitable tools for every core process such as intranet, ticketing, project management and ERP. He sees the current setup as a stable foundation for further development. The *CEO* adds that if they invest in digital development, they have established the foundation so that it will become effective.

Regarding the ERP system, many postings happen automated, especially the intercompany settlements between the eight firms within the group. However, throughout the interview, it appears that the ERP system is significantly less relevant than in other companies. Rather, the wiki, intranet, ticketing, and project management tools are prime.

Previously, all applications were hosted on premises. The company has, as of the interview date, started to set up a hybrid infrastructure. Several years ago, the systems were very unstable, which was hindering the effectiveness of the company. They then invested significantly to stabilize the systems. That was the time when IT was elevated to a management priority. The daily business was less an issue, and they could focus on strategic developments. The inception of the competence center automation was the climax of that development. The competence center was established to exploit synergies between the departments. Moreover, they adopted an external perspective, considering also industry trends and academic developments.

The company has established a so-called gardener team and the *Head of Automation* forms part of it. It is their responsibility to enhance the employees' digital competencies. Moreover, they serve as the primary contact for every employee regarding the tools, especially the intranet and project management tool. From colleague to colleague, one's inhibitions shall be reduced.

The various models that the management circle uses are quite abstract. In the past, they have tried to convince every single employee to take an active role in understanding and developing the models. This has turned out not to succeed as many of the workers were not interested in such considerations. Now, they only offer to everyone to take part, but do not oblige them. The employees are only required to know the most fundamental strategic directions. The management has recognized that one size does not fit all, meaning that individuals and teams need different kinds of communication, depending on their maturity and background.

For the *Head of Automation*, digitalization helps to achieve transparency. Moreover, it helps to keep records of improvement processes.

The management system also represents the digital transformation strategy. It operationalizes the strategy into specific projects. By working on the four strategic spheres and with digital transformation being a key aspect of the organizational model, it inherently always forms part of any strategic development.

Furthermore, there are specific IT-related projects to explicitly foster the digital infrastructure, such as document management system or the server landscape.

Apart from sustained success for companies, digital transformation will be inevitable for human survival, according to the *CEO*. Humankind will not be able to solve the gigantic challenges, especially regarding energy supply, without making use of smart digital systems.

No negative side effects of digitalization were mentioned.

The *Head of HR* recommends not forgetting about the humans that eventually will work with the tools that the digital transformation yields. The *Head of Automation* confirms that.

Moreover, the *Head of Automation* advises to place the responsibility for digital transformation within the management circle. The *CEO* adds that this responsibility is not delegable.

Peta

The *Head of Digitalization* is the son of the founders and is 27 years old. He has been in the company for one year. The *Head of Digitalization* had never planned to enter the family business, but when the responsible IT employee left the company unexpectedly, he decided to help out temporarily on a part-time basis parallelly to his main job. He has completed an apprenticeship as computer scientist with a specialization in application development. After that, he worked for eight years in the IT support for ERP systems in the medical industry. When the company grew and an ERP system became necessary, he decided to fully take on the job. The only condition was that his parents would not be his direct supervisors. Formally, his supervisor is one of the group leaders. In the long run, he does not desire to be the sole managing director of the company. Either he remains a leader of one of the groups or teams, or he will engage co-directors with whom he can lead the company. He does not feel confident heading a company. His parents will still lead the company for the next five to ten years. According to the Manageress, she and her husband demand the commitment from their children by 2023 if one of them wants to take over the company someday. In the Vision 2030, both are still active in the company. The *Head of Digitalization* regards digital transformation partly as an opportunity and partly as a thread. He is aware of the risks that, for example, cloud computing comes along with.

The *Office Worker* is occupied with procurement duties and has been in the company for six months. She is 43 years old and remembers the time when she still used fax machines and typewriters. Moreover, she has been the key user in the procurement department for implementing the new ERP system. The *Office Worker* is aware of the risks such as data security and hacking that a company faces due to digitalization. But she rather emphasizes her personal advantages and weights them more heavily than the corporate risks. She explicitly mentions that she can work faster and simpler.

The Manageress founded the company together with her husband who is the *CEO* in 2009.

The founders used computers from the very beginning. Even if most of the computational efforts were very basic word and calculation software, it was

digital. That was also when the *Head of Digitalization* got in touch with computers as a child.

The founders used cloud services already in 2014. For them, it was important to for several persons to work on one document simultaneously. Moreover, she wanted to get rid of paper.

In early stages of the company, they built their own solutions based on Excel for basic operative processes such as offers or calculating provisions.

The *Head of Digitalization* thinks that compared to their industry, the company is a digital vanguard. However, there is still plenty of room for improvement. This statement is surprising considering that the company has only been digitalizing for 18 months, according to the *Head of Digitalization*.

The Manageress opines that the company is extremely digital compared to other skilled crafts businesses.

The company has a written vision how it is supposed to be in 2030, respectively in eight years. Regarding digital transformation, it does specify the following: People will be able to work in the office and remotely in their home office. The ERP system is fully implemented. All processes and structures are standardized and digitalized. The employees find all their summarized tasks and the key performance indicators on their individual dashboards. Procurement, accounting, and human resources will be managed centrally. Apart from that, the six subsidiaries work autonomously and on their own responsibility. Moreover, the company esteems itself as the digital vanguard in the industry. Furthermore, they will have established an online shop that contributes significantly to the company's sales.

The *Head of Digitalization* mentions that in the future, customers shall be able to check their order status online in a portal. Thus, he demonstrates a view that transcends the organizational boundaries by including external parties in their IT considerations.

The Manageress states that she and her husband want to create a company that also functions without them. Only then, it will have long-term value.

The rapid growth has inhibited the digitalization because internal resources are required otherwise. On the other hand, the growth has made it inevitable to digitalize in order to be able to deal with the growth.

As the main drivers for digitalization, the *Head of Digitalization* mentions himself and the CEO. The *Head of Digitalization* focuses on *Peta* and software, whereas the CEO is concerned with the digitalization towards the customers. The CEO has dealt with digital customer interaction during the pandemic and gained good knowledge. He was inspired by other companies that he was in contact with. However, the *Office Worker* believes that the CEO does not know a lot about digitalization and apparently, he himself occasionally admits that. According to the *Office Worker*, both CEOs rely on and trust their son, the *Head of Digitalization*, and his team that he will take care of the digital transformation of the company.

The Manageress states that the founders are frequently in contact with other entrepreneurs. The exchange helps them to see other perspectives. Moreover, they engage in professional trainings.

Social media is used for marketing purposes.

Most of the innovation arises from a practical necessity and does not follow a pre-determined digital transformation path.

According to the *Office Worker*, the CEOs champion the digital transformation of the company. Moreover, the *Head of Digitalization* pushes it from a realization point of view. It does not have to be the top management who pushes digital transformation, but they must absolutely champion the change.

Moreover, she thinks that also employees contribute with their ideas, especially the younger ones who recently finished school or university. They might even expect the usage of digital tools in a company and might decide against a company if it is not sufficiently digital. The Manageress also states that the ideas of the employees are very important.

For the *Office Worker*, another driver is to keep up with other companies.

Furthermore, she mentions that sometime the support for certain tools ends and forces the users to upgrade.

The pandemic was a driver for the digitalization. The company launched a web shop which accounts for more than 10% of the sales. Moreover, they transformed their open house Sundays into a digital format via video conferencing.

The company uses a tool to manage trainings.

The *Office Worker* has been quite new in the company. Her previous employer was vastly non-digital and for her, it was quite a change that she had to get accustomed to.

The *Office Worker* opines that employees can always get trainings but is not aware of a specific framework. There is, however, the idea to establish an academy. It essentially comprises online learning resources such as videos and instructions that are produced by employees for employees. Personally, she has not used it, but other employees apparently use it. The Manageress mentions a set of different trainings that the management and the employees have attended. So clearly, this is not just a claim, but actually happens at the company.

Neither of the founders has a particularly high IT affinity. But they have been eager to learn and taught the important skills themselves.

In the company, everybody is on first-name terms. The *Head of Digitalization* calls it a *people culture* rather than a *number culture*. The *Office Worker* confirms that the work atmosphere is very pleasant and casual. All employees seem to get along with each other quite well. There are minor disputes just like in any company, but nothing severe. The corporate culture is very enjoyable.

The management has also visually (furnishing and room layout) arranged for a setup that fosters collaboration and wellbeing. According to my observations, the furnishing is functional and invites to casual chats. The *Office Worker* mentions

that these spaces are also available for meetings. The employees can sit on swings or deck chairs.

As of the time of the interview, the digitalization department consists of 3,5 full-time equivalents. According to the website, the headcount has risen to 6 full-time equivalents by April, 2024. This is an increase of 71% in just 20 months.

The *Head of Digitalization* states that physical IT hardware is expensive. There must be an awareness for a necessity to invest regularly. The Manageress admits that she and her husband would have never thought that they would spend so much money on an ERP system as they are doing currently. She plans with an amortization time of two to five years by being faster.

The organizational chart is outdated and currently being renovated, according to the *Head of Digitalization*. This is an indicator that the company has not achieved to properly manage its rapid growth structurally as the *Office Worker* suggests.

The *Head of Digitalization* states that in recruiting, they search for candidates who share the company's goals. The *Office Worker* mentions that the corporate culture was one of the reasons to join the company.

The company has established a goal management method that aims at fostering constant improvement by every employee on an individual basis. The employees shall gain motivation by improving and comparing to other employees. Moderators for each group ensure the consistency of the individual goals. In monthly meetings, goals are evaluated and set for the next month. The advantages, according to the *Head of Digitalization*, are (1) that the employees see the impact they have on the organization and that (2) the change is measurable. The yearly goal is set once a year and individual goals are deducted from it, going through group and team goals. The method resembles OKR and was adopted from a consultancy firm. The *Office Worker* has grasped the sense of the method; however, she thinks that the individual goals are supposed to be part of her daily business anyway. For her, the method seems a bit bloated, even if she understands that it may be beneficial in some cases.

For the *Office Worker*, management championship of digitalization is crucial. Compared to her previous employer where there was no disposition to invest and improve in digital transformation, the management of *Peta* ensured their participation and proactiveness. She deems it important to start in any direction and pursue a path, even if it later turns out to be the wrong path. Then, adjustments can still be made.

Apart from the usual setup with smartphones and laptops, there are no significant other digital devices.

The *Head of Digitalization* states that the corporate culture regarding digitalization and continuous improvements has not been internalized by every employee. Some employees lack digital knowledge. Other do not yet trust the digital tools to fully rely on them, and consequently create their own analog workarounds which foils the desired results of digital transformation. The *Head of Digitalization* notes that they must augment the digital maturity of the employees on an individual level.

The ERP system that is being implemented as of the date of the interview, is being introduced in waves. First, the accounting and procurement departments were implemented, after that follows warehouse and logistics. Finally, project management shall be implemented.

The *Office Worker* states that the rapid growth in the recent months has hampered the company's processes. She is afraid that if the company wants to achieve too much in too little time, they might not be able to establish the right structures.

According to the *Office Worker*, the company is very responsive to new ideas and extremely fast in realizing ideas. She does not refer to digital ideas only, but in general such as establishing new offices. Ideas are not discussed in depth by many people, but simply realized. Sometimes, however, she opines that ideas could be thought through more thoroughly. The Manageress confirms that her husband tends to propose ideas that he has developed on his own without consulting any other person. Furthermore, the CEO permits a high degree of scope for development within the teams to find an appropriate solution. This is highly motivational for the employees, according to the *Office Worker*. The employees might even be more willing to let go of well-tried tools or procedures.

One of the reasons to introduce a new ERP system is that the previous one had an outdated database structure.

Apart from the ERP system, the company uses isolated tools that they have programmed according to their needs over time. But they are only scarcely interconnected. The *Office Worker* confirms that there are custom programmed tools, for example for project management.

The *Head of Digitalization* was not part of the decision and the selection process for the new ERP system. The company engaged an external project lead to assist them because they did not have enough experience.

The company already uses cloud computing, alongside with servers on premise.

The *Head of Digitalization* rates the company as technologically very flexible. Being a technical company, they want to excel with the latest technologies.

Some facets of a company cannot be digitalized. This applies especially for HR, such as work contracts. It also applies for logistics because a shipment needs to be accompanied by paperwork.

By using video conferencing systems, the sales and consulting process has been sped up significantly. Moreover, it reduces a lot of travel costs for the company.

The *Head of Digitalization* states that they introduce new procedures and tool with the corresponding departments, not for them. They want them to be involved in the process all along the way.

The *Head of Digitalization* is the co-project-lead for the introduction of the ERP system. Moreover, he sees his responsibility to establish formal IT structures. Even if he is formally the leader of the team, he emphasizes the importance of every team member and that he cannot know or resolve every IT topic. He tries to be a normal employee without any privileges but confirms that his belonging to

the CEO family is not always possible to hide. The *Office Worker* also believes that he has a lot of influence on the development of the company even if he formally is not part of the management or the steering committee.

According to the *Head of Digitalization*, the hierarchy allows very direct communication. The hierarchy comprises of four levels: Management, group leaders, team leaders, and staff. The management comprises of the two founders. There are three group leaders.

Formally, there is no IT department, but a digitalization department. The *Head of Digitalization* still calls his team sometimes IT, sometimes digitalization. The reason for that taxonomy is that IT is just the technology, but they wanted to give it a human-oriented name, with digitalization being people working with IT. This includes structures.

There is a steering committee which comprises of the CEOs and the group leaders. They meet regularly, usually once per week. The *Head of Digitalization* is not part of the steering committee.

The *Office Worker* was chosen to be a key user for the new ERP system because she started to formally be the procurement department and the procurement was one of the first departments to be implemented. However, she had no prior experience with ERP systems.

The Manageress states that most employees have a portable computer. Moreover, they introduced voice-over-IP in 2019 so that the switch to home office during the pandemic was easy.

The *Head of Digitalization* states that the company does not have an explicit digital transformation strategy, but a general strategy for the development of the company.

The *Office Worker* cannot relate to the term strategy as such. Rather, she describes that there were no structures at all in the processes when she started to work in the company. There was not even a centralized procurement employee or team. Rather, everybody ordered what they deemed necessary. Formally, the Manageress was in charge of purchasing the material.

According to the Manageress, they want to optimize processes to be leaner and faster. Customer satisfaction shall be at the maximum.

The *Head of Digitalization* wants the employees to work effectively with IT. Moreover, the digitalization shall facilitate a relaxed rather than an overstrained way of working.

For the *Head of Digitalization*, digitalization is working with IT and therefore simplifying and improving processes. Every task that can be digitalized and automated shall be digitalized and automated. The humans shall focus on tasks that cannot be automated. Efficiency is important to him.

The *Head of Digitalization* states that among the members of the steering committee, it is clear that digitalization must contribute to make everything as simple and as effective as possible.

For the *Office Worker*, digitalization is mainly about getting rid of paper. Information is stored centrally and transparently. Moreover, she mentions the importance of connecting different tools via interfaces, such as the ERP system and the bank. Furthermore, digitalization permits remote work.

The Manageress expects transparency, speed, flexibility, time savings, and a general view of the company based on figures and facts as an outcome of digitalization. Moreover, she wants employees to be able to work independently in terms of place and time. Finally, she wants to get rid of manual tasks that can potentially be automated.

The *Head of Digitalization* sees a potential risk of alienation between people due to digitalization. However, a strong corporate culture can prevent that to a huge degree.

The *Head of Digitalization* emphasizes wholeheartedly that every employee shall be given decent IT hardware and software. Additional gimmicks such as height adjustable desk further advance the motivation of employees to work with computers.

For a company in general, he recommends working with a goal management method.

When implementing an ERP system, the *Office Worker* recommends a thorough preparation phase. There will always be aspects that could not be anticipated, but the aspects that can be anticipated should be properly treated. The Manageress confirms that.

Moreover, the Manageress emphasizes that the employees have to be taken along on digitization projects.

Furthermore, the Manageress mentions the importance of clear structures and precise processes.

Additionally, she recommends employing an inhouse IT department if the size of the company permits that.

Moreover, she recommends regularly talking to experts in the field of digital transformation.

In retrospect, the *Head of Digitalization* would have strengthened the structures earlier on. Moreover, he would have prioritized differently. He does not specify how exactly. But he emphasizes that the learning process itself was valuable.

Regarding the company in general, he would have started to foster the new corporate culture earlier. This is an endeavor of many years. The new culture was initiated in a time when the company had an economically difficult phase. Had the company started to digitalize earlier, they could have lived through the crisis better.

The *Office Worker* would place attention to not change to many things at a time, but step by step.

The Manageress has learned to put emphasis on the fact that the software landscape should not be too scattered with too many tools.

Moreover, she would engage more workforce for the introduction of the ERP system. They have underestimated the effort that the implementation requires.

Exa

The *CEO* has been in the company for five years.

The *Manager for Production Planning and Control* has been in *Exa* for 24 years.

The *Deputy Head of Project Management* has been in the company for 26 years. He already went through his apprenticeship in *Exa* and was promoted gradually to the position he now holds. During that trajectory, he has attended several further education and training in technical and managerial skills. His direct supervisor is the *CEO*. His responsibility is to realize projects from the technical perspective from the first customer inquiry until the series-production readiness. The *CEO* presented him as a person from the sales team, but the *Deputy Head of Project Management* only partially assumes sales responsibilities. At some point during the interview, he refers to himself as a salesperson. Their main sales channel is a trade fair every year or every second year. In fact, there is no actual sales team in *Exa* that sells products. Instead, they identify as a system supplier that offers customized solutions to their customers. *Exa* sells the company rather than the products. Their competitive advantage is to offer three subsections that usually are delivered by different companies, namely toolmaking, foundry, and surface finishing. For the *Deputy Head of Project Management*, digitalization is a chance rather than a threat. However, he imagines that for some people, it represents a threat, primarily because it might cause job cuts. The affected people will be impossible to convince, especially if there are no other positions they could assure otherwise. For him personally, it allows him to work faster, smarter, and safer.

In 2009, an ERP system was implemented by the *Deputy Head of Project Management* and the current *Commercial Director*. According to the *Manager for Production Planning and Control* it was already much better than the previous rudimentary merchandize management system. For the *CEO*, it was still very limited compared to a full-scale ERP system. Before 2009, the planning was constrained, and the introduction of the ERP system was a big leap forward.

In the production, *Exa* has gradually upgraded to machinery that permit machine data logging to gain numerical insights in the production process. The first digital machine was purchased between 2007 and 2012 (the *Manager for Production Planning and Control* is unsure when exactly). These data are further processed by a production control station which is, in turn, connected to the ERP system.

In 2014, an intranet was introduced. It gives every employee access to processes, information, workflows, audits, projects, meeting minutes, and even lunch menus. For the *Manager for Production Planning and Control*, it is a very good tool. All employees use it, according to him.

The digitalization really started when the three brothers entered the company, starting in 2015. The *Manager for Production Planning and Control* is sure that with the previous generation still in charge, the digital development would not have taken off as it did with the new generation. Even more drastically, the *Deputy*

Head of Project Management states that the previous management has strongly impeded any digital development. Their attitude towards computing devices was dominated by a fear from cyber-attacks. The only computer was only turned on twice a day and there was only one computer for everyone. In contrast, the digital transformation since the generational succession has been tremendously successful. The absence of constant doubts and skepticism by the previous management was pivotal for the positive development.

In 2017/2018, *Exa* started to implement the KPI controlling system. It helps them to see all relevant company data in a well-arranged manner. Data quality is crucial to gain meaningful insights.

In 2017/2018, *Exa* introduced a manufacturing execution system (MES). The MES is the tie between the production data acquisition system (shopfloor level) and the ERP system (company level). For the *Manager for Production Planning and Control*, it allowed him to conduct detailed planning. The accuracy of the material and resource planning has greatly improved. Moreover, pricing for product became more solid.

The ERP system focuses on the customer, such as sales figures and lean processes in the sales department.

Exa uses a document management system.

Soon, the ERP system shall be upgraded. The requirement specifications were composed by the management and were based on the knowledge from the existing ERP system. Therefore, the specifications could be formulated very accurately. These specifications were reconciled with insights from competitors. For the final selection of the ERP system, the location was irrelevant. It does not have to be a local provider, but the one that fits best the company's needs.

On of the next milestones will be the implementation of cost accounting.

The brochure by their IT service provider describes *Exa* as an exemplary innovator and an early adopter. According to the *CEO*, they always try to be ahead of their competitors. They have realized that they are very mature regarding software, which gives them a competitive advantage. They use a production control station with real-time data which allows high transparency in the production process.

The *Manager for Production Planning and Control* estimates the digital maturity as 6/7 out of 10. He still sees a lot of potential in the predominantly manual departments in the production.

For the *Deputy Head of Project Management*, digitalization is about paperless working. Moreover, he emphasizes the interconnectivity between systems. Generally speaking, digitalization is about making use of the myriad of possibilities 'out there'. He estimates the digital maturity to be 70-75%. The most important digitalization steps are finished. He is aware that there are more possibilities, but for the company size and the industry, he deems *Exa* to be very advanced. He is skeptical that *Exa* even must reach a stage of digitalization such as in the automotive industry where the newest technologies such as AI are employed.

The *Deputy Head of Project Management* adds that for many employees, the pace of digital innovations is rather too high than too low. Personally, he also thinks that existing tools should be perfected before introducing new systems. After innovations, there must be a phase of consolidation in order to not overstrain the employees. It is crucial to make the employees realize why they shall use a certain tool or follow a new procedure. Even if they offer voluntary trainings, some employees opt for not joining. Moreover, the middle management has a critical role in the digital transformation process. They have to convey the message in a plausible and convincing way. With a high credibility, the employees rather condone shifts of directions.

All investing initiatives are driven by financial considerations. By making the costs and benefits transparent, they establish a stable foundation for investment decisions.

The digitalization does not follow a predetermined strategy. IT projects are considered one by one and usually on their own.

Exa formulates yearly goals as part of the quality management, which is required by the ISO 9001 norm. But most of the goals are medium-term goals rather than long-term goals. *Exa* is still in upheaval due to the switch in business models and the *CEO* states that first, they need a phase of consolidation.

As part of the KPI controlling system, goals were also formulated.

The *CEO* mentions that customers are the primary drivers of digital innovation. Moreover, the management drives the digitalization. Furthermore, there are some very interested and engaged employees who propose new ideas for digitalization. According to the *Deputy Head of Project Management*, it is important that the ones who drive the digitalization have an overview of the costs that incur. Every digital initiative must render some benefit, such as time saving. Just nice to haves are not feasible.

The *Deputy Head of Project Management* adds that the introduction of the new business unit was a booster for their digitalization. The new requirements forced *Exa* to innovate digitally. At first, they had to make up for decades of inactivity. But after leveling with market standards, they gained momentum and overtook most of their competitors.

There is no formal innovation management and no reward system for ideas, either. Rather, the hierarchy is very flat so that employees refer to the management directly if they have suggestions. Due to the fact that three brothers lead the company, they in themselves cover most topics and there is only a slim middle management level, according to the *CEO*. Contrarily, the *Manager for Production Planning and Control* states that there are eight or nine middle managers. This is relative to the company size quite a lot. Moreover, the fact that he does not know the exact number of middle managers and that he is a bit unsure of who exactly is a middle manager gives evidence that the organizational structures are not fully established, even if there is a formal org chart.

The *Manager for Production Planning and Control* states that usually, his employees first address him and then he, in turn, makes a first assessment before

he directs the idea to his direct supervisor, which is one of the CEOs. His personal assessment criteria are egoistic and not aligned with other managers.

The Covid pandemic has increased the share of online video conferencing and email communication, according to the *Manager for Production Planning and Control*. Apart from that, he did not mention any significant changes that the pandemic triggered.

The *Manager for Production Planning and Control* states that the main drivers are, in order of importance, the *Commercial Director* and the quality management representative. Moreover, the *CEO* is a driver for pricing innovations. The other two brothers are only involved in the decision-making process, not so much in the digitalization itself.

Exa has an employee with the knowledge and motivation to design and program dashboards that visualize data for business intelligence purposes. He is not a programmer or developer, but a key user for the specific tool.

The *Manager for Production Planning and Control* deduces training needs for his employees from his KPI dashboard. If he recognizes that a KPI deteriorates, he will induce training sessions for the corresponding employees to get back on track.

The company has paid for the further education and training that the *Deputy Head of Project Management* was able to achieve in his year-long employment. The only condition was to return to the company afterwards. This is a strong sign that the management values the individual training of its employees.

Exa constantly invests in its digitalization.

The *CEO* states that it is crucial to take the employees along in the digitalization journey. If they see that the digitalization projects are successful and benefit the company, they will embark on the journey. *Exa* involves the employees by providing a lot of information. This happens through the aforementioned training sessions where they can also give feedback. The sessions were conveyed 15-20 times a year before the Covid pandemic. Some were mandatory, some voluntary. Since the pandemic, the number of sessions has decreased significantly, the *Exa* aims at increasing the frequency again.

The *Manager for Production Planning and Control* has been in the company for 24 years and therefore has lived through many changes and experiences. When he started, there were not even emails, but only a fax *Exa*. He had always been in favor of digitalization in the company because he was used to computers from his private life. *Exa*, by that time, was very outdated regarding IT. Additionally, the staff was generally older, and these employees used to bridle at computing devices. But with every successful digitalization step, the company benefitted. The *Manager for Production Planning and Control* is aware that upon implementing a new tool, initial problems are inevitable and must be solved, but do not derogate the importance of evolving digitally. He emphasizes how exciting it is for him to contribute to the digitalization, so he evidently has a supportive mindset. Even when he was a regular office worker without management duties,

he tried to optimize processes, but was limited due to the constrained technological possibilities in the time.

The older employees still struggle with new digital technologies at times, according to the *Manager for Production Planning and Control*. They need more guidance and more frequent trainings, but then they also accept and work with the tools. The best way to convince them is to oblige them by introducing the new tool and banish the old one. He is sure that if they had the chance to elect, they would always choose the conventional tool. However, he also mentions that with each new tool, even the older employees become more confident with digital technology. The *Deputy Head of Project Management* confirms that stance. However, he adds that also the younger employees can struggle, but due to a lack of interest.

The *Manager for Production Planning and Control* is conscious that a digital work environment is constantly more important as an employer attractiveness factor in recruiting. With regard to the skilled-labor shortage, the *Deputy Head of Project Management* adds that for simple tasks, there might not be anyone at all in the future to do the job. Therefore, repetitive manual tasks must be automated wherever possible.

The *Deputy Head of Project Management* thinks that the best way to enthuse employees is when they realize their personal benefits, for example less extra working hours that were caused by human mistakes and do not occur anymore with a digitalized solution.

The manufacturing workers must book their times at their workplaces to acquire their spent resource data.

Exa uses robots in the production facilities. But there is no direct human-machine interaction.

Exa is very fast and lean in its decision-making process. Often, especially for minor changes, the responsibility alongside the decision power is placed within the corresponding team. According to the *Deputy Head of Project Management*, it is more difficult to inform every user about the change and enable them to work in a new way.

Exa has an internal initiative which serves as a forum for all kinds of employee engagement activities such as trainings, information meetings, or townhall meetings.

Exa has benefitted from major changes regarding their business model in 2015. The staff has lived through these significant changes and in this vein, many structural changes have been implemented. This resulted, according to the CEO, a mindset of adaptability and willingness to change. Simultaneously, these changes helped the management to justify certain IT projects as the requirements from the market became more discerning.

The previous CEO, the father, has always been supportive. In the previous business model, the requirements from the market were not discerning regarding digitalization or quality management. The new business model and the business succession with the three brothers coincided, which was a lucky coincidence.

The *Manager for Production Planning and Control* greatly benefits from the KPI controlling system. He bases his daily management decisions on the data and derives conclusions. The same applies for the *Deputy Head of Project Management*. The tool gives him significant advantages and allows him decisions based on actual data, whereas previously decisions were based on the gut feeling.

Exa tries to be flexible in every way, not just technologically, according to the CEO. Moreover, he is aware that by using solutions by major providers like Microsoft at scale, it reduces the need for interfaces between individual tools. For him, there is no question that nowadays, all tools must be connected to each other to gain maximum value from the data in the company. However, he mentions that this reduces the dependency from these big providers. For the CEO, flexibility in the usage of a tool, especially ERP system, is crucial. He does not want to depend on a service provider or system house to make minor changes in the code.

The *Manager for Production Planning and Control* wished the management had chosen to introduce a new ERP system earlier. He is aware that it is a major investment decision that has to be taken carefully.

Exa does not have an explicit IT department. Rather, two persons take on IT responsibilities alongside their main position. They are supported by an external IT service provider.

The IT service provider is a rather big company. Before that, *Exa* was supported by a small IT service provider. However, they could not fulfill their expectations anymore, which is why they switched. But even the new provider does not actively inform about market trends and potential improvements. Rather, this is done sporadically by the management.

Digitalization has had an impact on the organizational structure in the team of the *Manager for Production Planning and Control*. By a more pronounced division of labor, the work that has previously been done by twelve people is now completed by two persons in a much more coordinated and purposeful manner. In turn, the other persons now conduct other parts of the operations process. The areas of responsibility have therefore been refined and are now more focused. The results are now a lot better than before. Moreover, the overall headcount in the team has been reduced through an increase in productivity.

The *Manager for Production Planning and Control* does not know about any digital transformation strategy. He is engaged in the decision-making process for major tools like ERP or MES, but the final decision is taken by the management.

The *Deputy Head of Project Management* is not aware of any common digital transformation goals or roadmaps. New digitalization projects are realized based on short-term demands.

In the course of the interview, the CEO has started to realize that they need more long-term strategic plans.

For the CEO, digitalization is about data and finally about transparency. As the CEO, he wants to be able to know the KPIs of every department at any time. The

CEO has developed this opinion about what digitalization means from a managerial perspective in the implementation process of the KPI controlling system.

For the *Manager for Production Planning and Control*, digitalization is about unifying processes in a lean and paperless way. Moreover, he wants to achieve a better planning ability and reliability.

Furthermore, he mentions that as a corporate goal, *Exa* shall generate more sales and more customers through digitalization. However, everything he has stated in the interview does not directly pay dividends to that goal. Upon being alluded to that contradiction, he does not further elaborate on the matter. Rather, he adds that by increasing the quality of the products through automated quality check, *Exa* could save big amounts of money that are currently lost due to cull.

There do not seem to be commonly defined or communicated digitalization goals.

The *Manager for Production Planning and Control* sees job losses due to automation as a potential negative aspect of digitalization. The kind of jobs that tend to be reduced due to automation have low-skilled profiles that are difficult to employ in other positions.

For the *CEO*, transparency is crucial. Moreover, to react quickly to changing environments in a software landscape with manageable complexity, for example react to changing material prices like during the Ukraine war.

The *Manager for Production Planning and Control* recommends considering which processes can be improved through digitalization. His main focus is to improve the planning reliability that can be greatly enhanced through digital tools.

The *Deputy Head of Project Management* is sure that the only way a SME can digitalize is with the technological knowledge and processual experience. According to him, it is almost impossible to induce a digital transformation without adequate expertise in the company. Moreover, he recommends an active exchange on management level with other companies, especially from the same industry. A profound network of entrepreneurs is highly beneficial to get insights from other firms.

The CEO would not make any major different decision in retrospect. There are some minor adjustments, but generally the learning curve has been very valuable. Generally, they could have taken a few minor shortcuts, but the path they have gone has been instructive in many ways.

Regarding digitalization, the *Manager for Production Planning and Control* would have implemented the ERP system significantly earlier. That would have saved them lots of stress and dispute.

Furthermore, he would have started the digital transformation significantly earlier, even with the previous CEO. He thinks that they might even have kept up with their Chinese competitors in the conventional business unit if they had automated their production earlier. The economic slump during the crisis starting in 2008 has led to job cuts by 20%.

The *Deputy Head of Project Management* has learned to consider the basics when introducing an ERP system. With his experience from one implementation when he was responsible, he would not assume the job a second time. Moreover, specifications should be clearly defined in a written way. What seems logical to one person might be completely different for another person. Furthermore, he mentions that the budget for an ERP introduction will almost certainly be exceeded by far. In addition, the users must be involved frequently to gain their knowledge and perspective. Lastly, he would be overly cautious with the selection of the system house. Their goal should not be to sell as many tickets and additional modules as possible, but to assist a company.

Zetta

The primary data that was generated for *Zetta* consisted of two interviews with the *CEO* and the *Management Assistant*.

The *Management Assistant* has been working for *Zetta* for four and a half years. She is currently pursuing an extra-occupational master's degree which is offered digitally by a remote college. Her view on digitalization upon briefly researching the term is rather the one of digitization in the context of this thesis, as the primary focus is converting analog artefacts to digital data. Her view prior to her research was process oriented. She is responsible for data security, quality assurance, marketing, sales operations, and assisting the *CEO*. The *Management Assistant* sees digitalization as a chance for a company. Her scant substantiation was that she is young. Upon further elaborating, she thinks that age plays at least partially a role in how people perceive digitalization. More generally, she believes that there are companies who actually have already benefitted from digitalization, so that makes her think it is a chance rather than a threat. Personally, she has already benefitted from digitalization it has made her daily business easier in some cases.

Zetta uses a CRM system since 2017. The *Management Assistant* does not like it because it is outdated. The *CEO* decided to not update the system and therefore, it is technologically stuck at the stage when it was implemented.

Zetta is not yet using an ERP system. However, the *CEO* plans on introducing an ERP system soon. It is his sole responsibility to drive the implementation, but he lacks the time to do so currently. When the time comes, he wants to involve the users in the decision-making process. The *CEO* mentions that he is very design-oriented and that he would choose the system with the most intuitive user interface. However, he has recognized that this is not the only deciding factor and will let the users decide whichever product they prefer. He is even willing to replace the current CRM system in favor of a more extensive ERP system that inherently offers CRM capabilities. He emphasizes that the users must be in favor of the tool.

The *CEO* estimates the digital maturity of *Zetta* to be at the very beginning. The *Management Assistant* confirms that. In comparison to other companies, he places *Zetta* in the lowest third. The employees use a lot of Excel sheets and write their offers in Word with extensive usage of templates. It is not an ERP system, but is a system based on clear processes that work as long as every user

adheres strictly to the established organizational structures. Moreover, the office is far from paperless, with the printer being an important device for the employees. As an observation, even the *CEO's* desk is overloaded with printed documents and folders. According to the *Management Assistant*, there are days when it is even more overcrowded.

The processes are currently functional even if they are outdated technically, but the *CEO* wants to digitalize more. This is the internal and process-oriented perspective on digitalization, which the *CEO* apparently regards as the 'real' digitalization. He neglects that being a firm that develops its own software and offering digital products, *Zetta* has already made significant digital transformation efforts.

Especially in the production department, *Zetta* is fully analog. For example, the assembly instructions are printed and attached to each workplace, which implies that they are never up to date. As already mentioned several times, the *CEO* wants to digitalize, but simply does not do it. He regards the digitalization of assembly instructions as a big step, even if objectively it is a minor effort.

When they started to develop their own software, the awareness for digitalization rose.

The *CEO* is aware that digitalization is inevitable if his company is to survive.

The products that *Zetta* sells are mobile digital cameras for drainage inspections. As such, they have a digital component because they produce digital files. However, only until recently the company has started to write its own software as an add-on to the camera system. The hardware plus the software makes for a complete system, according to the *CEO*. The customers purchase an unlimited software license that even includes updates. *Zetta* uses the complementary software as a sales argument and the *CEO* states that they were already able to sell camera systems that they would not have sold without the additional software. The margin for the camera system is significantly higher than for the software licenses. However, he is not sure for how long they will be able to maintain that monetization strategy as the software hardly generates any revenue this way. By offering free updates, the *CEO* thinks that it is a fair deal if the customers provide feedback on the software in turn. He is aware that this is an exception and regards this stance as a competitive advantage for *Zetta*. Usually, software providers charge for updates and still expect feedback from the customers. His way is unique not only in his industry, but in the software business in general, the *CEO* thinks. He wants his customers to fully trust his company and the products they sell.

The software must be flawless and easy to use. It must support the user to produce data with high quality.

Zetta provides webinars to customers in order to generate leads.

The *CEO's* perspective on digitalization is strongly centered around the products and sales. He regards digitalization as an important part of the value that his products generate. The result of an inspection is a set of videos, pictures, and reports. They are provided to the client via a standardized interface.

Their industry is digitally very immature. The main driver for creating a specific software for the operation of their camera systems was that they could not find any supplier for that niche application. There are suppliers which develop just the software, but without satisfying system integration. Four years ago, they decided to create their own software to fill that gap. Two and a half years ago, they started to develop their own software, which was a big step for such a small company. The *CEO* compares it to founding a new company in the open countryside. He emphasizes several times how far behind the competitors are and that he regards *Zetta* as a pioneer in the market.

The software has three modules, which of the first two have been released. The third and most important module is still two years away from release.

After finalizing the third module, the *CEO* wants to implement AI for automated reports or defect recognition. Moreover, he imagines operability via gestures and many other ideas. However, he hopes that these AI solutions will be developed by the big players in the industry and that SMEs such as *Zetta* can rely on these systems rather than dozens of firms developing their own flawed solutions.

The employees do not contribute to the digitalization of the company, according to the *CEO*. Hardly ever does the *CEO* receive requests for digital initiatives from the employees. If he does, it is usually just a software with an isolated purpose. The *Management Assistant*, however, opines that she and her colleagues do indeed partake in digital initiatives. But the ideas are never realized. In a very revealing comment, upon being asked what happens once she presents an idea to *CEO*, she says that then an idea lounges around for a few years. For example, she had investigated regarding tools to digitalize the documentation in the production process. Two years later, the *CEO* decided to test the tool, but when the key user left the company, it was put back on hold.

Even if it sounds as if the *CEO* is the bottleneck in the digital transformation, the *Management Assistant* denies that. Rather, she ascribes it to the lack of human resources and time. The *CEO* is very much engaged in sales activities. If they had more salespersons, the *CEO* could dedicate more time to the digital transformation of *Zetta*, according to the *Management Assistant*.

The *CEO* attends expert symposia for his industry, but not specifically for digitalization.

For the development of their software, *Zetta* has established a software programming team. It consists of two software developers.

Zetta uses social media as a recruitment channel.

The *CEO* believes that in the future, the new generation of employees will not want to work with paper anymore, but fully digital. He is aware that *Zetta* will need to digitalize to be attractive for younger employees.

The *CEO* is aware that digitalization is costly, and he is willing to invest in digital tools, but the expenses must be controlled.

For data security according to GDPR, *Zetta* has contracted an external data protection officer. The *Management Assistant* coordinates between him and the company.

When there are digital innovations in the company, there are always employees who grumble at the changes. These persons must be convinced with good arguments as to why they must change their habits. Generally, the *Management Assistant* thinks that the company culture is beneficial to induce and support change.

I observed that all employees refer to the *CEO* formally with 'Sie'. According to the *Management Assistant*, this is intended as he wants to maintain a certain hierarchical distance to his employees.

During the Covid pandemic, when interpersonal contacts were restricted, *Zetta* has set up the hardware infrastructure to produce high-quality webinars. These webinars were supposed to show the combination of hardware and software as a comprehensive system solution to customers and leads. However, the registration numbers are almost imperceptible. The *CEO* attributes this to the fact that the most important module has not been released in the software and that the webinars will be fully booked once the product has been finalized. However, I at least partly ascribe the lack of interest in the webinars to the fact that they are not promoted and just accessible through the website.

The *CEO* has a tendency towards uncertainty avoidance. For example, he fears additional costs that might occur during the implementation of an ERP system. However, this almost certainly will happen. This attitude is also visible in the product placement where he does not sell support contracts to his customers because he does not want them to pay for services that are not specified clearly in advance.

These concerns might be ascribed to his experience with the CRM system. According to the *CEO*, there were many hidden costs and therefore the expenses for the CRM system were much higher than he had anticipated. Moreover, he feels bound to the system because it is not trivial to switch to another tool. His opinion is that the software producers are clearly aware of that dependency and exploit the customers.

Generally, I have gained the impression that the *CEO* distrusts software providers. This is clearly not beneficial for introducing new tools. He admits to his skepticism and suggests to himself to be more relaxed.

The CRM system has been in place before the *Management Assistant* joined *Zetta*. However, she states that only until recently, the corresponding employees have started to increasingly work with the tool. Up until then, it was rather used as a mere customer database.

The *CEO* mentions that the software that is developed in safe environments within the facilities must always work in subpar conditions in the field.

Apart from the CRM system, the main tool in *Zetta* is construction software. It is a very expensive software, but it is the main tool for the design engineers and therefore merits the high expenses. The premium software signals to the

employees that quality is essential to the products. A software that is not up to date would connote that the quality is not that relevant, according to the *CEO*.

The *CEO* is overwhelmed by the sheer quantity of CRM system providers. He is preoccupied that with the enormous number of tools on the market, the company might not elect the most appropriate solution. His focus is to develop the sales and not to implement a new CRM system every three years.

According to the *Management Assistant*, there are no external partners where she gets information or other input from. Her main channel of getting access to new trends or tools is her private network.

The *Management Assistant* would like to be more engaged in the digital transformation of *Zetta*. The *CEO* knows that, but has not acted towards that direction.

The *CEO's* goal is to make data available through digitalization. For example, the stockkeeping is fully manual. Every Friday, employees count the stocks and place purchasing orders. This manual scheme would not work in any other company, according to the *CEO*. But it has been done like that since its inception and it works. However, he wants to replace it by a professional digital stockkeeping method to be prepared for further growth. This method is limited to the current workforce but would not be apt for a more numerous production team.

Furthermore, the upheaval in the worldwide supply chains made any kind of conventional analytics that were provided to the *CEO* by his external accountancy partner once a month obsolete. These figures were useless in times of severe geopolitical changes.

The *Management Assistant* is not aware of any digital transformation roadmap or the like.

The *CEO* states that the different systems must be connected, such as a potential ERP system and the current CRM system or the construction software.

Moreover, he would like to make custom changes in the ERP system without needing to pay the system house to do so.

Furthermore, software must be easy to use and mobile-friendly. He applies this criterion to any software, including their own.

The *Management Assistant* desires leaner, faster and simpler processes through digitalization. There are no commonly accepted or communicated goals in *Zetta* regarding the digital transformation.

The *Management Assistant* states that a potential risk of digitalization is that processes are complicated rather than simplified. Moreover, she points to the danger of potential exclusion of employees who are less digitally affine. This is not actually happening at *Zetta*, but there is a certain risk that should be considered.

My interpretation is that the *CEO* has not yet grasped the scope of what digital transformation means. He is quite a conservative person not only regarding

digitalization, but in general. Therefore, I did not ask him about his recommendations for other SMEs.

The *Management Assistant* recommends taking every employee along in the digitalization journey. For example, common workshops help that everyone feels engaged and that potential resistances might be overcome. Moreover, the employees have to understand why a change is necessary, which is possible through transparent and well-thought-out communication.

The *Management Assistant* has learned not to be disappointed when her ideas are not realized or only four years later. Moreover, she would have been more patient. In my opinion, this is not a good sign for the company. Rather than benefitting from her enthusiasm, she has been streamlined towards the slow pace of *Zetta*.

Yotta

The primary data that was generated for *Yotta* consisted of three interviews with the *Head of Sales*, the *Executive Assistant* and the *CTO* who is also one of two managing directors (henceforth *CTO*).

The *Head of Sales* has joined *Yotta* in 2006 when there were less than 20 people in the company. She sees digitalization as a means to work more efficiently. Moreover, it allows them to engage better with their customers. Furthermore, processes can be designed more effectively, especially in a paperless manner. That helps to allow remote work.

The *Executive Assistant* reports directly to the managing directors as a staff unit. His official title is *Business Development Manager*, but put in his own word, that has 'nothing to do with what he actually does'. He joined *Yotta* in 2009, apparently with the intention to become one of the senior managers or even a managing director at some point. That was insinuated both by the *CTO* and by himself. His main occupancy is to apply for government-sponsored research, along with project management for other projects such as the relocation of the company to its new office in 2020. Moreover, he is increasingly involved in HR for recruiting responsibilities. After completing the ERP system implementation, the *Executive Assistant* had originally not intended any further engagement with the matter. As of the interview data, he could indeed imagine continuing that path, but he has not yet been asked if that was an option for him.

The *CTO* co-founded *Yotta* in 2001.

The current ERP system was introduced in 2009. Before that, manual spreadsheets were common for all kinds of processes, hence the switch to an ERP system was a big leap forward. The *CTO* is aware that by 2023, their current ERP system can be considered a tool from the Stone Age, metaphorically speaking.

For the *CTO*, digitalization is tightly related to a company's growth. Up until a size of 10-20 employees, processes based on Excel and spontaneous demand on request work quite fine. Another big step is when the company grows towards 100 employees and a middle hierarchical level is required. For the *CEO*, every digitalization initiative must either support the growth or enhance the efficiency.

They do sometimes play around with minor projects for the sake of experimentation, but before rolling them out companywide, they must provide some kind of benefit.

For the *CTO*, the implementation of voice over IP phone system was a milestone.

Moreover, he emphasizes that their ticketing system is crucial. Especially the software developers organize their daily task with that tool.

Another milestone for the *CTO* was the introduction of a versioning server. All software that is developed internally is documented there. The developers are scattered all over Germany and that is their central documentation hub. Moreover, they outsource some programming to external providers who co-develop code with *Yotta's* developers. Furthermore, they interact also with customers. According to the *CTO*, the software development department is the most digitally mature team of the company.

As time of the interviews, *Yotta* is introducing a new ERP system by a different provider. The project manager for the implementation is the *Executive Assistant*. The selection process started in 2021 and since the beginning of 2022, they are working on the actual implementation. Concerning the selection of the new provider, the *Executive Assistant* was officially free to take the decision to remain with the previous provider, but actually the decision had already been made before he assumed to project lead. Hence, he did not impugn the choice fundamentally.

The company decided against the major ERP providers because of various reasons. First, they wanted a specialized rather than a standardized solution to avoid additional expenses of custom programming. Second, they did not want to be disregarded as a SME, which might be more probable with the major ERP providers.

During the further stages of the selection process, the *Executive Assistant* involved the key users of all departments. Their feedback was used to narrow down the range of providers. When only two ERP systems were left, the final choice was made according to financial considerations, namely the licensing model, and the providers' ability to apprehend the peculiarities in *Yotta's* business.

The ERP introduction will be delayed due to unforeseen circumstances. Most importantly, the significant growth shifted the priorities from the strategic project towards the operative business. The *Executive Assistant* mentions to not pay attention to feature every minor exception, but focus on the core processes. Long-term users tend to expect a high level of detail regarding an ERP system's ability to handle special cases.

According to the *Head of Sales*, the digital maturity within *Yotta* is very heterogeneous depending on the department. Even across teams, it varies considerably. She misses a concept to drive the digital transformation centrally.

Her sales team, for example, which consists of ten persons, is digitally very mature. A reason for that is that the team members are geographically scattered around the world. Her team has benefitted from the new work routines during the

Covid pandemic. With a regular call that is arranged daily at the same time, the team members have grown together as a unit, no matter the distance between them. The call is voluntary and private topics are equally allowed just as business-related subjects. The *Head of Sales* does not even attend herself every time as she wants to give her team members space to unfurl without their supervisor listening.

In contrast, the accounting team still adheres to very conventional work practices.

She sees the responsibility to create uniform work practices in the senior managers. Apart from clear guidelines, the employees must be instructed to work with the tools. In her team, they have taught each other to use the tools in the best way possible.

For the *Executive Assistant*, digitalization is about simplifying processes to make them more efficient by the means of digital technologies. Ultimately, manual tasks shall be abandoned and friction losses in the communication shall be reduced.

According to the *Executive Assistant*, the company is not as digitally mature as they would like to be. He differentiates between different kinds of digitalization. Firstly, regarding the IT infrastructure, he estimates *Yotta* to be digitally advanced. Remote work is possible without any problems because all the necessary tools are in place. Secondly and in contrast, the management of documents is to be improved, such as collaborate editing or a formal DMS to uniformly access and archive files. Thirdly, the ERP system is borderline outdated, dating back to 2009. For the revenue and the headcount, a much more advanced system would be necessary. It does not offer many features that are mandatory by now and therefore, parallel procedures have been established. For example, offers are archived on a fileserver, whereas the orders are processed with the ERP system. These media discontinuities cause major frictional losses.

The *CTO* confirms that the digital maturity among the departments varies significantly. As already mentioned, the software development team is the most digitally evolved team. The least is the HR department where they still have analog personnel files stored in cabinets.

The interaction with customers is more digital than before. The salespersons are less physically present at the customers' facilities. What remains important in sales is the human factor. What has changed more fundamentally is customer service. Whereas previously, installations were conducted by service technicians at the customers' facilities, nowadays the customers are instructed by the service technicians via video calls. The customers have appreciated the new procedure because they gained more knowledge about the product while installing it. However, not all cultures accepted that. For example, in Japan the customers expect a service technician to install the products.

Moreover, seminars that were previously conducted on premises are now hybrid webinars. *Yotta* wants to reach a broader audience as a new sales channel.

The products are already digital. They contain a computing unit and are accessible remotely. The *Head of Sales* does not see any further digitalization possibilities or new business models.

The *Executive Assistant* states that the company possesses a general strategy. However, it is very vague and does not specifically address the digital transformation. He is quite critical towards that product strategy. *Yotta* is the global market leader for their sophisticated products that address universities and laboratories, but increasingly tries to enter the industrial market with mass-market products. For the *Executive Assistant*, these two directions diverge too much because they require completely different organizational setups regarding service or quality management. Moreover, *Yotta* has product families in their portfolio that have operated at a loss for years. The *Executive Assistant* cannot understand these strategic decisions but tolerates them.

For the *CTO*, independence is a crucial value in general, but also for the digitalization. He does not want to depend on any provider because according to him that might be 'lethal'. Not only applies that for the tools themselves, but also for the infrastructure. Consequently, *Yotta* hosts most of their systems with servers on premise. They only rely on external hosts for services that can easily be moved from one provider to another. The most important reason for hosting most of the data on premises is that the *CTO* wants to protect their intellectual property. They depend very much on their knowledge, and he wants to be sure that these data are safe. The *CTO* feels that only by hosting these data on premises, he can be sure they are safe. In the past, when *Yotta* primarily supplied the academic market, they were not that much exposed to cyber threats. Now that they are moving also towards industrial customers, that might aggravate. In addition, these new customers might stipulate that *Yotta* complies with certain IT security requirements. Until now, ISO 27001 has not been requested, but that might change soon.

According to the *Head of Sales*, there is no harmonized way how digital innovations take place. But usually, the *CTO* decides on his own if a digital initiative will be realized or not. Hence, if someone wants to use a new tool, for example, they have to convince the *CTO*.

The customers are mainly universities, and they are obliged to purchase products from *Yotta* via tenders. These tenders have become increasingly digital through platforms, what used to be printed folders that were sent by conventional mail. Hence, if *Yotta* wants to participate in these tenders, they must submit their offer on these platforms.

Upon asked who the main driver of digital initiatives is, the *Executive Assistant* interestingly answered that it is not the managing directors. Instead, the digitalization is very much employee driven. When an idea surges among the employees, they must lobby with the managing directors or the management circle until their suggestion is accepted, or not. The ERP system was an exception because it was regarded by the management as a risk factor that could potentially threaten the existence of the company.

The *CTO* states that most ideas surge from the employees. Being a high-tech company, the employees are rather susceptible to digitalization.

According to the *CTO*, there are regular trainings for the employees, especially for the specific software tools such as circuit board layout or graphics. Moreover,

the employees assist each other. For simpler tools such as the telephone system, the employees are provided with a written manual.

The software programmers rely on their guidelines to assure a common understanding of software development within *Yotta*.

The *CTO* is responsible for the conceptional digitalization decisions. However, the *Head of Sales* opines that IT is just one of many topics for the *CTO* and does not receive the attention it deserves. The *Executive Assistant* adds that the *CTO* has built *Yotta* from scratch and does not see a necessity to alter procedures that have served them well for decades. In that vein, he seems to neglect the remarkable growth of the recent years. Certain approaches simply do not work anymore as they used to due to the growth of team size and headcount. Moreover, the *CTO* is not exposed to certain operational problems that the employees face due to the lack of appropriate digital tools and therefore might not recognize them as such. As examples, the *Executive Assistant* mentions arranging meetings without a synchronized calendar, creating documents with several contributors in absence of a tool for collaborative editing, and project management without the possibility of assigning tasks to individual team members.

The *Executive Assistant* attributes the *CTO's* attitude to both an obstinate mindset and a lack of resources, especially time. The *CTO* is generally skeptical towards disruptive changes and the *Executive Assistant* concedes this attitude to his boss after having built a successful company from scratch. To formulate it more positively, the *Executive Assistant* suggests that it is maybe a fruitful sovereignty to not react to every single wish that originates from the staff.

The *Head of Sales* states that the employees have to understand why new tools are implemented. Moreover, they have to be ready to learn new digital tools. The individual readiness depends on the educational background and on the age of the employee. There are still users who do not utilize the modern tools that they have access to. An example is the new communication tool which allows both chat functionality and availability status, which is only used by a part of the staff.

The *Head of Sales* has observed skepticism among the employees regarding data security. For her, it is not an issue.

For the *Head of Sales*, some meetings cannot be conducted digitally. The direct personal contact is crucial at least one a year when she organizes an event for her sales team on site.

The *Head of Sales* thinks that the corporate culture at *Yotta* is beneficial for the digital transformation.

Yotta has implemented a project management software but has not succeeded in rolling it out company wide. For the *CTO*, every change is potentially detrimental and needs to be moderated well. He does not mention whose responsibility that is.

The *CTO* mentions that if an employee diverges too much from *Yotta's* corporate culture, he prefers to part ways. When there is a lack of cultural fit, both the company and the employee suffer.

There is a small IT department that consists of one system administrator. Moreover, two other employees contribute to IT topics, but they are both originally assigned to other departments. According to the *Executive Assistant*, they want to hire two more IT employees. They have realized in conversations with other companies of a similar nature that they tend to have higher quotes of IT employees than *Yotta* does.

The disadvantage of the absence of a unified concept was especially visible with the lack of a central company-wide calendar. To simply find a common time slot for an internal appointment, numerous email hand to be written instead of just checking everyone's availability in the calendar. Both paper and digital calendars in different tools were commonly used. This nuisance was visible to everyone in the company. It was also the most intriguing shortcoming that the *Executive Assistant* noted upon joining *Yotta*. Meanwhile, there is a concerted calendar system, but it has taken four years to technically implement, and the *Executive Assistant* needed to shove the *CTO* a lot until he reluctantly agreed. But even now, no every employee uses it. The *Executive Assistant* blames a lack of change management. The employees were not adequately taken along and therefore see the entry barrier as too high.

The *CTO* sees a lot of room for improvement in the training of the employees. Due to limited personnel resources and the parallel implementation of the new ERP system, priorities have been set elsewhere. He mentions that somehow, the processes work the way they are. But he is aware that by taking along the employees better, their satisfaction could be risen.

In absence of a central concept, the IT landscape is very fragmented, according to the *Head of Sales*. Each team or even each employee must arrange their personal tool setup, which is intensive in time and knowledge. Whoever is not willing to invest either the time or the knowledge will remain without the respective digital tools. The *CTO* metaphorically speaks of '1,000 isolated applications' that *Yotta* currently runs. He wants to harmonize this plethora of tools or at least connect them via interfaces, but finds it very tortuous. However, first they want to finish the implementation of the ERP system and then reconsider which tools can be standardized with the ERP system being in the heart of the IT landscape.

The *CTO* explains that fundamentally, *Yotta* comprises of two fractions regarding the technological stance towards digitalization. On the one hand, there is the fraction that would like to rely heavily on the Microsoft ecosystem of business applications. On the other hand, the mostly Linux-centric users eschew Microsoft and prefer open-source software. He sees his role intermediary, but his remarks suggest that he feels more sympathy for the latter group. According to the *CTO*, each group is aware of the other group. These discussions are of long standing in *Yotta*.

Yotta has established an intranet that also serves as knowledge base and quality management platform. The *Head of Sales* thinks it is a very valuable platform to access all kinds of information. For example, information about the IT infrastructure is also available in the intranet. But for someone who is not digitally affine, it might be difficult to train themselves just based on the information provided by the intranet. In *Yotta's* corporate culture, there is a strong reliance on

every employee's own initiative. The *CTO* adds that he was skeptical at the beginning, but now thinks it is a very valuable platform.

Generally, *Yotta* is extremely technology centric. For example, on the website, there is hardly any information about the company or anything that is not deeply concerned with technology.

The management circle consists of eight persons: The two managing directors and six senior managers. The *Executive Assistant* is not part of the management circle. Still, he forms part of the workshop that I conducted with the management circle, so apparently, he is attributed a certain importance within the company, which he also admits. However, he complains that he is not allowed to take part in the crucial meetings but has to bear the consequences that evolve from these meetings.

The organizational structures are adjusted permanently. But the reason is not digital transformation, rather the dynamic growth, according to the *Head of Sales*. A major restructuring was conducted parallel to the ERP system implementation, which is viewed critically by the *Executive Assistant*. A completely new department called operations was founded which bundles materials administration, procurement, order processing, and order control. The *Head of Operations* was hired from outside the company. Previously, these activities were decentralized and conducted upon demand by line managers in a fully vertical integration, rather than centrally and systematically by dedicated functional teams. The restructuring is about 2/3 finished. The main shortcoming of this structure was that it was not scalable for further growth. The hiring of an external manager was a novelty in *Yotta* and according to the *CTO*, it is much more difficult to get the manager on track than he would have thought. For such a technical company, he lacks the technical knowledge to be fully accepted by the experts.

Later on, the *CTO* alluded to the fact that the restructuring is partially ascribed to the new ERP system. ERP systems are usually horizontally integrated and the previous organization would have implied many customizations in the ERP system. Hence, the restructuring went hand in hand with the ERP system integration.

According to the *Head of Sales*, there is no digital transformation strategy. If there is one, it is in the *CTO's* head. In the management circle, they have committed to introduce a new ERP system which includes a DMS. The accounting shall be made paperless in this context.

There is an overall corporate strategy, but that refers to their products and the related technology, according to the *Head of Sales*.

The *Executive Assistant* is not aware of any digital transformation roadmap.

The *CTO* mentions that there is a list of projects they want to realize. It is constantly complemented with insights from the staff. These projects are prioritized regularly by him in consultancy with respective users. In his prioritization efforts, he always wants to consider the subjective sensitivities of the employees

Yotta has two external IT partners that assist them on demand when they need help. Moreover, they have an external data security representative. All of the mentioned external partner regularly deliver news, so there is never a shortage of ideas, according to the *CTO*.

For the *Head of Sales*, efficiency and bringing people who work remotely together are crucial goals.

The *Executive Assistant's* goal is that the employees like to work with the tools. Digitalization shall make the daily tasks of the employees easier, and the processes shall be homogeneous. Moreover, the employees shall focus on more challenging tasks and automate all simple routine tasks.

The *Executive Assistant* is aware of the common fear that digitalization might lead to job cuts. However, he does not anticipate that in any way for *Yotta*. The employees tend to be overstrained and welcome alleviation brought by digitalization.

Furthermore, he is aware of prevalent preoccupations regarding the estrangement between employees. However, the *Executive Assistant* does not share these preoccupations, either. *Yotta* is still small enough to preserve a familiar atmosphere even though digital interactions have increased significantly. However, he bemoans an inflation of unnecessary meetings. Issues that previously used to be clarified at the coffee machine between two persons within a few minutes are now discussed between eight persons during an hour. Especially during the Covid pandemic, this was true and has now ceased a bit.

The *CTO* fears cyber-attacks and being paralyzed as a company without access to IT tools.

Moreover, the *CTO* sees the danger of interpreting digitalization too dogmatic. He wants to represent the counterweight in the company to not digitalize for the sake of digitalization, but also to serve a purpose.

Furthermore, he recognizes a risk of making processes more difficult rather than simplifying them.

The *Head of Sales* recommends not just introducing new digital tools but conducting intense trainings for the users. Not only is it important that the employees know how to use a tool, but to have a common understanding of a tool. Moreover, she recommends listening to the employees. Their ideas and sense for shortcomings in the IT landscape are highly valuable.

The *Executive Assistant* recommends, on the one hand, listening to the employees, especially to their subjective emotional pain points that are caused by the digital transformation (or the lack of it). On the other hand, he recommends quantifying the digital transformation. Specifically, to assess where a company can achieve the biggest leverage effects by digitalizing in order to lower the costs or increase the sales. Out of these two areas (subjective and objective), he would compile a master list. By prioritizing this master list, a digital transformation roadmap would unfold.

The three recommendations from the *CTO* are to not be afraid of digitalization, always keep the purpose in mind, and getting the acceptance of the employees.

The *Head of Sales* would do anything different if she started anew at *Yotta* with the knowledge from today. It has been a constant evolution, mainly due to the permanent growth of the company.

The *Executive Assistant* mentions that he does not have any decision power regarding digitalization, all he can do is lobbying. In retrospect, he would have insisted even stronger to introduce a central calendar. Furthermore, he would have enabled the employees to work with video conferencing tools earlier because it fosters and simplifies the communication with the international subsidiaries. Alongside, he would have emphasized to enable home office for the employees. This would have increased their employer attractiveness, but also relieved the shortage of office space.

If he had had the decision power, the *Executive Assistant* would have started the replacement process of the old ERP system significantly earlier. Interestingly, the *CTO* confirms that idea: He would have started earlier as well in hindsight. With a few important digitalization projects, *Yotta* has tended to procrastinate.

Ronna

The primary data that was generated for *Ronna* consisted of four interviews with a *Sales Coordinator*, a *Software Developer* and the two managing directors (*CEO1* and *CEO2*). The participants were chosen by the *CEO1*.

The *Sales Coordinator* is responsible for special purpose machinery. Moreover, he is the Certified Machinery Safety Expert and the team leader frontend. He has been in *Ronna* for twelve years and now leads a team of five persons, which of three are apprentices. For the *Sales Coordinator*, digitalization is about automating processes with all available technological means, for example control technique, CPU, and AI. The goal is to reduce the work burden of the employees by eliminating repetitive tasks. In the end, for him digitalization is about efficiency.

The *Software Developer* joined *Ronna* ten years ago as an apprentice for Management Assistant in Informatics. As part of the apprenticeship, he got acquainted with both the commercial and the technical aspects of IT. Currently, he is the main developer for the products of the new business unit *Digitalization*, but he also writes code for other internal applications. He mainly writes code in HLL which he taught himself as an autodidact. The *Sales Coordinator* refers to the *Software Developer* as a universal IT talent, especially regarding internal software and processes. For the *Software Developer*, digitalization is about simplifying and automating processes. Moreover, digitalization serves to collect and analyze data. In the end, the work of the employees shall be facilitated.

The *CEO1* views digitalization as a means to make processes transparent, fast, accessible from everywhere, and scalable. The ultimate goal is to save time.

The *CEO2* has been in the company for nine years. He has been promoted to managing director less than nine months prior to the interview. In the same breath, he has acquired 25% of the ownership quota of the company. By the way he articulates, I note that he is still in the process of assuming his new role. For

example, he uses the term 'gesellschaftender Geschäftsführer' as opposed to the correct formulation 'geschäftsführender Gesellschafter'. He started off in *Ronna* as an electrotechnical engineer, mainly in field work. After three and a half years, he took over the electrotechnical construction engineering team until he was promoted to CEO. He has always walked the extra mile for the company and never dodged from responsibility. Hence, when he was asked if he wanted to be part of the management by *CEO1* and the previous owner who then left the company, he agreed.

In 2012, a new ERP system was established. Before that, *Ronna* had a very outdated DOS-based system. This ERP is still currently used and was highly customized by *Ronna* over the course of the years. Now, it is even possible to order lunch via the ERP system. What sounds trivial at first brings a significant reduction in manual effort for different teams. The workflow of ordering the food at the local butchery, passing the figures to the payroll team by the end of the month and finalizing the accounting, all is automated. From the perspective of *CEO2*, the ERP system enables him to access all relevant data on a daily basis. It is therefore an essential management tool.

The ERP system is an open-source solution, which is quite extraordinary considering the company size of *Ronna*. However, it has not been updated since its implementation in 2012. Even if the producer offers yearly updates, *Ronna* has not implemented them because they are incompatible with their customizations. If there are regulatory requirements such as new laws and the producer implements these changes in their standard, *Ronna* always has to reverse engineer a solution for their custom ERP system.

Ronna uses a DMS, mainly in the accounting department. The DMS is able to automate document workflows based on an identifier, which is the project number.

Moreover, *Ronna* employs a CRM system. It is mostly used for issuing offers to their customers, principally regarding spare parts. It is capable of browsing through previous projects to identify the relevant items.

Especially for the new business unit *Digitalization*, the *CEO1* is the mainspring. He had the initial idea in 2019 to digitalize the whole production and out of this vision, the business unit *Digitalization* emerged. In its current iteration, the product is essentially a production control center for manufacturing SMEs. The original inducement was to find production drawings on the file server and material in the warehouse right away without losing time searching for them. As for the production drawings, the tool is essentially a database with to index files. As for the material in the warehouse, they make use of digital tags (e-shelf labels) that can be localized via GPS to identify workpieces. As per the interview, they have already launched two addons to complement the functionality of the original product.

The *CEO1* has a strong network of entrepreneurs and therefore possesses a good feeling as to what the market needs, according to the *Sales Coordinator*. He also gives speeches regarding the topic.

The *Sales Coordinator* estimates the digital maturity to be 80%. He emphasizes that it is important not to implement too many initiatives at a time.

The *Sales Coordinator* still sees potential in the management of product documentation. Currently, it involves a lot of manual work for assemble operating instructions, CAD files, and so on.

Moreover, he sees potential in reducing human errors in time stamps that the production workers book in the ERP system. It happens frequently that they inadvertently book on a wrong project, which impairs the complete cost and controlling logic of the ERP system. By automating the time stamping process, these faults could be eradicated.

The *Software Developer* estimates the digital maturity as 80%. He thinks that *Ronna* is already very advanced, especially in the production and in the construction engineering department. The reason is that a lot of software in these departments has been customized according to their wishes. Moreover, these departments are highly automated to keep the processes lean. There is still potential to improve in every department, but to determine what exactly, the *Software Developer* would need several days to analyze the processes in detail. He would immerge in the teams to detect the concrete room for improvement.

The *CEO2* estimates the digital maturity to be 80% as of the current state of the art in digitalization. He is aware that the possibilities evolve rapidly and that the frame of reference changes over time. Moreover, he mentions that some departments are more mature than others. Especially in the business unit *Contract Manufacturing* with a high share of manual work, the degree of digitalization is lower.

The *CEO1* estimates the digital maturity to be 80%. He sees potential in introducing their solution for digital manufacturing in all business units. Moreover, they are working on a solution to provide the technical documentation of their products on a digital way to the customers.

All four participants have responded identically as to the digital maturity in percent. This bespeaks of a common mindset and understanding of digital transformation within *Ronna*.

The business unit *Digitalization* was founded to assist their customers to reduce their energy consumption and to enable paperless manufacturing. Initially, they developed this solution for their own purposes. When they realized that other SMEs could benefit from the solution, they cast it into a business model. According to the *Sales Coordinator*, this business unit goes beyond mere generation of profit, but to enable other companies. Contrarily, the *CEO1* states that from an early stage, they pursued a monetization purpose with the development of their digital solutions. Nevertheless, I can sense the pride that the *Sales Coordinator* feels for the innovation, even if he is not directly involved neither in the development nor in sales of the solution. As such, the new business unit and the product augment the cohesion of the workforce and give a sense of identification with a modern employer.

Even if there is a high demand among SMEs, the digital products by *Ronna* are difficult to sell because such an investment decision takes time. Moreover, the public awareness is still too low, and *Ronna* is not associated with software solutions. This may result in a lack of trust in their digital product, according to *CEO2*. *Ronna* is now actively working on marketing the digitalization department, for example through short video snippets on social media. However, the *CEO2* admits that they are not quite sure what the reason is for the tenacious sales of their digital solutions. The *CEO1* presents another explanation by stating that their potential customers lack skilled workforce to implement their solution. Their solution has, as in happens, sold only once up to now and one prospective customer in the near future.

There is a general business strategy, according to the *Sales Coordinator*. However, digital aspects are not explicitly part of it. The *CEO2* confirms that. The *Sales Coordinator* states that *Ronna* is quite cautious to set high goals for the business unit *Digitalization*. They are not certain if the market will accept the product.

The *Sales Coordinator* states that digital innovations are created through spontaneous ideas. They do not follow a predetermined path. There were also ideas that were not realized because they were 'dead ends'.

According to the *Sales Coordinator*, ideas also originate from the employees. The common channel is that they present their already elaborated drafts directly to the *CEO1*. This is possible due to the flat hierarchy and the employees feel that the *CEO1* is always available for them. The *Sales Coordinator* mentions the analogy of a constantly open door for the employees. Then, the idea is discussed with the *CEO1* to determine if it will be realized or not. If it is a small improvement like new button in the CRM system, the employees communicate directly with the inhouse software development team. They have a backlog of ideas which are prioritized in regular meetings in which also the managing directors participate. This way, they want to make sure that important developments are not delayed due to small improvements diverting the programming resources. The final decision of prioritization is taken by the *CEO1*.

According to the *Software Developer*, the *CEO1* is the main driver of digitalization. He always strives to find improvements, either directly with the *Software Developer* or with other colleagues. All of the interviewees confirm that *CEO1* is the principal innovator in the company.

According to the *Sales Coordinator*, the company has an employee base with above-average motivation and skills. He feels that almost all employees enjoy innovating and want to push forward. This applies for all departments. The *Sales Coordinator* attributes that attitude partly to the low average age and that therefore, there are few beaten paths.

The *Sales Coordinator* is sure that it is crucial for the success of a company in general and for a company's digital transformation in particular to attract the right employees. He calls it 'the big challenge of our times' to find capable employees and motivate them to stay in the company. Among all the applicants, it is essential to find the ones who fit the company best in order to go the extra mile. *Ronna* has

the advantage on the job market that they have four distinct business units and therefore, they tend to attract applicants who endorse variety. Such a mindset favors the innovative culture of *Ronna*.

According to the *Sales Coordinator*, the company is afflicted by the skilled labor shortage. Without it, they would have grown even stronger. In some areas, they have a high fluctuation, especially in the construction engineering team. He attributes that fluctuation to the nature of the projects without specifying further. Moreover, the *Sales Coordinator* notes a cultural change in society where the private life is weighed higher than professional attainment. Values that are important to him such as life-long learning or success on the job are less prevalent in today's society than they used to. This further hampers the development of *Ronna* because it makes finding top performers even more difficult.

The *Software Developer* affirms that the managing directors are susceptible to new ideas at any time. Figuratively, their ears are always open towards for anyone.

According to the *Software Developer*, both managing directors are technically minded, which helps to get practical feedback and ideas for their software. They are able to see the big picture.

For the *Software Developer*, the corporate culture is conducive to enable digital transformation. There are some people who are more reluctant to new software, different work practices or other approaches, but most employees are optimistic. The key to convince employees is to implement software that provides a perceptible improvement in their daily routines.

The first aspect that the *CEO2* mentions about digitalization is to take the employees along. Even if big changes are to take place, it is important to boil them down to small steps. And the employees have to feel the ease in their daily work routine. Sometimes, it is necessary to force them to use the tools in order to make them realize the benefits of digitalization.

CEO2 states that it is almost impossible to calculate the return of invest of digital transformation. Rather than just focusing on the costs, he mentions that there are other unquantifiable benefits such as employer attractiveness or credibility as an innovative machinery producer. He is aware that employing five IT engineers is a luxury situation for a SME of their size. Just in terms of costs, he does not think that all the IT investments have yet amortized. But as a lighthouse, it is very important for *Ronna* on many levels.

In his team, the *Sales Coordinator* sees a high motivation to digitalize. He describes the key features of his team culture as follows, but it appears that these traits can be generalized to the whole company. First, it is important to him to give honest and transparent feedback to the team members. Second, empathy is crucial as to how he interprets leadership. He is aware of the individuality of every person and that everyone needs a unique treatment, following the principle of challenging and encouraging. Third, the employees have permanent access to trainings in the most diverse areas of interest. Fourth, employees at *Ronna* have the chance to accomplish career paths, which is a crucial motivational factor.

Fifth, a relationship within the teams, but also with the managers that is based on trust is fundamental.

Apart from the two managing directors, there are twelve middle managers. They have increasingly assumed responsibility from the *CEO1*. He wants to invest the freed time in new ideas and strategies.

Their current ERP system has reached its performance limit. However, *Ronna* has decided not to upgrade to a new ERP system anymore. They prefer to rather invest in the further development of their own solution. With ERP systems by external providers, they fear that at some point they might not be compatible with their customizations. It is evident that flexibility is an important value for *Ronna*.

Even if he tries to conceal it, I can sense the *Software Developer's* skepticism towards their own product. There is no doubt that he is proud of what they have accomplished. Even if in the beginning, the tool was supposed to be substantially less comprehensive than it has turned out to be now, he would still do it again the same way. But at the same time, *Ronna* is trying to develop a product with three software engineers that competitors develop with dozens of software engineers. He thinks that the *CEO1* does not recognize or comprehend that under these circumstances, it is inevitable that *Ronna* is slower than their competitors with significantly more resources. The main difference is that the software that they offer is tailored to the customers' needs, whereas standard software is more of a one-size-fits-all-approach. The customization of *Ronna's* solution requires considerable programming effort. Their USP is that their solution is completely oriented to practice, rather than generative software that does not pay much attention to the frontline workers' needs, according to the *Software Developer*.

The IT engineers in *Ronna* have developed software for almost any scenario by themselves, rather than buying existing software. An example are the licenses for Microsoft Office, to which they are subscribed. For example, they have programmed PowerShell scripts for email signature standardization, a very common application for which dozens of commercial software solutions exist on the market. There are two reasons for that strategy: First, the managing directors reject any software-as-a-service solutions because of the running costs. Second, they can make any change in the software according to their needs at any time, at no additional cost. They have even programmed their own CRM system. All tools that they have developed are connected, which is an additional value of programming it themselves.

The aversion for running costs can also be observed in their own products. On their website, the absence of running costs, no obligation for maintenance contracts, and not being a cloud solution are used as marketing arguments in favor of their products.

The *CEO1* has expressed a wish to someday replace the ERP system by their own solution, according to the *Software Developer*. However, the *Software Developer* is highly skeptical that this would work because of the incredible effort that this would mean for the software engineers. The *Software Developer* cannot imagine that their current ERP system with all of its customization will be replaced someday. He hopes that the current ERP system will not be replaced for as long

as he works at *Ronna*. He is aware that this is a risky strategy because there are parameters that are out of their control, such as mandatory upgrades by the ERP system producer or the operating system on the devices.

Ronna employs five IT employees. Two of them are responsible for the internal IT and two for the development of the products and services of the business unit *Digitalization*. The team for internal IT mainly takes care of hardware such as servers and computers. The team for developing their own tool develops new features and provides service to their customer (currently only one customer). Feature requests by the customer are not free of charge and must be ordered according to formal purchase orders. Apart from selling the product, this is a second monetization channel in the new business unit *Digitalization*.

The *Software Developer* is the brains of both teams and is not definitely assigned to either of them, but has no disciplinary leading role either. The *Sales Coordinator* admits that *Ronna* has quite a high dependency on the *Software Developer*. At the same time, he thinks that the *Software Developer* is not prone to leaving the company because he has worked there for many years. Moreover, it is very difficult to find capable IT employees. They have already spread the responsibility on several shoulders and would like to continue doing so, but currently there are not any more IT employees.

The business unit for plastics technology has a special role in *Ronna*. The *Software Developer* speaks of 'them' as if it were a separate company and indeed, he confirms that this business unit operates independently for the most part. They are currently implementing their own solution in that business unit, and it runs an own instance, rather than unifying the business units under the same umbrella.

Ronna does not use a ticket system for task and feature management. All ideas, suggestions and features are collected manually. The *Software Developer* disapproves of that procedure, but the *CEO1* insists that the contact between the IT department and the rest of the employees remains personal. The channels through which ideas find their way to the *Software Developer* are manifold. Telephone, email, and personal conversations must all be consolidated. Especially when features must be implemented instantly by order of the *CEO1*, it is a source of stress for the IT team. For the *Software Developer*, the benefit of running a proper ticket system exceeds the additional administrative effort by far. Even if he does not articulate it clearly, I can sense his frustration with the situation.

What causes unnecessary stress, according to the *Software Developer*, is when he and his team need to develop features to potential customers which a very short notice ahead. Sometimes, features are promised by the *CEO1* to potential customers even if they are not finished. The *Software Developer* wished he was included in these decisions.

The *CEO1* is quite impatient with new features. Once articulated, he expects results immediately. According to the *Software Developer*, he lacks the understanding of how complex it is to develop stable software that can be used flawlessly by a multifaceted audience with diverse user profiles. Contrarily, the

CEO2 states that speed is important and that a quick first shot with 70% of the functionalities is better than the perfect solution that takes a long time. The reason for their speed is that the software engineers and the employees have a common language by now, which permits them to communicate more effectively than with external service providers. With external partners such as universities, colleges, or service providers, a lot of time and effort evaporates just by writing project specifications. The *CEO1*'s philosophy is to rather invest that effort in the actual development of the software.

Not all software developments turn out to be successful, according to the *CEO1*. Sometimes, they have to dismiss significant parts of a software because it turned out not to work as intended. But they are very flexible and concede these mistakes as a beneficial part of the learning process. Hence, *Ronna* demonstrates a high degree of experimentation in their digitalization. Moreover, they are courageous and set high expectations, which further fosters their digital transformation. The *CEO1* states that only by reaching their limits, they can know what is theoretically possible.

The *Software Developer* thinks that it is not clear who is responsible for what. There is a formal organization chart, but responsibilities shift constantly, which makes it very untransparent. He sees lots of room for organizational improvements. In his view, everybody needs to know everything in *Ronna*, which causes stress to the respective employees.

The *CEO1* thinks it is crucial to know how the frontline workers actually conduct their work in order to be able to digitalize effectively. He sometimes even uses the machinery and tries out processes to get a feeling for how the employees perceive processes. This testifies a high level of empathy for the employees. He mentions that he reflects his actions daily.

Ronna has an external partner, which is a system house. They support mainly regarding IT security and network architecture. However, most of the IT issues are resolved internally.

The *Software Developer* sees the rising complexity as a downside of digitalization. On the frontend, the users are enabled to work faster and simpler which saves time and costs. On the backend, however, the number of tools, interfaces, and scripts increases significantly, which makes it more difficult for the IT engineers to sustain the whole system. But still, he does not see any alternative to transform digitally.

The *Sales Coordinator* recommends kicking off the digital transformation of a SME with a strategy symposium in order to question everything within the company with the eyes of an outsider. Figuratively, he sees the necessity to turn a company upside down before engaging in concrete digitalization endeavors. As another metaphor, he finds it crucial to think outside the beaten paths, which is difficult for most employees, especially the one with a long tenure in the company. Employees become cushy in the wake of sustained economic success, and they forget to take risks in order to further evolve.

The *Software Developer* recommends establishing standards that apply for everyone in a SME. The digitalization of a company inevitably concurs with new

structures that a company must be disposed to accept. Moreover, he recommends being patient for the significant investments that go along with digitalization to yield fruit. The positive effects of digitalization only crystallize with a certain time offset and cannot be measured right away. This applies especially for CEOs who base their investment decisions on short amortization times and expect the return of invest for digitalization measures to be equally low as for conventional investments such as production machinery. For SMEs that have difficulties in assuming a new digital mindset, he adverts to events where other companies show how they have successfully mastered their digital transformation. Furthermore, he recommends defining a clear direction and following that path step by step, rather than too much at once.

The *CEO1* main recommendation to other SMEs is to just do it. In most industries, he sees digitalization as a necessity to remain competitive. From an internal perspective, digital transformation can be fun and helps motivate the employees. The employees shall focus on activities that add value to the company and put their energy in the products, rather than in repetitive administrative work. The work in the heads of the employees must be the center of attention. Everything else must be digitalized. The *CEO1* thinks it is important to tell the employees that they need not be afraid of digitalization. Furthermore, digitalization should be cut down to various steps, rather than one enormous effort to change everything at once. For example by digitalizing by departments. The departments infect each other incrementally. Once one department realizes that digitalization has been successful with significant advantages for another department, they will want to become part of the digitalization wave as well. Digitalization can become a sure-fire success even for a SME.

On a personal level, the *Sales Coordinator* has learned to be more relaxed and to subordinate his perfectionism. Regarding the company, he has ascertained that nothing is carved in stone. When he started twelve years ago, there were entrenched processes in *Ronna* that nobody dared to question for years. Over time, however, even those processes were adapted. In order to do so, he regards courage as an important value for digital transformation. Moreover, successful digital transformation needs talented employees who are motivated and skilled to drive the change. Overall, he mentions that digital transformation is a learning exercise during which a company evolves.

The *CEO1* would not do anything major thing differently. Even what did not work out in the past has been an important learning experience.

Quetta

The primary data that was generated for *Quetta* consisted of two interviews. On the one hand with the *Head of IT*, on the other hand with the *CEO* and the *Head of HR*.

The *Head of IT* has been in the company for seven years. For the *Head of IT*, digitalization means to transform analog paper into digital data. A benefit is that data is, in contrast to paper, independent from a location. Moreover, digitalization can speed up processes. Lastly, data can be analyzed. He explicitly mentions that new business models ought to be derived from data.

The *CEO* and the *Head of HR* are married and lead the company for nine years as the fifth generation of the family business.

For the *Head of IT*, the biggest milestone of his tenure at *Quetta* was the introduction of the current ERP system in 2018. Before that, there already was a small ERP system in place. And before that, there was an even smaller one. The *Head of IT* notes that the company has steadily outgrown its ERP systems over the years.

Another milestone was to host the emails and calendars centrally, first on premise and then in the cloud.

A further milestone was the hosting of the servers in data centers starting in 2018. When the Covid pandemic hit, *Quetta* was already prepared for remote work at scale, which would not have worked with the previous IT infrastructure on premises before that.

Quetta is currently introducing a new ERP system. It is hosted in the cloud and offers many opportunities for further improvements. They try to stay as close to the standard as possible.

According to the *Head of IT*, the company would like to be much more digitally mature than they actually are. They have relied on an external partner that has turned out to be the wrong one. There was not enough cultural fit between the two companies. Shortly before going live with the new ERP system, they were forced to switch the system house. As a result, *Quetta* has two, maybe even three years of digital transformation, according to the *Head of IT*.

The *Head of IT* mentions that digitalization has no definitive limit and therefore, a company can never reach the end of digitalization. Reluctantly, he estimates the digital maturity to be 50%. But he is aware that these 50% are relative and might change quickly in either direction.

The *Head of IT* sees most room for improvement in a DMS.

The previous CEO had already stated the vision of a paperless office. With the introduction of the new ERP system and the simultaneous implementation of a DMS, that goal might be finally reached. In general, the previous CEO had been very supportive of any digitalization efforts. He has always risen awareness to drawbacks as a way of constant improvement. He was never involved in the actual realization of digital innovation but has signposted to necessary changes. The young generation sometime even thought that they were digitalizing too slowly, even if the pace was adequate. The CEO mentions that digitalization is a never-ending endeavor. There will always be new challenges that cannot be anticipated today.

Quetta has founded a subsidiary company that focuses on software (henceforth *software spin-off*). The majority of shares is held by the parent company, but the *Head of IT* holds shares as well. Furthermore, he is one of the two managing directors of the *software spin-off*. He had always wanted to be self-employed, and this was a good opportunity to set up a new firm for him. In terms of business model, the *software spin-off* is supposed to sell software for the plant construction equipment that *Quetta* sells. The management saw many business opportunities

in digital solutions for the industry and by founding a new firm, that path shall be emphasized. Furthermore, the parent company is not renowned for software products and with the new company, they want to push this business unit. They want to target new customer segments that have not been addressed in the past. The *Head of IT* has many ideas for new applications that deviate completely from the traditional business. If they were a stereotypical start-up, they would now raise venture capital and go full throttle with their software solutions. However, that is not the way they will proceed, but rather step by step. The *software spin-off* has to finance its growth and the development of the products by itself and with the assistance of the parent company, respectively. Currently, the *software spin-off* is also formally responsible for the implementation of the new ERP system and the DMS. The *CEO's* intention is to give the *software spin-off* a certain basic utilization, but not permanently use 100% of their resources.

In the future, the *software spin-off* shall close the gap between an ERP system and the process control systems that *Quetta* offers, namely the MES. If they manage to introduce a MES solution, *Quetta* would be able to provide a holistic solution to their customers: plant construction with automated machines, process control systems, MES, and the interface to ERP systems. The *CEO* adds that his goals for the *software spin-off* is to develop a standardized software product can be scaled up, rather than develop individual software upon customer request. These are very advanced strategic considerations that fully account for the digital transformation of the company on every scale.

According to the *CEO*, the step to found the *software spin-off* has been courageous. They did not know and still do not know if it will turn out to be successful. One year after the interviews, the website of the *software spin-off* still does not contain more information than shortly after its inception. Apparently, they are still occupied with internal issues, most likely the introduction of the new ERP system. The *CEO* expresses that the only way to find out if a business model works is to try it out. For him an important aspect of the *software spin-off* was to not put at risk the core business.

The *Head of IT* regards the digitalization towards the customer as the next steps. He explicitly mentions machine data collection to derive new business models or the digitalization of after sales services such as requesting a technician or ordering spare parts via a smartphone application. In the past, the digitalization has had a strong internal focus.

According to the *CEO*, their corporate strategy inherently implies digital transformation aspects because their products and services are already highly digitalized. *Quetta* not just sells mechanical plant constructions, but completely automated process solutions. Especially with their automation department, *Quetta* is renowned for user-friendly HMI in their industry. Their process control system adapts to the customer, whereas the solutions by competitors tend to force the customers to adapt to their system. By offering both the machinery and the automation technology, *Quetta's* solutions are highly integrated.

For the *CEO*, collecting machine data is crucial. They want to establish remote services based on data. At the moment, they already deliver remote services free of charge. In the future, remote services shall be monetized. The customers are

willing to pay for the additional benefit they gain from these services. The customers want their plants to operate smoothly and efficiently. Regular and preventive maintenance are inevitable to ensure the longevity of their investment.

According to the *Head of IT*, the main driver of digital innovation is the CEO. However, also the IT department, consisting of the *Head of IT* and the system administrator, push digital initiatives.

Furthermore, the middle managers suggest measures of digitalization. From the employees, the *Head of IT* does not receive many ideas. When the *Head of IT* receives a suggestion, he informs himself first, usually via online videos. After that, he searches for possible providers. Subsequently, the selected providers conduct presentations. Whenever he needs the opinion of colleagues, he reaches out to them directly. Finally, the digital innovation is realized bit by bit and goes live in the end.

Once a year, there is an internal future symposium where all managers and department heads participate. Within this framework, they often decide in which direction the company will develop.

During the implementation process, especially for the ERP system, the relevant employees were involved early on in workshops.

In some cases, the company just turns off the old tool so that the employees can only work with the new tool. For more complex software, they conduct training sessions. For example, the usage of barcode scanners is optional for the users and the responsible supply chain manager trained his staff to convince them to use the new possibility, rather than obliging them.

In the past, the *Head of IT* states that they have already had many ideas for digital transformation initiatives towards the customers. They had even already started to work on some projects. However, due to a lack of time, which is essentially a lack of workforce, these projects have been put on hold. The ERP system now has the highest priority, and every other project follows after that. Besides, the ERP system offers many technical possibilities that might facilitate the further development of digital initiatives.

According to the *Head of IT*, there are always employees who are reluctant to use new tools. He ascribes that to a general aversion to change. No matter how many times they are trained and instructed, it is impossible to convince them.

For both the *CEO* and the *Head of HR*, the corporate culture plays a pivotal role in the digital transformation of a company. It is especially difficult to crack open the attitude of 'we have always done it this way'. *Quetta* benefits from a technological pioneering attitude within the company. For decades, they have always been at the forefront of technological innovation in their industry and that has transferred to their corporate DNA.

The *CEO* is sure that in order to succeed, the digital transformation must be championed by the decision makers in a company. The employees regard the management as archetypes for the digital transformation. Even if not all desired projects can be realized at the same time, they still trust in the management that their ideas are valued and maybe realized later.

Furthermore, the *CEO* does not want to overemphasize his own role. He is aware that without the eager participation of the employees, many digital initiatives would not be possible. He sees his role to enable the employees, who will then in turn realize their potential, and with it that of the company.

Quetta has a department that focuses on the automation of their products. It comprises of seven people plus the *Head of IT* and an external programmer. In the automation department, the employees are PLC engineers. Only the *Head of IT* and the external programmer develop tools in HLL. A big competitive advantage that *Quetta* possesses is that the PLC engineers are all brewers. They are not only able to automate the machinery but can simultaneously consult the customers with their expertise in the field.

With the automation department, *Quetta* is already able to deliver process control systems to their customers. Under some circumstances, they do not sell any hardware, but the product is the digitalization of the customer's brewing process. That department in itself is already a business model innovation based on digital technologies.

The *Head of HR* emphasizes that deceptions and painful experiences are part of the learning process. The solutions that gradually evolve over time are always better than the solution that was implemented in the first place. But in order to reach that conscience and knowledge, the journey has to be undertaken by a company.

Quetta has decided to go cloud-only wherever possible. The big advantage is that they do not have to care about maintenance of hardware. Maintaining own servers is costly and knowledge-intensive and *Quetta* wants to outsource these tasks. Moreover, they benefit from location-independent access to their IT systems.

By using the wide palette of applications by a big provider like Microsoft inherently implies the risk of dependency, admits the *Head of IT*. For example, a SME cannot subtend anything when Microsoft raises the subscription fees.

Quetta has decided to maintain knowledge with intellectual property on the in-house servers, for example CAD construction files.

Across the four companies, the standing data are not harmonized. All of the companies have their own data. Just some prices are balanced via an interface.

The IT department consists of two persons: the *Head of IT* and a systems administrator.

Quetta cooperates with two system houses for hardware, server hosting, security and infrastructure. These partners do inform the *Head of IT* about new offers, but most of the information is sought out by *Quetta*. Moreover, the *Head of IT* informs himself through IT news portals. Furthermore, conversations with other companies or customers are valuable for him.

The *Head of IT* explains their vision to launch new business models. For example, in the future, they might not sell per plant construction, but per production output by their customers. The data for this new monetization model would originate

from their plant construction and would be transmitted to their ERP system to then be billed to the customer, all in a fully automated process.

None of these strategic thoughts are written down, as far as the *Head of IT* knows.

For the *Head of HR*, digitalization is crucial for quality management and the continuous improvement of processes. The company has reached a point where further improvements cannot be realized in analog ways. Moreover, some processes in the company have become a habit and very complex. Through digitalization, these processes can be revisited and enhanced through a different lens. Finally, digitalization shall produce significant time and labor reductions. The *CEO* adds that the investments in time and money will materialize in the future so that processes are more efficient and faster. Many SMEs may hesitate to overcome that initial hurdle in the first place and therefore never reach the stage when the digitalization yields positive effects. He mentions that SME must force themselves even if it hurts, figuratively speaking.

The *Head of IT* recommends starting in any direction. If later it turns out to be the wrong direction, it can still be changed. It is crucial to get moving.

Furthermore, he recommends having a general vision for the company. The IT domain is very volatile, and it must be embedded in a bigger picture in order for a company to prosper in the long run. The digitalization must be aligned to the overall strategy of a company. And without an overall strategy, the digitalization roams without orientation.

The *CEO* recommends investing both temporal and financial resources on digitalization. The digital transformation of a SME must be regarded separately from the core business to receive the attention it deserves. As long as it is subject to the daily prioritization of the core business, it will always be the subject of less importance.

The *Head of IT* would do three things differently. First, establish a cloud-hosted central solution for emails and calendar. Second, choose the right system house for the ERP system. Third, collect data from their machines as early as possible to develop an after sales solution.

Appendix E: Codebook

DEPLOYING DIGITAL INITIATIVES

Digital initiatives describe the technological activities a company realizes on its digital trajectory.

Digitizing data

Digital initiatives which are related to information technology enabled work practices.

Collaboration tools	Software that permits the digital collaboration between employees and external stakeholders.
Data and IT security	The more a company is digitalized, the more it might be exposed to hacking attacks or data breaches. Assuring data and IT security is crucial by protecting intellectual property, complying with regulatory policies and ensuring operating stability.
Mobile work technologies	Technologies that enable remote work and access to all relevant systems from outside the company premises.
Online presence	A company's official representation in the world wide web.
Special purpose software	Software that is dedicated to digitizing work practices with a limited but highly specialized scope.

Digitalizing processes

Digital initiatives which are related to standardizing, automating and accelerating business processes.

Enterprise systems	Comprehensive software that encompasses a wide range of value adding business processes.
Interoperability	Connecting different systems and software with workflows and interfaces.
Smart manufacturing	Connecting and enhancing the physical manufacturing processes with data-driven systems.
Business intelligence	Software architecture that renders all the generated data viable for human cognition.

Extending physical products and services

Digital initiatives that add digital value to physical products and services.

Digital servitization	Existing services are enhanced with digital value.
Smart physical products	Existing physical products are enhanced with digital value.

Innovating the business model

Digital initiatives that aim at innovating the value creation, delivery, and capture mechanisms of the company.

Dedicated business units	The foundation of new company units that are organizationally separated from the existing business.
E-commerce	Value delivery and capture mechanisms that make use of internet platforms to access new customers.
Software products	Developing software for sale or rental that is independent of existing products.

ESTABLISHING BUSINESS RATIONALES

The business rationales describe incitements and desired effects of digital initiatives in a company.

Maximizing workplace flexibility

Business rationales that aim at maximizing the flexibility for the employees.

Abolishing paper	Any information that is not available digitally, first and foremost paper, has to be digitized. Contributing to ecological sustainability, especially by reducing paper consumption.
Attaining temporal and local autonomy	Being able to work from anywhere, independence, work life balance, being able to realize home office, learning how to handle permanent availability, connecting different subsidiaries.
Democratizing knowledge and collaboration	Making knowledge universally accessible to all employees.

Increasing process efficiency		
Business rationales that aim at making processes in a company as efficient as possible.		
Accelerating internal workflows	Increasing simplicity, efficiency and speed by automating and standardizing processes.	
Connecting with customers	By capitalizing on new communication channels, firms can connect with customers in new ways. Regarding suppliers, interfaces like EDI are crucial.	
Enhancing transparency	Improving decision-making, gaining an overview based on data, conducting data analytics, and big data insights.	
Handling growth	Past and future quantitative growth must be handled. Structures, tools, and processes must be adapted to the company's size, mainly regarding headcount, but also revenue.	
Relieving the employees	Reducing stress and increasing the motivation.	
Enhancing portfolio competitiveness		
Business rationales that aim at making the products and services more competitive.		
Complying with customer requirements	Pressure by customers that lead to digital initiatives in a SME.	
Incorporating market shifts	Companies do not operate in isolation but in a market. The trends in the market influence the digital transformation behavior of a company.	
Innovating intrinsically	In manufacturing firms, most products used to be fully physical. By adding digital components or services to these products, the companies can generate additional value. Many firms have an intrinsic motivation to innovate.	
Sustaining economic success		
Business rationales that aim at financial success in the long run.		
Diversifying the business activities	By innovating the business model making use of digital technologies, incumbent SMEs can reduce their dependency on their existing business model(s).	
Pioneering within the industry	Some SMEs have the aspiration to lead their market and therefore develop digital business models.	
Unveiling new revenue opportunities	New business models with the aim of increasing the sales figures.	
FACILITATING ORGANIZATIONAL CHANGE		
These transformative enablers are factors that facilitate the digital transformation of a SME.		
Allocating resources		
Factors that facilitate organizational change by having access to the right amount of resources.		
Building digital capabilities	Enhancing the employees' expertise in the domain of digital technologies.	
Cooperating with external partners	The choice of the external partners is crucial for every firm. Since internal resources (especially knowledge) are always limited in SMEs, external IT partners become very important.	
Providing internal capacities	Internal personnel are crucial even for SMEs. The internal capacities refer not only to resources (time and money), but also knowledge, capabilities and managerial competences.	
Nurturing the corporate culture		
Factors that facilitate organizational change by positively contributing to a beneficial corporate culture.		
Boosting digital initiatives by executives	Executives (managers, senior managers, and other persons in leading positions below C-level) who drive the digital transformation.	
Cultivating a positive mindset	Related to the management and employees alike, a favorable attitude is key. Traits like persisting, not giving up, resilience towards failures; seeing digital transformation as a marathon, not a sprint; patience; pragmatism, not perfectionism; courage; frustration tolerance, adaptability,	

	flexibility, and willingness to change are captured by this code.
Recruiting suitable employees	Finding and hiring persons who fit the digital corporate culture; employer branding as a digital firm; attracting candidates with a change-positive mindset; it's not about a cultural fit for the existing culture, but for the desired culture, which must be one that is affine to change.
Reducing hierarchical distance	For fast decision-making, employees should not be discouraged from engaging in digital initiatives by executives, top management or any other hierarchical structure.
Moderating the transformation	
Factors that facilitate organizational change by an active moderation of the change that is induced by digital technologies.	
Coping with resistance	There are always people who have more difficulties adapting to digital transformation than others and need to be appropriately handled.
Evoking employee initiative	Listening to the employees rather than restraining them and motivating them to be proactive in the digital transformation.
Striking the right balance	Determining the right pace of a company's digital development. This code addresses dichotomies such as: Too much or not enough? Too fast or too slow? Too expensive or insufficient quality? Security or productivity? Digitalizing just for the sake of digitalizing?
Ensuring management advocacy	
Factors that facilitate organizational change by the top management leading the change that digital transformation brings for all stakeholders within and related to the SME.	
Driving digital transformation by the management	How the top management (managing directors and other persons in leading C-level positions) drive the digital transformation. In family firms, the succession of the new generation is particularly relevant.
Financing digital transformation	Prioritizing investment decisions for digital initiatives, adopting an attitude towards spending money on digital transformation and calculating the ROI of digital initiatives with a willingness to accept longer periods.
Networking with external stakeholders	Building and utilizing the managers' network to emulate their experiences and knowledge.
Relying on managerial intuition	Rather than devising multi-year strategic plans, SME managers tend to rely on their experience and gut feeling.