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Managing Digital Transformation of Pre-Digital Organizations

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"*The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill.*"

Albert Einstein

To Julia and my family.

I would like to express my gratitude to my mentors Gilbert, Nick, and Robert, as well as my friends, co-authors, and colleagues.

Copyright Statement

The following sections comprise partly of content taken from the research papers embedded in this thesis. To improve the readability of the text, I have omitted the standard labeling of these citations.

Abstract

The widespread adoption of digital technologies continues to drive the changing environment of pre-digital organizations. Social, mobile, analytics, cloud, IoT technologies, and blockchain platforms increase the amount of available data and enable new business models. Against this background, incumbents must deal with several challenges and respond to emerging opportunities. While customers' expectations of digital offerings are rising, digital technologies are lowering market-entry barriers, leading to intensified competition. This poses a major challenge for incumbent organizations with a traditional, pre-digital business model. However, these organizations are mostly not designed for digital technologies and their implications because of their inherent structures. Therefore, pre-digital organizations striving for new value creation paths must develop the capabilities required to successfully adopt digital technologies. Furthermore, pre-digital organizations must often change existing routines and established structures to drive digital transformation.

This study investigates three areas from a generalized view of the digital transformation of pre-digital organizations. First, how can pre-digital organizations adopt digital technologies? Second, how do they implement structures for digital transformation? Third, how do they organize themselves for new value creation paths? This study includes six research papers, two of which can be assigned to each of these three areas. The first paper examined how pre-digital organizations may approach digital platforms and develop a platform strategy. The second paper investigated the adoption of AI-enabled systems and the effects of the techno-organizational context during the experimentation phase. The third paper introduced various approaches to developing digital capabilities regarding speed and applicability. The fourth paper investigated how pre-digital organizations manage multiple concurrent digital transformation initiatives, demonstrating how beneficial interplay management leads to complementary duality in organizational ambidexterity. The fifth and sixth research papers explored the relationship between organizational agility and organizational reliability. Therefore, the papers elaborate on the decoupling strategy and how organizations should manage their digital debt.

In summary, this study examined the complexities of managing digital transformation from the perspective of pre-digital organizations, contributing to a better understanding of digital transformation.

Table of Contents

1. Introduction 1
1.1 Motivation 1
1.2 Research Aim 4
2 Adopting Digital Technologies 7
2.1 Developing a Digital Platform Strategy 9
2.2 Implementing AI-enabled Systems 11
3 Implementing Structures for Digital Transformation 14
3.1 Developing Capabilities to Use Digital Technologies 15
3.2 Managing Concurrent Digital Transformation Initiatives 17
4 Organizing for New Value Creation Paths 19
4.1 The Trade-off between Organizational Agility and Organizational Reliability 20
4.2 Managing Digital Debt 22
5 Conclusion 23
6 Acknowledgment of Previous and Related Work 24
7 References 25
8 Appendix 40
8.1 Index of Research Articles 40
8.2 Declaration of Co-authorship and Individual Contribution 42
8.3 Research Paper 1 - Developing a Digital Platform Strategy: How Dr. Oetker Learned Cross-Platform Orchestration 44
8.4 Research Paper 2 - Generative mechanisms of AI experimentation: A critical realist perspective on predictive maintenance 45
8.5 Research Paper 3 - Pathways to Developing Digital Capabilities within Entrepreneurial Initiatives in Pre-Digital Organizations 47
8.6 Research Paper 4 - Managing the Complexity of Digital Transformation – How Multiple Concurrent Initiatives Foster Hybrid Ambidexterity 48
8.7 Research Paper 5 - Decoupling, Information Technology, and the Tradeoff between Organizational Reliability and Organizational Agility 49
8.8 Research Paper 6 - When Procrastination Pays Off: Leveraging Digital Debt to Balance Organizational Reliability and Organizational Agility 50

1. Introduction

1.1 Motivation

"We are a medium-sized company that has grown traditionally. We have two missions. The existing classic IT organization, which takes care of order processing, production, and logistics is running and we continue to develop it further if necessary. But we need to implement new things in the areas of CRM, e-commerce, and with digital products."

– Head of IT #1 (Research Paper 6)

New digital technologies, changing customer expectations, and increased data availability are among a range of factors that are transforming the business landscape of pre-digital organizations (Bailey et al., 2019; Vial, 2019). The widespread adoption of digital technologies has increased consumer and employee expectations regarding digital services (Gregory et al., 2018), such as mobile banking (Sia et al., 2016), online grocery shopping, and remote work (Leinwand & Mani, 2021). Thus, traditional organizations face the challenge of digital transformation in response to this changing environment. Furthermore, competition intensifies because digital technologies lower market-entry barriers and enable companies to develop new digital offerings (Yoo et al., 2012). Netflix and Spotify, for example, are young digital companies that use digital advances in their business models to disrupt long-held business paradigms (Verhoef et al., 2021). Conversely, pre-digital organizations are characterized by an established business model in a traditional industry (Chanias et al., 2019), and are also known as incumbent organizations (Ossenbrink et al., 2019; Svahn et al., 2017) or industrial-age firms (Hanelt et al., 2021). Most of these organizations are not designed for digital technologies and their implications (Ross et al., 2019). For example, many traditional organizations follow the waterfall model, which is a sequential, linear approach to project management. Digitalization and the corresponding rapid changes often require a more agile approach.

Pre-digital organizations typically produce physical products, which can reduce unit costs and sell their products at a profit because of their large production numbers. Therefore, they focus on supply-side economies of scale with hierarchical coordination within a linear value chain (Research Paper 1). Conversely, digital technologies, such as platforms, leverage network effects (Jacobides et al., 2018). Network effects increase the value of the platform as

more users join the network, with the marginal cost of an additional user being close to zero. Thus, platforms such as Spotify and Airbnb leverage demand-side economies, which put traditional business models under pressure (Libert et al., 2014). Hence, digital technologies disrupt existing industries, forcing incumbent organizations to improve their business models. Therefore, digital transformation goes beyond digitization because it requires an upheaval of existing structures and a change in value creation (Greiner, 1998; van Alstyne & Parker, 2021), particularly for pre-digital organizations (Research Paper 1). Traditional organizations that must respond and transform to remain competitive face both threats and opportunities because of these disruptions (Bailey et al., 2022; Sebastian et al., 2017).

Digital transformation can be defined as the "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" (Verhoef et al., 2021, p. 889). It depicts the process of an organization's transformation to adopt digital technologies and integrate them into its value proposition (Nambisan et al., 2017; Vial, 2019). Furthermore, research distinguishes between IT-enabled organizational transformation and digital transformation regarding value proposition and organizational identity (Baiyere et al., 2020; Wessel et al., 2021). Digital transformation activities use digital technologies to create new value propositions, which are usually accompanied by a new organizational identity, whereas IT-enabled organizational transformation supports the current value proposition and strengthens the existing organizational identity (Wessel et al., 2021). Moreover, different digital technologies may foster different levels of digital transformation (Subramaniam, 2021).

Digital technologies are manifold, including cloud computing, AI, digital platforms, and distributed ledger technology. The reprogrammability, homogenization of data, and self-referential nature of digital technologies distinguish them from traditional information technology (Yoo et al., 2010). For example, Apple may enhance the functionality of an iPhone by releasing new applications or software updates, even if the device has already been purchased. This offers numerous opportunities for engaging with customers and expanding existing business models. Thus, organizations must rethink the role of IT strategy and align it with their business strategy to form a digital business strategy, instead of simply considering it as a functional subordinate strategy (Bharadwaj et al., 2013; Queiroz et al., 2020; Yeow et al., 2018). Therefore, organizations may develop and implement a digital transformation strategy to govern their transformation (Chanias et al., 2019; Matt et al., 2015).

Hence, pre-digital organizations can use their existing organizational capabilities as IT or dynamic capabilities (Grant, 1996) (Research Paper 3). Existing research suggests that IT capabilities positively impact digital transformation (Eller et al., 2020). IT capabilities are part of organizational capabilities that indicate how well a firm manages IT resources to support business strategies and processes (Lu & Ramamurthy, 2011). Organizational capabilities describe "the integration of individuals specialized knowledge" (Grant, 1996), whereas more complex capabilities, such as dynamic or digital capabilities, may comprise combinations of simpler capabilities (Wheeler, 2002). Digital capabilities differ from existing IT capabilities because they exceed the technical process including a sociotechnical perspective (Legner et al., 2017). Moreover, digital capabilities are essential for the digital transformation of pre-digital organizations because they facilitate the use of digital technologies for innovation. Thus, digital capabilities allow organizations to use digital technologies and drive digital transformation (Matt et al., 2015; Wiesböck & Hess, 2020). Dynamic capabilities, such as organizational agility, organizational ambidexterity, and organizational reliability, enable the exploitation of emerging market opportunities while maintaining reliable processes to avoid disruptions (Hannan & Freeman, 1984; Overby et al., 2006; Sambamurthy et al., 2003). Furthermore, dynamic capabilities can help an organization begin and design its digital transformation (Matarazzo et al., 2021). Therefore, pre-digital organizations face the challenge of developing the capabilities required to successfully manage digital transformation and adopt emerging digital technologies (Sebastian et al., 2017). Research suggested different pathways and trajectories how to tackle digital transformation and develop digital capabilities (Drechsler et al., 2020; van der Meulen et al., 2020) (Research Paper 3). However, organizations may need to change existing routines and established structures in order to drive digital transformation (Rerup & Feldman, 2011; Vial, 2019).

Organizations must manage structural and contextual changes (Jöhnk et al., 2020) and cope with organizational barriers such as inertia (Vial, 2019) and anxiety (Research Paper 2). Additionally, organizations that aim to succeed in digital transformation activities, must eliminate their "debt" (Hay et al., 2021). Research refers to the metaphor of technical or digital debt which is defined as the "gap between the current state of a software system and some hypothesized ideal state" (Brown et al., 2010, p. 48) in the context of legacy systems and outdated IT (Rolland et al., 2018) (Research Paper 6). Organizations accumulate digital debt over time in the form of software obligations that must be met in the future (Ramasubbu & Kemerer, 2016; Woodard et al., 2013). On the one hand, digital debt may hinder

organizations seizing emerging market opportunities (Research Paper 5). On the other hand, accumulating more digital debt, such as through decoupling, may enable organizations to pursue opportunities (Rolland et al., 2018) (Research Papers 5 and 6). Thus, organizations must monitor their digital debt while driving digital transformation (Research Paper 6).

Therefore, managing digital transformation, involves several opportunities and challenges for pre-digital organizations.

1.2 Research Aim

Digital transformation entails a holistic approach involving new value creation paths (Warner & Wäger, 2019), a new emerging identity (Wessel et al., 2021) beyond existing IT capabilities, and a focus on efficiency (Legner et al., 2017). As outlined in Figure 1, Vial (2019) described the interplay between digital transformation via eight building blocks. The nomological net in Figure 1 represents the relevant concepts of this thesis and their interrelationships.

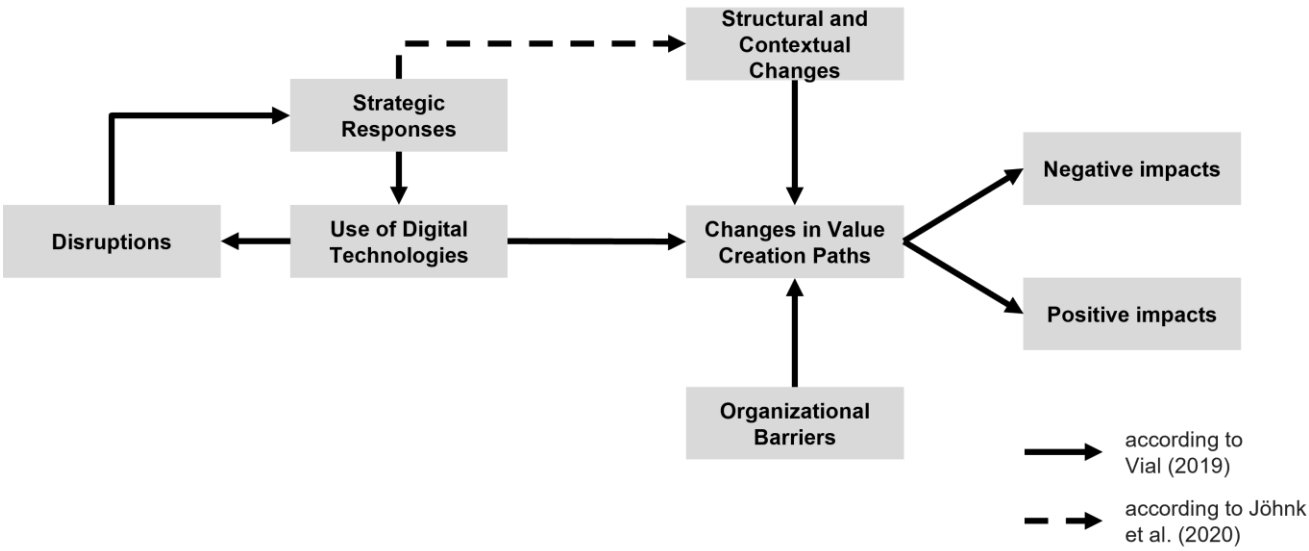


Figure 1. Nomological Net of Digital Transformation within an Organization

While *digital technologies* cause *disruptions*, they also enable organizations to change their *value creation path,* which includes value proposition (Vial, 2019) and capabilities, such as the ability to adapt to changes and respond to market opportunities (Lu & Ramamurthy, 2011; Sambamurthy et al., 2003). Disruptions elicit digital technology-based *strategic responses* (Vial, 2019) and induce *structural and contextual changes* in organizations (Jöhnk et al., 2020). Furthermore, organizations must overcome *organizational barriers* such as inertia

and resistance which may affect their digital transformation (Vial, 2019). Resistance to new technologies can emerge because of the organizational and cultural factors, that incumbents must consider (Lapointe & Rivard, 2005; Rivard & Lapointe, 2012). Finally, while digital transformation provides positive impacts as organizational effectiveness and efficiency (Goldfarb & Tucker, 2019), it also poses IT security risks owing to cyber threats (Bitzer, Brinz, & Ollig, 2021).

In this context, this thesis provides an overview of the complexities of managing digital transformation in traditional organizations. First, it provides insights into how pre-digital organizations approach and adopt digital technologies, considering structural and contextual factors. Second, it investigates the development of the capabilities required for digital transformation. Finally, this study outlines how pre-digital organizations cope with organizational challenges to enable new value creation paths.

Therefore, this thesis contributes to the theoretical understanding of digital transformation research by investigating pre-digital organizations in real-world settings. Since demand is steadily increasing (Gregor, 2006; Mueller & Urbach, 2013), this thesis aims to develop and contribute to theory within the IS discipline. Theories are "nets cast to catch what we call 'the world', to rationalize, to explain and to master it." (Popper, 1959, p. 59). Most theories focus on the what, how and why of phenomena (Mueller & Urbach, 2013; Whetten, 1989). Although a good theory is plausible (DiMaggio, 1995; Gregor, 2006), explaining obvious, irrelevant or absurd relationships adds no value (Klein & Myers, 1999). As W. E. Deming famously said "without data, you're just another person with an opinion," the development of a theory may be based on qualitative data (Carroll & Swatman, 2000). The embedded research papers follow a single or multiple case study approach (Yin, 2017) with qualitative semi-structured interviews. Qualitative interviews are a common qualitative research method that is excellent for gathering data (Myers & Newman, 2007). According to DiMaggio (1995) theory strives for "enlightenment," and qualitative interviews may serve as "night goggles" (Rubin & Rubin, 2011) to wander around in the dark.

Therefore, this thesis and its embedded research papers aim to shed light on the theoretical and practical aspects of digital transformation of pre-digital organizations.

1.3 Structure of the Thesis and Overview of Embedded Research Papers

The following section presents the structure of this thesis and provides an overview of the embedded research papers. This cumulative doctoral thesis comprises six research articles that investigate digital transformation in the context of pre-digital organizations. Therefore, this thesis incorporates the findings gathered from all research papers. As outlined in Figure 2, the research articles in this study focus on various aspects of the digital transformation process.

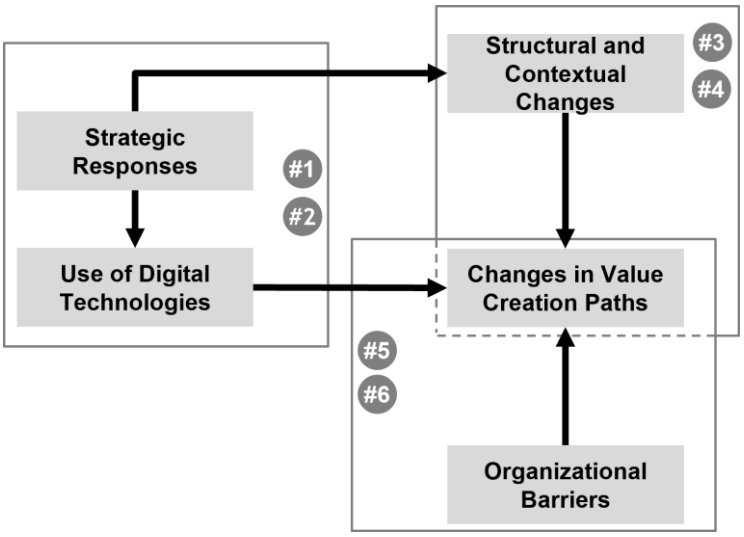


Figure 2. Structure of the Thesis

Each embedded research paper addresses a specific research question related to a specific aspect of the digital transformation of pre-digital organizations (Table 1).

Table 1. Overview of Research Questions of the Embedded Paper

Paper ID	Research Question
#1	How do incumbents develop a platform strategy and learn cross-platform orchestration?
#2	How does the techno-organizational context affect the experimentation phase of AI-enabled predictive maintenance systems?
#3	How do the pathways for developing digital capabilities differ within a PDO?
#4	How do incumbents manage the interplay between multiple concurrent DTIs and how does this foster hybrid ambidexterity?
#5	How are organizational reliability and organizational agility related to each other and how do organizations deal with this trade-off?
#6	How do organizations deal with the trade-off between organizational reliability and agility and manage their accumulating digital debt?

The remainder of this thesis is organized as follows. Section 2 illustrates how incumbent organizations may adopt digital technologies. On the one hand, digital technologies fuel disruptions and change market conditions, putting organizations under pressure to develop an appropriate top-down strategy (Section 2.1). On the other hand, digital technologies enable the beneficial affordances that pre-digital organizations may leverage by implementing them (Section 2.2). Section 3 introduces how traditional organizations adapt their organizational structure to cope with the changing environment and pursue new value creation paths. Therefore, incumbents may launch multiple initiatives to develop digital capabilities (Section 3.1). However, organizations must monitor and manage the interplay between these initiatives as well as between core organizations and initiatives (Section 3.2). Section 4 outlines how pre-digital organizations can prepare for digital transformation. Thus, incumbents must manage the trade-off between organizational agility and organizational reliability (Section 4.1) as well as their digital debt (Section 4.2). Section 5 concludes with a summary of the thesis and Section 6 acknowledges previous and related work. Section 7 lists the references, and Section 8 forms the appendix of the thesis, providing detailed information on the embedded research papers.

2 Adopting Digital Technologies

Social, mobile, analytics, cloud, and IoT technologies, also referred to as SMACIT (Ross et al., 2019; Sebastian et al., 2017; Urbach et al., 2019), as well as blockchain technology that has been implemented in several cases beyond cryptocurrency (Sedlmeir et al., 2020), change the business environment of incumbent organizations (Bailey et al., 2022). Technology comprises “all tools, machines, utensils, weapons, instruments, housing, clothing, communicating and transporting devise and the skills by which we produce and use them” (Bain, 1937, p. 860). Therefore, technologies merely come from “nowhere,” but build on existing ones (Arthur, 2009). For example, a new gasoline engine builds on previous engines while also improving the vehicle’s speed and fuel efficiency.

However, digital technologies differ from earlier ones because of their inherent characteristics (Briel et al., 2018; Yoo et al., 2010). Digital technologies enable the creation of new products that combine a physical component with software-based capabilities (Yoo et

al., 2010). As both parts are only loosely coupled, digital technology is flexible and can be easily adapted without changing the entire design (Henfridsson et al., 2014; Huang et al., 2017; Nambisan, 2017). Thus, digital offerings may be “ever-in-the-making” (Lehmann & Recker, 2022). For example, owing to its reprogrammability, Tesla can improve the performance of the car even after it sold the vehicle which enables new opportunities for establishing a customer relationship and expanding the business model. Furthermore, Tesla leverages its battery technology and focuses on software to minimize the total cost of ownership (Shipley, 2020). Tesla’s innovative approach disrupts the century-old automotive industry and challenges the incumbent manufacturers.

Organizations may approach technologies using a top-down approach to align their structures with their digital strategy (Benbya & Leidner, 2018). Alternatively, digital technologies may serve as enablers for new digital services (Barrett et al., 2015). In both cases, organizations use digital technologies to support their current value proposition or create new value propositions (Wessel et al., 2021). Thus, digital technologies offer numerous opportunities for incumbent organizations regarding organizational effectiveness and efficiency, as well as new business models (Goldfarb & Tucker, 2019). Considering digital technologies, pre-digital organizations must contend with two current trends: digital platforms and AI-enabled systems.

Digital platform companies act as an intermediary between suppliers and consumers (Miric et al., 2021) and replace existing distribution channels such as retailers. Thus, online retailers such as Amazon and Alibaba have surpassed traditional retailers such as Walmart in global sales and market capitalization (Zeng, 2018). Furthermore, social media platforms such as Facebook or Instagram and operating system platforms like Android and iOS have changed social and mobile communication (Reuver et al., 2018). Therefore, pre-digital organizations must develop a digital platform strategy to respond to the new market competition.

AI can improve the customer experience, accelerate internal processes, and enable new business opportunities. For example, AI recommends products on Amazon, songs on Spotify, and checks the creditworthiness of potential borrowers (Iansiti & Lakhani, 2020). Thus, pre-digital organizations must evaluate in which business areas the use of AI makes sense and how to implement AI successfully.

2.1 Developing a Digital Platform Strategy

"These digital platforms [...] are actually outside the competences and channels of what we do today. We cannot really bring our marketing expertise to bear, we cannot really use our sales team for it and certainly not our own production and supply chain."

– Head of Corporate Strategy #2 (Research Paper 1)

Digital platforms offer technical infrastructure for platform ecosystems (Hein et al., 2020). By approaching built-up economies of scale and scope differently, digital platforms transform long-standing industries and their boundaries (Iansiti & Lakhani, 2020). Platforms use their network to create lock-in effects, that retain customers on their network and make switching to another provider inconvenient (Parker et al., 2016). For example, the benefit of social media platforms is derived from the number of friends who use it (Edelman, 2015; Zhu & Iansiti, 2019). A new messenger service may have endless functionality, but it will be useless if users cannot write to anyone they know. Therefore, multi-sided platforms face the chicken-egg problem (Drasch et al., 2020). On the one hand, Uber needs to attract consumers looking for a ride. One the other hand, Uber needs to attract drivers willing to join the platform. However, the driver will only join the platform if there are enough consumers. The same principle applies to Airbnb and Amazon. Nevertheless, once platforms overcome this obstacle, they begin a virtuous circle that fosters growth and engagement (Wan et al., 2017). Collins (2019) referred to this virtuous circle also as a "flywheel", because it is difficult to push in the beginning, but the flywheel eventually spins much faster without pushing harder. However, network effects do not have to be durable, as MySpace or Yahoo demonstrate (Evans & Schmalensee, 2016).

Existing research on platform ecosystems focuses on how actors organize around a platform (Jacobides et al., 2018) and distinguishes between platform owners and platform complementors (Hein et al., 2020; Karhu et al., 2018). Platform owners must implement different strategies to manage the trade-offs between variety and unity, as well as open and closed platforms (Karhu et al., 2018). Platform complementors provide products and services to an owner's platform. While a diverse set of complements increases the attractiveness of the platform, too much variety can lead to platform fragmentation. Furthermore, platform owners may define boundary resources (Ghazawneh & Henfridsson, 2013) to protect their platforms from exploitation by complementors who may pursue opportunistic platform strategies (Karhu & Ritala, 2021).

Platform businesses are considered more profitable because of their lower marginal costs and higher returns (Libert et al., 2014). Additionally, the platform economy is expected to spread across industries, thus, challenging incumbent organizations (Iansiti & Lakhani, 2017). Compared with born-digital organizations, traditional firms are half as likely to develop their own digital platforms (Bughin et al., 2019). Therefore, pre-digital organizations must identify and assess existing or potential digital platforms that (may help) address consumer needs according to their business strategy. Incumbents can approach digital platforms with a cooperative or competitive mindset. On the one hand, cooperating as a complementor in existing platforms involves risks, such as reliance on the platform's owner and the challenge of differentiating its complementary products and services from other offers on the platform. On the other hand, competing with other digital platforms by developing their own platforms also involves risk, such as the risk of network effects or capabilities required to operate modular digital infrastructure. Depending on the incumbent's mindset and whether it acts as an owner or complementor, the organization may follow four different strategies (Figure 3) (Research Paper 1).

If the incumbent strives for platform ownership, it may develop its own digital platform or collaborate with other organizations to do so. Many financial service providers collaborate with Fintech startups to provide digital platform services. For example, Hilton partnered with Uber to provide customers with a convenient mode of transportation at their hotels (Zhang et al., 2018).

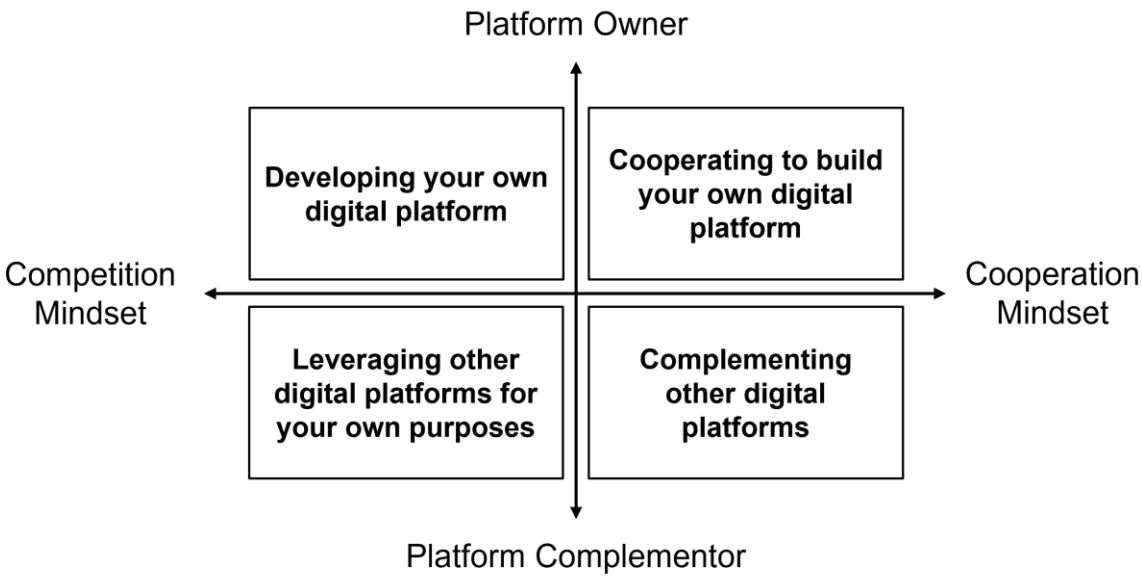


Figure 3. Tactics within a Traditional Firm's Digital Platform Strategy (Research Paper 1)

Choosing whether to invest solely or jointly in a platform requires an in-depth understanding of the relationship between a digital platform and a company's overall business strategy. In addition to assessing opportunities, firms must consider the platform's value creation and capture dynamics. As complementors, incumbents may complement other digital platforms or leverage them for their own purposes, following an opportunistic strategy. For example, most companies use social media platforms for their marketing presence complementing the platform with their content. Traditional firms that aim to embrace digital platforms contend with different platforms that have varying strategic implications for their business strategies. Thus, incumbents must tailor their approach to each digital platform. As a result, a traditional firm's digital platform strategy involves multiple concurrent tactics based on the strategic relevance; there is no "one-size-fits-all" approach.

2.2 Implementing AI-enabled Systems

"When you hire a data science guy who has no idea what the machine and application really do, that doesn't help. You also need specialist knowledge and I think this is the biggest fallacy that the whole industry is currently falling for."

– Engineer #3 (Research Paper 2)

In today's world, AI has taken over many tasks that we take for granted (Agrawal et al., 2018; Fügener et al., 2021; Jöhnk et al., 2021). Digital technologies increase the amount and quality of available data (Alaimo & Kallinikos, 2022; Bharadwaj et al., 2013; Vial, 2019). Therefore, in 2006, Clive Humby coined the phrase "data are the new oil." However, he emphasized that data similar to oil are only valuable if they are appropriately refined. In this context, data analytics has become both a game-changing opportunity and a major challenge for organizations (Günther et al., 2017). Organizations may use data analytics to understand their business and market, as well as make better and more timely decisions (Chen et al., 2012; Sturm et al., 2021).

Organizations can use AI to analyze vast amounts of data. AI refers to the ability of a machine to perform cognitive functions similar to human minds, such as learning, reasoning, and complex decision-making (Rai et al., 2019). This ability to perform cognitive functions opens up a host of new possibilities, but it also distinguishes AI from traditional digital technologies (Rai et al., 2019). Additionally, AI can help many organizations redefine their value creation

path (Vial, 2019) by enabling business model innovation (Buck et al., 2021). Thus, it is unlikely that AI will simply fit into existing IT management concepts (Yan et al., 2018)(Research Paper 2). Nevertheless, AI does not provide intelligence in general, but enables systems, also referred to as AI-enabled systems, to make predictions (Agrawal et al., 2018). For example, Uber uses AI-enabled systems to match customers with drivers and determine the ride's dynamic prices (vom Brocke et al., 2018).

Currently, AI-enabled systems are primarily used to optimize existing business tasks, such as customer contact in call centers or predictive maintenance (vom Brocke et al., 2018). Hence, managers must determine when and where AI-enabled systems should be used to replace, change, or enhance human work (Aleksander, 2017; Bailey et al., 2022). However, the implementation of AI bears many risks as fiction stories and movies about robot uprisings vividly demonstrate (Granados, 2022). In particular, the coordination of humans and AI is a major challenge for organizations (Schuetz & Venkatesh, 2020; Sturm et al., 2021). AI may make humans less effective if they blindly rely on AI-enabled systems even if they recommend the wrong path (Fügener et al., 2021; Granados, 2022). This is particularly critical when making decisions that affect people's lives. For example, AI-enabled systems such as Apple's credit card algorithm or Amazon's automated résumé screener have discriminated against women (Candelon et al., 2021).

Nevertheless, the implementation of AI-enabled systems offers opportunities for pre-digital organizations, particularly car manufacturers (Dremel et al., 2017). AI-enabled predictive maintenance systems enable automated and intelligent scheduling of maintenance activities based on continuous analysis of the operating conditions of a system (Mobley, 2002). Therefore, AI-enabled systems predict and preemptively mediate maintenance needs and system failures to optimize process availability, safety, and quality, as well as higher productivity and reduced maintenance costs (Christer et al., 1997; Mobley, 2002).

To assess the potential actions of emerging use of digital technologies, researchers draw on affordance theory, which enables the investigation of phenomena on a sociotechnical continuum (Markus & Silver, 2008). Affordance-(Experimentation-)Actualization theory provides a framework for adopting (emerging) technologies that considers technological features and organizational actors and their goals (Du et al., 2019)(Research Paper 2). Organizations adopt digital technologies in two phases: experimentation and actualization (Du et al., 2019). The techno-organizational context can either stimulate or constrain the experimentation or actualization phases (Research Paper 2). Research Paper 2 identifies

several factors that stimulate and constrain the experimentation phase of implementing AI-enabled systems (Figure 4).

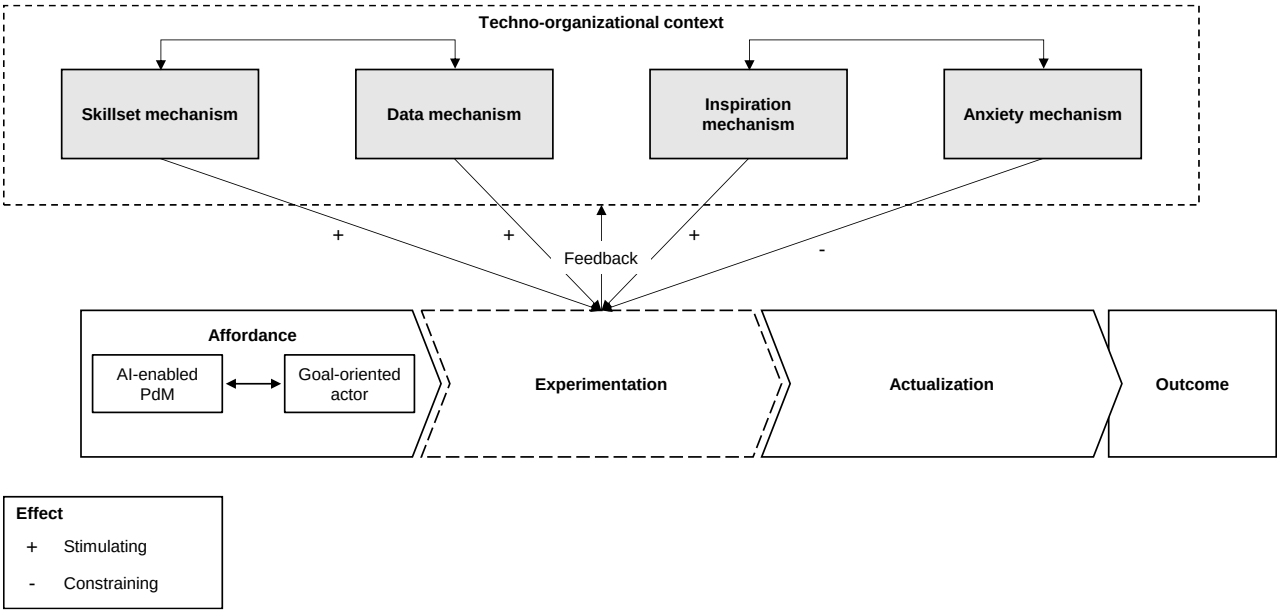


Figure 4. Techno-organizational context affecting the experimentation with AI-enabled predictive maintenance (Research Paper 2)

First, assembling technical and domain-specific skills fosters interdisciplinary collaboration and cooperation while also allowing for more in-depth experiments. Second, engaging with the previously collected data generates important insights and encourages further data collection. Third, positive outcomes from pilot projects in the form of success stories may inspire more actors to expand their activities and initiate new projects. However, a lack of knowledge about AI-enabled predictive maintenance systems leads to uncertainty and eventually resistance to current and future projects. Fear of losing one's job can also contribute to uncertainty regarding new technologies (Orlikowski, 1993; Tabrizi et al., 2019).

Nevertheless, the implementation of AI-enabled predictive maintenance systems may facilitate the generation of additional revenue and profit by enabling additional maintenance services. Therefore, they help in transforming business models and creating new value paths (Buck et al., 2021) (Research Paper 2). To implement AI-enabled systems, organizations may need to change their structures, processes and cultures (Jöhnk et al., 2020; Vial, 2019)(Research Paper 2).

3 Implementing Structures for Digital Transformation

Incumbent organizations that aim to manage digital transformation must adapt their structures since their existing organizational structure is not aligned with a digital strategy (Bharadwaj et al., 2013; Ross et al., 2019). Organizational structures and routines play a central role in digital transformation because they serve as a source of change (Rerup & Feldman, 2011) and shock absorbers (Berente et al., 2016). Organizational capabilities comprises high-level routines or a set of routines that support management decision-making (Winter, 2003). Therefore, organizational capabilities include both organizational structure, actions, and people (Feldman & Pentland, 2003). Digital transformation comprises several dimensions besides organizational structure, such as strategic vision, digital capabilities, strategic alignment, and culture of innovation (Gurbaxani & Dunkle, 2019). As digital strategy requires strong leadership (Sia et al., 2016), organizations must prioritize alignment with business strategy (Preston & Karahanna, 2009). Therefore, some organizations implement a chief digital officer to embed digital transformation in their executive boards (Tumbas et al., 2017). However, organizations must simultaneously rethink their digital strategies and address change management to persuade all stakeholders (Giebe, 2019).

As existing organizational structures may hamper coping with innovation and disruption, strategic responses require structural and contextual changes (Hess et al., 2016; Jöhnk et al., 2020; Vial, 2019). Therefore, organizations may introduce separate dedicated structures to pursue digital transformation because traditional hierarchies may hinder a fast decision-making process (Tabrizi et al., 2019). For example, incumbents can launch multiple initiatives to tackle digital transformation and adopt digital technologies (Research Paper 4).

Furthermore, these initiatives pursue the goal to develop digital capabilities (Research Paper 3), that are required to leverage digital technologies appropriately (Steininger et al., 2022; Wiesböck et al., 2020). In this context, digital technologies may require a redesign of the way how entrepreneurial opportunities are pursued (Nambisan, 2017). Thus, digital entrepreneurship within organizations may help to use digital technologies and establish new business models (Nambisan et al., 2019; Ritala et al., 2021)(Research Paper 3). Existing IT capabilities can support digital entrepreneurship as facilitator (Steininger, 2019). However, pre-digital organizations need new capabilities to successfully establish digital business models (Steininger et al., 2022). Similar to a digital platform strategy, traditional

organizations can collaborate with start-ups to develop the missing capabilities (Dörner et al., 2020).

3.1 Developing Capabilities to Use Digital Technologies

"We want to build that [business model] up and we have zero expertise in this business model yet."

- Manager Business Model Development #4 (Research Paper 3)

Pre-digital organizations must simultaneously overcome the challenge of maintaining established competencies and pursuing digital transformation (Besson & Rowe, 2012). Furthermore, incumbents must frequently consider the physical elements that they combine with digital elements in their digital transformation (Bygstad et al., 2020; Svahn et al., 2017). Thus, digital transformation requires incumbent organizations to develop new capabilities (Nambisan et al., 2017; Soluk & Kammerlander, 2021) and exploit existing capabilities (Huang et al., 2022; Svahn et al., 2017; Warner & Wäger, 2019).

Organizational capability theory provides a knowledge-based lens with the organization serving as an integrator of an individual's specialized knowledge (Grant, 1996). Therefore, knowledge itself may be considered an organizational capability (Alavi & Leidner, 2001). Pre-digital organizations may leverage their existing IT capabilities to foster IT-enabled organizational transformation (Boudreau & Robey, 2005). IT capabilities are defined as an organization's ability to use IT resources to support business strategies and work processes (Lu & Ramamurthy, 2011). Furthermore, existing research assumes IT capabilities have a direct or an indirect impact on innovation capabilities (Wiesböck et al., 2020) and organizational agility (Tallon et al., 2019). Moreover, organizations require IT capabilities to use digital technologies to address automation and increase operational excellence (Sebastian et al., 2017). Therefore, IT capabilities support the current value proposition and foster IT-enabled organizational transformations (van der Meulen et al., 2020; Wessel et al., 2021).

However, with the advent of digital technologies, organizations must develop new capabilities that are significantly different from IT capabilities (Li et al., 2018). Digital capabilities enable organizations, inter alia, to exploit digital resources and explore new value creation paths (Wiesböck et al., 2020). Thus, digital capabilities reflect the knowledge required and the

organization's ability to create new digital innovations that comprise novel processes, products, services, and business models (Grant, 1996; Nambisan et al., 2017; Wiesböck & Hess, 2020). Digital capabilities include digital expertise, technical talent for innovation and the skills required to define and execute a digital strategy (Gurbaxani & Dunkle, 2019).

Organizations can follow different pathways and trajectories to foster digital innovation and transformation and develop the required digital capabilities (Drechsler et al., 2020; van der Meulen et al., 2020)(Research Paper 3). A pathway or trajectory refers to how a job is completed (Pentland et al., 2022). Digital entrepreneurship which involves "ventures and transformation of existing businesses by creating novel digital technologies and/or novel usage of such technologies" (Shen et al., 2018, p. 1125), offers opportunities to develop digital capabilities (Research Paper 3). Research Paper 3 synthesizes four pathways that the pre-digital organization FoodLtd followed to develop its capabilities: capability acquisition, nascent partnership, multi-unit orchestra, and (new-) unit head-start. If the organic development of digital capabilities is impossible or would require unwarranted effort, incumbents can either acquire them or partner with other organizations. For example, the hotel chain Hyatt invested in onefinestay (Zhang et al., 2018), which follows a similar approach to Airbnb for high-end customers. Acquisitions enable organizations to eliminate potential competitors from the market and adopt their capabilities (Miric et al., 2021). In this context, pre-digital organizations may also initiate corporate venture funds to invest in innovative start-ups (Lerner, 2013). Thus, incumbents can immediately extend their traditional business models using digital components. However, re-applying these digital capabilities in other digital transformation contexts may cause potential conflicts within the pre-digital organization (Research Paper 3). As part of an organic path, pre-digital organizations can launch dedicated entrepreneurial initiatives to pursue the development of digital capabilities. Therefore, the initiative can be based in a single department (unit head start) or involve employees from several departments (multi-unit orchestra). The latter fosters cross-functional collaboration, which is critical for successful alignment of organizational and digital strategies (Maedche, 2016; Seo, 2017; Vial, 2019). To cope with speed and emerging market opportunities, incumbents launch multiple concurrent initiatives that combine their transformation and innovation efforts (Gassmann et al., 2012).

3.2 Managing Concurrent Digital Transformation Initiatives

"The CEO said he doesn't want us to be tied up by the big tanker. But that we also simply have the freedom to do things and not have to follow all the rules."
– Manager Business Development #5 (Research Paper 6)

Depending on their goals, organizations may choose between different approaches to digital transformation initiatives (Jöhnk et al., 2017). Organizations can consider structural separated units to bypass existing boundaries and increase speed (Maedche, 2016; Sia et al., 2016)(Research Paper 4). First, organizations can implement innovation-focused digital transformation initiatives such as accelerators or incubators. Accelerators provide a formalized support process for nascent outside ventures to foster digital innovation (Cohen et al., 2019). Incubators provide tangible resources such as space and equipment, as well as access to internal knowledge and networks to establish and grow new ventures (Masucci et al., 2020). Second, organizations can launch delivery-focused digital transformation initiatives, also known as hubs (Svahn et al., 2017) or units (Jöhnk et al., 2017). However, organizations may launch organization-wide transformation programs to drive the contextual changes required for digital transformation (Research Paper 4). These contextual initiatives aim to develop digital capabilities (Svahn et al., 2017)(Research Paper 3) or facilitate cultural change (El Sawy et al., 2020).

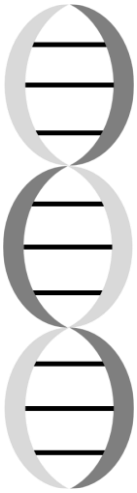
Companies often simultaneously launch multiple digital transformation initiatives, resulting in significant organizational complexity that must be managed, also referred to as an interplay (Jöhnk et al., 2020). Interplay can be used to describe either intertemporal interdependencies (logical and technical dependencies that manifest over time owing to interrelated activities and outcomes) or intra-temporal interdependencies (resource and structural dependencies that result from simultaneous activities and manifest immediately) (Research Paper 4). Since digital transformation (re)defines the value creation of pre-digital organizations (Vial, 2019; Wessel et al., 2021), it "captures the metamorphosis of a company toward creating and delivering digital value propositions" (Baiyere et al., 2020, p. 242). This transformation results in the emergence of a new organizational identity (Wessel et al., 2021). Organizational identity depicts what an organization is (Albert & Whetten, 1985; Whetten & Mackey, 2002) and how members make sense of what the organization claims (Corley & Gioia, 2004; Gioia & Thomas, 1996). While an unstable organizational identity does not destabilize the organization but rather enables it to change (Gioia et al., 2000), the emergence

of a completely new organizational identity can cause conflicts and tensions with the existing identity (Svahn et al., 2017)(Research Paper 3). For example, there may be competing concerns regarding budgets (Svahn et al., 2017) and other competing perspectives (Balogun et al., 2015; Berghaus & Back, 2017). Furthermore, engaging in both competition and cooperation simultaneously may increase tensions (Hoffmann et al., 2018).

Therefore, all digital transformation initiatives must be aligned with the overarching digital transformation strategy (Hess et al., 2016) and be integrated into the existing organization. Managerial responses to such conflicts may be defensive, which causes digital transformation to stall, or receptive, which mitigates tensions and opens new value creation paths (Soh et al., 2019). Tumbas et al. (2018) introduced grafting, bridging, and decoupling as three approaches for CDOs to manage tensions between existing departments and digital initiatives. While grafting tightly connects existing functional units with the digital initiative, decoupling keeps both separated to enable fast implementation. However, this may result in a lack of integration with existing structures. Bridging aims to address these problems and establish a collaborative working mode.

Finally, managing the interplay between initiatives enables purposeful and fruitful collaboration and aids in the integration of innovative outcomes into the core organization (Research Paper 4). Rather than simply coexisting, pre-digital organizations must overcome the seemingly opposing scope and setup of initiatives and core organizations. This emphasizes the complementarity of digital transformation initiatives and the core organization's activities as mutually enabling elements within a shared strategic vision (Farjoun, 2010). To operationalize the management of the interplay, pre-digital organizations may use a helix as a structure (Smet et al., 2019), which provides a balance of flexibility and stability (Figure 5).

Digital transformation activities and core organization traditional activities form two structurally separated chains in an incumbent's DNA. Contextual digital transformation initiatives, such as cultural change programs, represent the bonds that facilitate the integration of both chains. They seek to create patterns of shared values, norms, and practices that serve as a glue between exploratory and exploitative activities (Karimi & Walter, 2015) (Research Paper 4).



- The core organization focuses on **traditional activities**
- DTIs comprise structural and contextual changes that focus on **digital activities**
  - Structurally ambidextrous DTIs seek to separate from organizational boundaries to **drive digital innovation**
  - Contextually ambidextrous DTIs are crucial to **integrating the outcomes of structurally ambidextrous DTIs in the core organization**
- Effective management of the interplay among DTIs and between the DTIs and the core organization enables successful digital transformation
- The resulting duality facilitates the emergence of a new DNA in DT, i.e. **a new organizational identity**

Figure 5. The Helix Structure of Interplay Management

Organizations that successfully manage multiple concurrent digital transformation initiatives and their interplays, transform their value creation process, and enable ambidexterity (Research Paper 4). Ambidexterity is defined as the ability to simultaneously pursue digital innovation through exploration activities on the one hand, and efficiency through exploitation activities on the other hand (Lee et al., 2015; Tushman & O'Reilly, 1996; Vial, 2019).

4 Organizing for New Value Creation Paths

Routines are a set of repeatable actions or patterns of behavior, as well as the corresponding rules (Feldman, 2000)(Research Paper 5). Winter (2003, p. 991) defines routines as "behavior that is learned, highly patterned, repetitious, or quasi-repetitious, founded in part in tacit knowledge." Therefore, routines offer stability and reliability to organizations (Butler & Gray, 2006; Feldman & Pentland, 2003). To transform digitally, organizations must scrutinize and change their routines that involve the risk of errors as the proverb "Never change a running system" suggests. However, organizations may implement meta-routines or dynamic capabilities, which are routines for changing routines (Eisenhardt & Martin, 2000; Pentland et al., 2012). These dynamic capabilities help organizations improve their business model design and leverage their value creation paths (Teece, 2018). Pre-digital

organizations may have followed the same value creation path for years, if not decades (van der Meulen et al., 2020)(Research Paper 3). Dynamic capabilities include the ability to sense, seize, and transform (Teece, 2018), which is why building these capabilities fosters the digital transformation process (Warner & Wäger, 2019).

4.1 The Trade-off between Organizational Agility and Organizational Reliability

"You get hired for innovation, but you get fired for reliability" - CIO #6

Organizational agility and organizational reliability are both dynamic capabilities and imperatives to business success (Butler & Gray, 2006; Sambamurthy et al., 2003). Time is a critical factor in detecting and exploring novel opportunities faster than competitors (Overby et al., 2006). Organizations must respond to emerging market opportunities and simultaneously maintain reliable processes (Urbach et al., 2017).

Organizational reliability refers to an organization's ability "to anticipate and explore potential and occurring hazards, prevent and resolve disruptions, and learn from the problems to maintain a proper organizational performance in both normal and abnormal situations" (Bieńkowska et al., 2020, p. i). The objective is to reduce the number of organizational errors required to sustain long-term organizational performance (Bieńkowska et al., 2020). Therefore, reliability minimizes the variance in performance rather than addressing the average level (Hannan & Freeman, 1984).

Organizational agility refers to the ability to appropriately detect and exploit emerging market opportunities (Overby et al., 2006; Sambamurthy et al., 2003). As the environment changes rapidly, relentlessly, and unexpectedly, organizations must respond quickly and innovatively (Lu & Ramamurthy, 2011; Overby et al., 2006; Urbach et al., 2017). Research identified different forms of organizational agility, such as market-capitalizing agility, which focuses on both product- and customer-driven changes and operational adjustment agility which describes the operational backbone required to manage either market- or demand-driven changes (Lu & Ramamurthy, 2011). IT capabilities have a significantly positive impact on the organizational agility of a company (Pinsonneault & Choi, 2022; Queiroz et al., 2018). For example, IT facilitates communication within an organization, allowing the organization

to respond more quickly to emerging opportunities (Tallon & Pinsonneault, 2011). However, there is ongoing discussion regarding the relationship between organizational agility and reliability (Figure 6) (Research Paper 5).

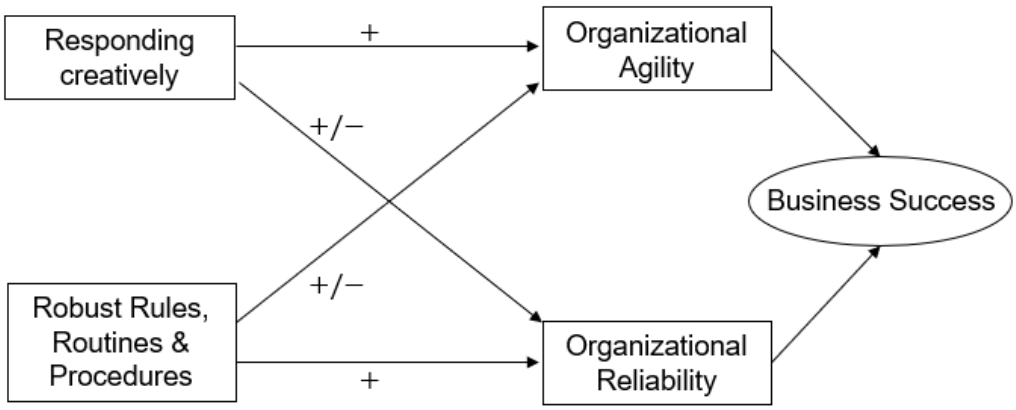


Figure 6. Relationship between organizational agility and organizational reliability (Research Paper 5)

On the one hand, reliability requires rules and routines, which can lead to bureaucracy and impede an organization's ability to respond creatively (Adler et al., 1999; Ghemawat & Ricart Costa, 1993). On the other hand, the ability to react appropriately in unexpected situations increases organizational reliability (Butler & Gray, 2006). Thus, both capabilities rely on similar human cognitions, such mindfulness, alertness and dynamic awareness (Butler & Gray, 2006; Dernbecher & Beck, 2017)(Research Paper 5).

To resolve this trade-off, organizations may follow a decoupling strategy (Research Paper 5). Decoupling can provide a possible solution to achieve both imperatives because it enables the organization to separate its systems (Berente & Yoo, 2012; Orton & Weick, 1990). Nevertheless, in the long-term, a decoupling strategy may foster the accumulation of digital debt (Research Paper 6).

4.2 Managing Digital Debt

"Companies don't want to spend money because the old system still works. Therefore, they only change something when the old system no longer works, or they need a function that the old system cannot provide." - Head of IT #7 (Research Paper 6)

Digital debt has evolved from the technical debt metaphor and refers to the "reflection of an organization's cumulative buildup of technical and informational obligations related to the maintenance and evolvability of its platform and infrastructure" (Rolland et al., 2018). This metaphor draws on the financial notion of capital in the form of capabilities and technologies as assets (Woodard et al., 2013). The cost of these assets may generate certain liabilities also known as debt (Woodard et al., 2013). The term 'technical debt' refers to obligations that must be addressed to achieve the hypothesized ideal state of IT (Brown et al., 2010). In addition to the software itself, technical debt includes all attendant aspects, such as architecture, design, documentation, and testing (Brown et al., 2010; Li et al., 2015). Digital debt comprises both technical debt and all digital aspects (Rolland et al., 2018)(Research Paper 6). Furthermore, digital debt breeds increased, partly recurring costs in the future owing to higher maintenance costs, additional effort to exercise digital options, inefficiency costs, and the cost of implementing regulatory requirements (MacCormack & Sturtevant, 2016; Tom et al., 2013; Woodard et al., 2013)(Research Paper 6). These recurring costs can be monitored as long as they do not grow too high (Brown et al., 2010). On the one hand, organizations may intentionally accumulate digital debt to save time or money (Kruchten et al., 2012; Ramasubbu & Kemerer, 2016). On the other hand, organizations may be unaware of the risk of digital debt owing to carelessness, lack of education or basic incompetence (Kruchten et al., 2012; Li et al., 2015). Therefore, perceived digital debt may differ from the actual debt. Similar to car maintenance, there may be hidden obligations in addition to obvious defects and planned wear (Smith & McKeen, 2020).

Since legacy systems may cause problems or hinder the adoption of new technologies (Fitzgerald et al., 2014), organizations must regularly renew their digital infrastructure (Wimelius et al., 2021). However, pursuing new digital options can either help resolve digital debt or lead to the accumulation of more digital debt (Rolland et al., 2018). Conversely, accumulating digital debt has some short-term benefits, such as budget and time saving (Li et al., 2015)(Research Paper 6). Thus, as the opening quote shows, incumbent organizations are not always eager to avoid digital debt (Research Paper 6). Furthermore, organizations

must replace their legacy systems to resolve digital debt. Therefore, the stability that leads to organizational reliability decreases as new systems and processes become more error-prone, and acclimation may be required (Research Paper 6). In terms of systems and software, this is referred to as a zero-day exploit, which is closed only by updates. To successfully manage digital debt, organizations must consider all relevant parameters (Research Paper 6). However, a certain amount of debt can be reasonable, similar to the leverage effect in financial debt.

5 Conclusion

Recently, an increasing number of studies have investigated the contextual conditions, mechanisms and consequences of digital transformation (Hanelt et al., 2021; Nadkarni & Prügl, 2021; Scott & Orlikowski, 2022), with a high potential for practical relevance (Moeini et al., 2019). This thesis highlights the complexity of managing digital transformation from the perspective of pre-digital organizations. Traditional organizations face several challenges of digital transformation such as changing customer expectations and increased competition because digital technologies lower market entry barriers. Therefore, pre-digital organizations approach and adopt digital technologies to seize emerging market opportunities and remain competitive (Research Papers 1 and 2). However, incumbents pursuing digital transformation must consider structural and contextual factors to develop missing but required capabilities. As a result, different paths have different implications regarding speed, re-applicability, and tension (Research Paper 3). To alleviate emerging tensions, pre-digital organizations must manage the interplay between core organizations and their multiple concurrent digital transformation initiatives (Research Paper 4). Successful management of tensions and driving digital transformation enables new value creation paths and dynamic capabilities. Dynamic capabilities such as ambidexterity and organizational agility enable incumbents to respond quickly to new digital opportunities. However, there can be a trade-off between responding creatively and routines that ensure reliability (Research Paper 5). To resolve this trade-off, organizations may follow a decoupling strategy. Nonetheless, decoupling leads to the accumulation of digital debt in the long term. Thus, organizations must manage the trade-off in consideration of their digital debt (Research Paper 6).

6 Acknowledgment of Previous and Related Work

In all research projects and papers, I collaborated with colleagues from the University of Bayreuth, the University of Augsburg, the Project Group Business and Information Systems Engineering of the Fraunhofer Institute for Applied Information Technology (FIT), and the Research Center Finance and Information Management (FIM).

Therefore, the embedded research papers were based on previous and related work conducted within these organizations. This thesis builds on the research on IT project management (Diepold et al., 2011; Neumeier et al., 2018; Neumeier & Wolf, 2017), IT project portfolio management (Beer et al., 2015; Fridgen & Müller, 2011; Guggenmos et al., 2019; Wehrmann et al., 2006; Zimmermann, 2008a, 2008b), and digital technologies such as cloud computing (Keller & König, 2014).

Research Paper 1 considers the era of platformization and the work on blockchain-based platforms of Drasch et al. (2020) and Schweizer et al. (2017). Keller et al. (2019) provided the idea and basis for Research Paper 2. Research Paper 3 complements Oberländer et al. (2021) and Bitzer et al. (2021) and contributes to the research on incumbent organizations facing the challenges of digital innovation and digital transformation. Moreover, the insights of organizational ambidexterity garnered from Stelzl et al. (2020) and Röglinger et al. (2018) in general influenced work on Research Paper 4. Additionally, the paper further develops the concept of bimodal IT of Jöhnk et al. (2017) and Jöhnk et al. (2019). Finally, Research Papers 5 and 6 combine Berente and Yoo (2012), and Tumbas et al. (2017), both of whom have motivated research on loose coupling and decoupling. Both studies considered research on IT investments (Fridgen & Moser, 2013; Heidemann et al., 2013; Wehrmann & Zimmermann, 2005) and the option theory (Sandberg et al., 2014; Ullrich, 2013).

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8 Appendix

8.1 Index of Research Articles[1]

Research Article #1:

Rövekamp, P., Ollig, P., Buhl, H.U., Keller, R., Christmann, A., Remmert, P., Thamm, T. (2021). Developing a Digital Platform Strategy: How Dr. Oetker Learned Cross-Platform Orchestration. *Management Information Systems Quarterly Executive*.

VHB-Jourqual 3: B

Research Article #2:

Stohr A, Ollig P, Keller R, Rieger A. (2022). Generative mechanisms of AI experimentation: A critical realist perspective on predictive maintenance.

Submitted to (major revision): *Information & Organization*

Research Article #3:

Keller, R., Ollig, P., Rövekamp, P. (2022). Pathways to Develop Digital Capabilities within Entrepreneurial Initiatives in Pre-Digital Organizations – A Single Case Study. *Business & Information Systems Engineering*.

VHB-Jourqual 3: B

Research Article #4:

Jöhnk, J., Oesterle, S., Ollig, P., Rövekamp, P. (2022). Managing the Complexity of Digital Transformation - How Multiple Concurrent Initiatives Foster Hybrid Ambidexterity. *Electronic Markets*.

VHB-Jourqual: B

Research Article #5:

Keller, R., Ollig, P., Fridgen, G. (2019). Decoupling, Information Technology, and the Tradeoff between Organizational Reliability and Organizational Agility. *Proceedings of the 27th European Conference on Information Systems (ECIS), Stockholm & Uppsala, Sweden*.

VHB-Jourqual 3: B

[1] Research Papers 1-6 can be found in the supplement. Kindly note that the text formatting and the reference style may differ from published papers, to allow for a consistent layout. There is a separate reference section, as well as a separate numbering of figures, tables, and footnotes for each paper.

Research Article #6:

Ollig, P., Berente, N., Fridgen, G. Keller, R., Rieger, A., Stohr, A. When Procrastination Pays Off: Leveraging Digital Debt to Balance Organizational Reliability and Organizational Agility.

Working paper

During my PhD, I also contributed to other publications, which are listed below. These publications are not part of this dissertation.

- Bitzer, M., Brinz, N., Ollig, P. (2021). Disentangling the Concept of Information Security Properties: Enabling Effective Information Security Governance. *Proceedings of the 29th European Conference on Information Systems (ECIS), Marrakesh, Morocco*.

  VHB-Jourqual 3: B

- Jöhnk, J., Oesterle, S., Ollig, P., Riedel, L.-N. (2020) The Complexity of Digital Transformation: Conceptualizing Multiple Concurrent Initiatives. *Proceedings of the 15th International Conference on Wirtschaftsinformatik (WI), GITO Verlag, Berlin*.

  VHB-Jourqual 3: C

- Leinauer, C., Schott, P., Fridgen, G, Keller, R., Ollig, P. (2022) Obstacles to demand flexibility: Why industrial companies do not adapt their power consumption to volatile power generation. *Energy Policy*

  VHB-Jourqual 3: B

- Guggenmos, F., Häckel, B., Ollig, P., Stahl, B. Security First, Security by Design, or Security Pragmatism – Strategic Roles of IT Security in Digitalization Projects.

  Submitted to (minor revision): *Computers & Security*

8.2 Declaration of Co-authorship and Individual Contribution

This doctoral thesis is cumulative and comprises seven research papers. All of them were written in collaboration with multiple co-authors. In this section, I will describe my individual contribution to each of the six papers.

Research Article #1:

I co-authored this research paper with Patrick Rövekamp, Hans Ulrich Buhl, Robert Keller, Albert Christmann, Pascal Remmert, and Tobias Thamm. I provided the initial research idea and contributed by co-initiating and co-developing the theoretical and conceptional work. Thereby, I engaged in the further development of the research idea as well as textual elaboration. Patrick Rövekamp is the lead author of this research paper.

Research Article #2:

I co-authored this research paper with Alexander Stohr, Robert Keller, and Alexander Rieger. I contributed to the research paper by conducting case interviews, supporting data analysis, and engaging in the further development of the research idea as well as textual elaboration. Alexander Stohr is the lead author of this research paper.

Research Article #3:

I co-authored this research paper with Robert Keller and Patrick Rövekamp. All authors contributed equally to this paper. I provided the initial research idea and contributed by co-initiating and co-developing the entire research project. Thereby, I managed the research process and engaged in the further development of the research idea as well as textual elaboration.

Research Article #4:

I co-authored this research paper with Jan Jöhnk, Severin Oesterle, and Patrick Rövekamp. All authors contributed equally to this paper. Specifically, I conducted the literature review and supported the data analysis and engaged in the further development of the research idea as well as textual elaboration.

Research Article #5:

I co-authored this research paper with Robert Keller and Gilbert Fridgen. I contributed to the research paper by conducting the literature review and the case interviews. Moreover, I organized the research project. By this, I also wrote the major share of the text in the article. Gilbert Fridgen guided the research process and provided us with valuable feedback. Hence, he contributed as sub-ordinate author, whereas Robert Keller and I acted as lead authors.

Research Article #6:

I co-authored this research paper with Nick Berente, Gilbert Fridgen, Robert Keller, Alexander Stohr, and Alexander Rieger. For the work of this research paper, I assigned as lead-author to the paper. In particular, I organized the paper project and wrote a major part of the paper.

8.3 Research Paper 1 - Developing a Digital Platform Strategy: How Dr. Oetker Learned Cross-Platform Orchestration

Authors: Rövekamp, Patrick; Ollig, Philipp; Buhl, Hans Ulrich; Keller, Robert; Christmann, Albert; Remmert, Pascal; Thamm, Tobias

Published in: *Management Information Systems Quarterly Executive* (2022)

Abstract: Fueled by digital technologies, digital platforms have entered the longstanding industries dominated by traditional firms. Incumbents are required to develop a strategy across all digital platform activities, which comprises two major elements. First, one of four tactics is chosen to approach a specific platform. Second, cross-platform orchestration, which a) manages the platforms' interplay with the firm's business strategy and b) balances the tactics across ecosystems to ensure their viability, is performed. This study examines the digital platform strategy adopted by Dr. Oetker. Moreover, based on Dr. Oetker's journey, we provide three recommendations on how to handle digital platform strategies in traditional firms.

8.4 Research Paper 2 - Generative mechanisms of AI experimentation: A critical realist perspective on predictive maintenance

Authors: Stohr, Alexander; Ollig, Philipp; Keller, Robert; Rieger, Alexander

Work paper

Extended Abstract:

Artificial intelligence (AI) can greatly support and indeed redefine the value creation path of many organizations (Stone et al., 2016; Vial, 2019). Some researchers are, therefore, calling AI the next general-purpose technology (Agrawal, Gans, & Goldfarb, 2019).

While IS research has been effective in guiding practitioners as they explore and manage traditional information technology, the ability of AI-enabled systems to perform cognitive functions may require a re-examination of various IS concepts (Rai et al., 2019). It is, therefore, unlikely that AI will simply fit into prevailing concepts for the management of traditional IT, nor is it self-evident how its wider use will affect innovativeness and competitive advantage (Benbya & Leidner, 2018; Yan, Leidner, & Benbya, 2018). The required experimentation, however, can be a considerable challenge because it depends on the organization's ability to understand and manage the effects of socio-technical context factors, such as technological features, human actors, and organizational goals.

Therefore, we draw on Affordance-(Experimentation-)Actualization (A-E-A) theory, that provides a framework for the adoption of (emergent) technologies and considers technological features as well as organizational actors and their goals (Du, Pan, Leidner, & Ying, 2019). Thereby, we pay particular attention to the generative mechanisms that underpin the effects of the techno-organizational context on experimentation with AI-enabled predictive maintenance systems. Based on a multiple-case study with two cases, we find four interdependent mechanisms: skillset, data, inspiration, and anxiety. Our analysis offers deeper insights into the adoption of AI-enabled predictive maintenance. The purpose of this study is to contribute to the

research on AI-enabled systems by providing insights into how socio-technical context factors affect the adoption process. More specifically, by looking at the generative mechanisms we mean to provide a clearer view of how techno-organizational factors affect the experimentation with AI-enabled systems, those factors being not only the organizational culture and structure but also the pre-existing technology. By doing so, we highlight the inclusive nature of this sociotechnical process.

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Du, W., Pan, S. L., Leidner, D. E., & Ying, W. (2019). Affordances, experimentation and actualization of FinTech: A blockchain implementation study. *The Journal of Strategic Information Systems, 28*(1), 50–65. https://doi.org/10.1016/j.jsis.2018.10.002.

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Yan, J., Leidner, D. E., & Benbya, H. (2018). Differential innovativeness outcomes of user and employee participation in an online user innovation community. *Journal of Management Information Systems, 35*(3), 900–933. https://doi.org/10.1080/07421222.2018.1481669.

8.5 Research Paper 3 - Pathways to Developing Digital Capabilities within Entrepreneurial Initiatives in Pre-Digital Organizations

Authors: Keller, Robert; Ollig, Philipp; Rövekamp, Patrick

Published in: *Business & Information Systems Engineering* (2022)

Abstract: To enable new digital business models, pre-digital organizations launch entrepreneurial initiatives. However, in developing the required digital capabilities, pre-digital organizations often face challenges as they are marked by the ways they have historically grown their organizational identity. Research on how pre-digital organizations can develop digital capabilities remains scarce. We draw on a single case study to illustrate potential pathways for the development of digital capabilities. We identify two key characteristics: the source of digital capability development and the set-up of the actors involved. We synthesize four possible pathway manifestations, discuss the dynamic nature of pathway combinations, and suggest that managing a portfolio of pathways may be crucial for pre-digital organizations. Therefore, our study contributes to a better understanding of digital transformation in pre-digital organizations. Furthermore, we provide guidance for practitioners to reflect on when deciding which pathways to follow.

8.6 Research Paper 4 - Managing the Complexity of Digital Transformation – How Multiple Concurrent Initiatives Foster Hybrid Ambidexterity

Authors: Jöhnk, Jan; Oesterle, Severin; Ollig, Philipp; Rövekamp, Patrick

Published in: *Electronic Markets* (2022)

Abstract: Incumbent companies are launching digital transformation initiatives (DTIs) to cope with technological changes, challenging competitive environments, increasing customer demands, and other digitalization challenges. The DTI spectrum is broad and covers structural and contextual changes. Companies often launch multiple concurrent DTIs, resulting in considerable organizational complexity. However, there has been very little research into the successful management of the interplay between DTIs. Drawing on five management aspects (strategic alignment, governance, methods/IT, people, and culture) and insights from three case companies, we elucidate DTIs' interplay, illustrating that beneficial DTI interplay management leads to a complementary duality instead of a competing dualism in organizational ambidexterity. We explicate that multiple concurrent DTIs can foster structural and contextual ambidexterity, which lead to hybrid ambidexterity, concluding that contextual ambidexterity coheres and balances exploration and exploitation efforts. Thereby, we contribute to a better understanding of DTIs, their interplay management, and their roles to foster hybrid ambidexterity.

8.7 Research Paper 5 - Decoupling, Information Technology, and the Tradeoff between Organizational Reliability and Organizational Agility

Authors: Keller, Robert; Ollig, Philipp; Fridgen, Gilbert

Published in: *Proceedings of the 27th European Conference on Information Systems (ECIS), Stockholm & Uppsala, Sweden (2019)*

Abstract: Information technology units within organizations pursue organizational reliability and agility goals. Both capabilities are imperatives for business success but there is an organizational tension arising in being agile and reliable at the same time. Reliability ensures the stability and business continuity of organizations, whereas agility helps to detect and exploit market opportunities. In our research, we study projects in 19 organizations and seek to unravel the relationship between agility and reliability. We observe that in certain cases reliability can undermine agility and vice versa. Global rules, routines, and procedures can hinder organizational agility whereas responding creatively for agility can locally undermine global organizational reliability. Further, we find that organizations often use decoupling to deal with this trade-off. Although decoupling enables them to be agile and reliable at the same time, it risks undermining both capabilities in the future, by encouraging the accumulation of technical debt. We find indications of how technical debt limits opportunities to creatively respond and increases vulnerabilities.

8.8 Research Paper 6 - When Procrastination Pays Off: Leveraging Digital Debt to Balance Organizational Reliability and Organizational Agility

Authors: Ollig, Philipp; Berente, Nicholas; Fridgen, Gilbert, Keller, Robert; Rieger, Alexander; Stohr, Alexander

Working paper

Extended Abstract:

Digital technologies continue to change the market environment and require organizations to develop new innovative offerings (Yoo et al., 2012) driving digital transformation within organizations (Bailey et al., 2022). Organizations face the challenge to adapt to their environment and find appropriate responds to opportunities and threats (Chakravarty et al., 2013; Pinsonneault & Choi, 2022). Thus, organizational agility, the ability to detect and exploit emerging market opportunities, becomes a competitive advantage (Sambamurthy et al., 2003; Tallon & Pinsonneault, 2011). At the same time, IT units need to maintain reliable processes and proactively avoid external disruptions (Urbach et al., 2017). Organizational reliability refers to an IT unit's ability to continue operating and delivering efficient and effective outcomes despite external disruptions, issues, and challenges (Butler & Gray, 2006). Existing literature suggests a trade-off between being agile and reliable at the same time such as standardization limits flexibility (Doz & Kosonen, 2010) and change lowers reliability (Butler & Gray, 2006). Furthermore, limit IT spending poses a major challenge to organizations who need to balance both imperatives (Tallon et al., 2019). Rules, routines, and procedures, required to establish a stable environment and to increase organizational reliability, may hinder creative, innovative responses to market opportunities. However, both capabilities, organizational agility, and organizational reliability, are imperatives for business success (Keller et al., 2019).

Decoupling can provide a possible solution to achieve both imperatives since it enables the organization to separate their systems (Berente & Yoo, 2012). Thus, possible vulnerabilities of one system do

not influence the reliability of the other system. However, in the long term, decoupling leads to a fragmented IT landscape which encourages the accumulation of digital debt. The term “digital debt” builds upon the metaphor of technical debt which is characterized “as a reflection of an organization’s cumulative build-up of technical and informational obligations related to the maintenance and evolvability of its platform and infrastructure” (Rolland et al., 2018, p. 420).

We draw on 37 narratives from 26 interviews to unpack the relationship between organizational reliability, organizational agility, and digital debt (Pentland, 1999). Thereby, we identify four main cost drivers of digital debt and observe that organizations have incentives to incur digital debt in favor of stability. Thus, the optimal debt ratio is not zero, similar to the financial leverage effect. We propose that organizations manage their digital debt not only for economic reasons but in consideration of organizational reliability and organizational agility.

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