Operational Capabilities in Times of Digitalization –
Surveys in Traditional Industry Companies

Von der Fakultät für Ingenieurwissenschaften, Abteilung Maschinenbau und Verfahrenstechnik
der
Universität Duisburg-Essen

zur Erlangung des akademischen Grades

eines

Doktors der Wirtschaftswissenschaften

Dr. rer. pol.

genehmigte Dissertation

von

Stefan Sommer
aus
Rheinberg

Gutachter: Frau Univ.-Prof. Dr. Heike Proff,
Herr Univ.-Prof. Dr. Andreas Wömpener

Tag der mündlichen Prüfung: 12.12.2022

Acknowledgements

I wish to express my deep gratitude and appreciation to my supervisor, Prof. Dr. Heike Proff. Her scientific expertise and knowledge of the subject matter steered me through this research. During my time at the Chair of General Business Administration & Int. Automotive Management (IAM), she also gave me the necessary freedom to independently choose my interests in strategic management research, project work, and academic teaching.

I would also like to thank the entire IAM-team for the support I have received over the years of collaboration. In particular, I am thinking of Dr. Florian Knobbe, Dr. Timo Günthner, and Dr. Gregor Schmid-Szybisty.

I am extremely grateful to my parents, Elke and Volkwin Sommer, my sister Jana Sommer and her boyfriend Julian Brock, and my girlfriend Mirja Müller for their endless patience and encouragement. Without them, I would not have been able to complete this thesis.

DOI: 10.17185/duepublico/78159
URN: urn:nbn:de:hbz:465-20230411-143002-5

Abstract

Traditional companies from capital-intensive industries are facing hard challenges in times of digitalization. Far-reaching technological changes have the potential to weaken long-time successful operational capabilities of the companies and make them obsolete. Based on theoretical explanations this paper examines the possibilities for accelerating digitalization and its impacts on the creation and transfer of operational capabilities using the example of traditional companies.

Therefore, in the first study, the digital status quo of 160 German industry companies was measured in a digital maturity assessment based on a theoretically derived maturity model. The average level of digital maturity is 3.92 out of 7 and shows a need for improvement. Further results make it clear that many companies (44%) have not yet experienced any increase in profitability as a result of digitalization. A cluster analysis was therefore used to identify six archetypes of companies with varying degrees of digitalization. Possible opportunities for acceleration were identified by comparing the levels within the maturity model dimensions.

Another quantitative study was conducted to compare the economic effects of digitalization and the requirements for the creation of operational capabilities in a structural equation model. The quantitative survey of 200 German industrial companies showed that increased adaptation to the environmental dynamics and intensive interaction in value-creation networks and ecosystems have a positive effect on the advantageousness of the capabilities created in times of digitalization. In contrast, the effects of higher imitability and tradeability of the capabilities do not have a significant impact.

By drawing on a third study based on qualitative content analysis, the impacts of digitalization on the trade-off between transfer and protection against disclosure of operational capabilities were investigated. Therefore, the single case study methodology was applied to a German manufacturing company. From the literature, the balancing parameters of decentralization of decision-making and information richness of communication mechanisms were identified as optimization parameters for the trade-off. By analyzing the interviews and further data sub-parameters were generated that are set differently in the case study company depending on the transfer technologies used. This optimization is needed to mitigate the trade-off between the transfer and protection of capabilities.

The present thesis thus makes a theoretical and practical contribution to improving digital maturity and maintaining the competence-based competitive advantages of capital-intensive industries in times of digitalization.

I. Table of Contents

II. List of Figures

III. List of Tables

Chapter A: Introduction

1. Motivation

Throughout economic history, numerous companies were facing a sudden loss of power regarding their decades-long and highly successful businesses (Rahmati et al., 2021; Riemer and Johnston, 2019). For example, in the case of Kodak the analog films for cameras lost demand during the rapid market ramp-up of digital photography (Vecchiato, 2017). The loss of performance of these companies reflects permanently competitive pressure, which is intensified due to disruptive technological changes (Adner and Liebermann, 2021; Alves et al., 2021), such as digitalization (Cozzolino and Rothaermel, 2018). The digitalization is not only seen as the enabler of new upcoming technology companies such as Google and Tesla (Barwise and Watkins, 2018; Thomas and Maine, 2019). It is also perceived as the greatest challenge for established companies in the near future (Björkdahl, 2020), and has become increasingly important within the last 10 years (see Fig. A-1).

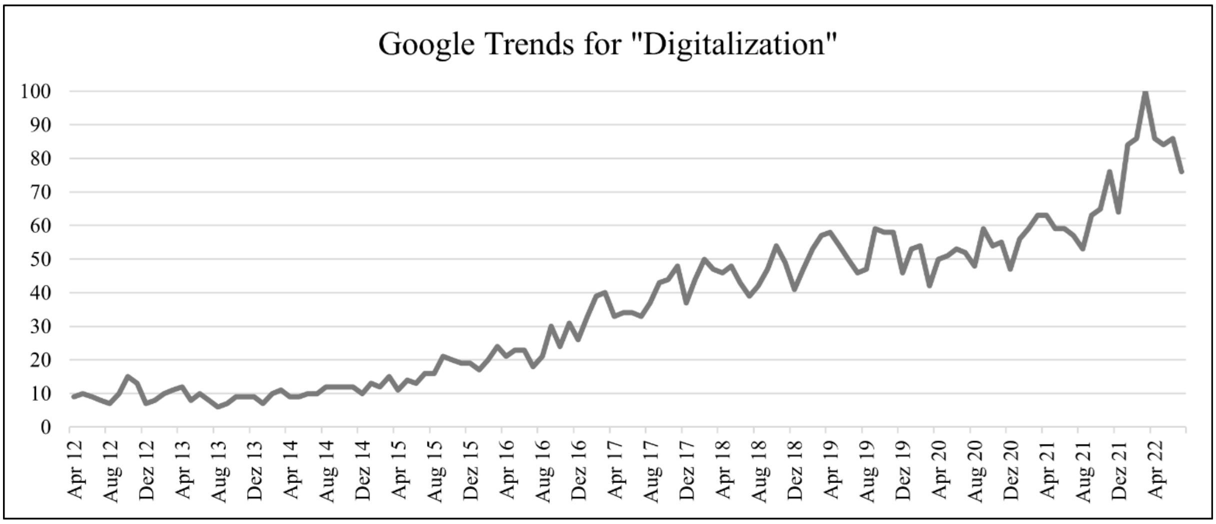

Fig. A-1: Search queries for “digitalization” at Google Trends over the last ten years (search volume on a relative scale from 0 to 100 with a maximum in March 2022; source: Google Trends, 2022)

Since the 1990s the internet is considered the central technology behind digitalization and thus builds the basis of this latest, that is, the fourth industrial revolution (Schwab, 2017; Deeken and Fuchs, 2018, p. 9). From that time on, billions of devices around the world could communicate with the internet (Ozcan, 2014). As a result, users started to exchange and generate media content collaboratively or individually on networks (Fuchs, 2021), and in the industry, the networking of objects, products, and machines emerged (Li et al., 2018), which facilitated the creation and analysis of large data volumes (Commuzzi and Patel, 2016).

However, from an economic perspective, digitalization is more than just an evolution of information technology (Brennen and Kreis, 2016). It can be explained by an increase in the environmental dynamics (Kane et al., 2016; Knobbe and Proff, 2020), which is shifting to an unstable status (Troise et al., 2022). Furthermore, digitalization is providing the technical standardization of interfaces between value creation activities in the traditional value chain (see Porter, 1985) for better internal and external coordination at lower transaction costs (Gulot et al., 2020; Hagiu and Wright, 2015; Williamson, 1975). Hence, e.g., flexible production lines quickly generate new product variants in response to changing customer demands (Lu et al., 2020). Digitalization can also be explained by a stronger interaction via digital platforms (Kapoor et al., 2021) that enable multiple partners to communicate more intensively, for instance, if suppliers and customers join forces in a digital production network (Yang et al., 2021) or if the companies co-create value with even better interaction and alignment in so-called ecosystems (Jacobides et al., 2018). In consequence, digitalization requires wide-ranging transformations from the companies being affected (Legner et al., 2017) because it not only triggers improvements in processes, such as networking of production systems in the matter of Industry 4.0 (Machado et al., 2020). It also bears the potential to fundamentally shift existing services and products, and business models (Appio et al., 2021; Proff, 2019), or even to make them obsolete, such as in the book, music, and film industries (Waldfogel, 2017).

The economic effects of digitalization are challenging especially the traditional industry companies. In the context of this work, this refers to the capital-intensive businesses of, e.g., industrial goods and services, automotive, or pharma and chemicals (e.g., Agostini and Nosella, 2020), because these companies have long time relied on the competitive advantages they have built up and maintained many years ago (Rahmati et al., 2021).

From the perspective of strategic management research, and according to the resource- and competence-based view, competitive advantages can be explained by the property and use of operational capabilities (Barney, 1991; Freiling and Fichtner, 2010; Lioukas et al., 2015). These operational capabilities can be understood more broadly as “repeatable patterns of action in using assets to create, produce, and offer products to the market” (Wade and Hulland, 2004, p. 109). More concretely, they can be found in “the routine activities, administration, and basic governance that allow any organization to pursue a given production program, or defined set of activities, more or less efficiently” (Teece, 2018, p. 1). Operational capabilities can create strong competitive advantages if they are based on valuable, rare, inimitable, and non-substitutable resources (“VRIN”-resources, Barney, 1991), such as knowledge (Papa et al., 2018), and if they emerge from organizational learning (Lin and Sanders, 2017; Mehrizi et al., 2022). In this case, they create value on the market (Wu and Li, 2018), are difficult to copy from outsiders, and keep pace with current technological developments (Singh et al., 2019). Google, for example, has outstanding operational capabilities in the development of algorithms that can collect and analyze data from users for target group marketing services (Vise, 2018). In comparison, Tesla owns advantageous operational capabilities regarding the development of autonomous cars (Dikmen and Burns, 2017). However, the competitive advantage of operational capabilities does not only concern their local use at the place of creation. According to the economies of scope (Helfat and Eisenhardt, 2004; Teece, 1980), multinational companies (MNCs) can transfer operational capabilities between different units of their organization. These transfers between, e.g., headquarters and subsidiaries or peer subsidiaries (Di Stefano and Micheli, 2022; Stadler et al., 2022) easily allow the company to tap into globally dispersed new markets with existing solutions (Gaur et al., 2019). More than this, operational capabilities can be an input factor for additional products (Audretsch and Link, 2019; Buchanan, 1965). That is, the recombination of capabilities creates completely new ideas or solutions (Argote et al., 2022), and facilitates the development of new products (Sanchez, 1996).

Since much uncertainty stems from the latest technical developments, especially traditional industrial companies do not know their status quo of digitalization or ways of acceleration (Hebbert, 2017), suffer from ambiguities about the creation of operational capabilities (Li et al., 2017; Tan et al., 2015), and often disclose strategically important knowledge to externals in their intra-firm transfers (Di Stefano and Micheli, 2022; Lenka et al. 2016; Nasiri et al. 2020; Remane et al., 2017). These research gaps form the motivation for the present thesis and must subsequently be differentiated and transferred into a research framework in the following section.

2. Research Questions and Objectives

The changes in times of digitalization that were outlined in the previous chapter have far-reaching impacts on traditional industry companies. In this context, a further investigation of these impacts requires a research framework that can be divided into four main areas (see Fig. A-2).

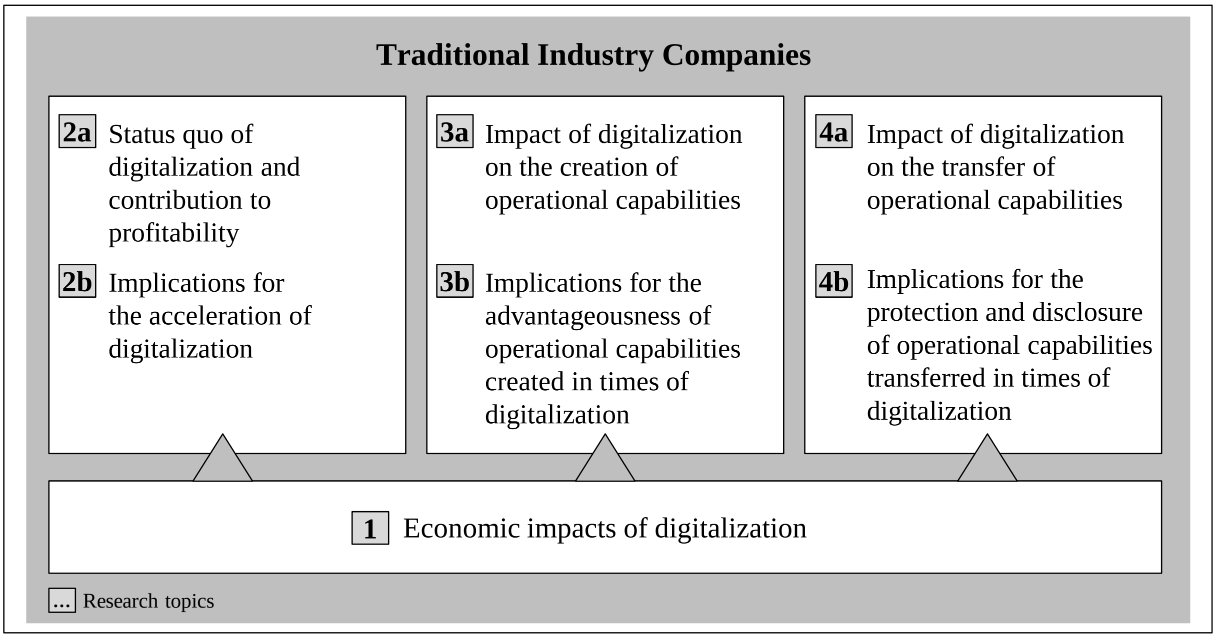

Fig. A-2: Research framework for this thesis (source: own compilation)

Recent literature shows that the management of traditional industries is not taking into account the impacts and chances of digitalization adequately (Matarazzo et al., 2021). In particular, this can be explained by remaining uncertainties regarding the effects of digitalization from an economic perspective (Koch and Windsperger, 2017; Kuusisto, 2017). That is, the impacts of digitalization such as improvements in the organizational structures and processes (Negoita et al., 2021), lower costs in organizational processes (Benner and Waldfogel, 2020), or the simplified and intensified exchange of information between internal and external stakeholders (Addo, 2022; Karhade and Dong, 2021) have not yet been explained using a theoretical explanatory approach. Therefore, at the beginning of this thesis the following research question is inevitable, addressing research topic 1 in Fig. A-2.

RQ1: What are the impacts of digitalization from an economic perspective?

Since their long-term businesses were profitable for decades (Rahmati et al., 2021; Riemer and Johnston, 2019), and the companies' willingness for renewal or improvement is low (Fitzgerald et al., 2014), traditional industry companies are losing out to the competition from an overall organizational perspective. The main reason for this is the lack of a holistic point of view of digitalization, including the status quo of changes in the company (Hess et al., 2016), e.g., the business activities and strategies. Managers often do not know how to digitally transform their organization (Kumar et al., 2016), and are uncertain about the necessary processes, topics, and approaches (Øvrelid and Bygstad, 2019). Therefore, reviewing the digital status quo of the company can reveal the digital readiness and thus be the groundwork to exploit the chances of digitalization to contribute to the company's profitability (Ostmeier and Strobel, 2022). Usually, in literature, existing studies are developed by practitioners and neglect neither to provide a theoretical foundation for responses to the discontinuous changes nor to derive adequate paths to accelerate digitalization (Teichert, 2019; Thordsen et al., 2020). For this reason, a holistic assessment of the status quo of digitalization in traditional companies is required, which also can identify necessary acceleration approaches (research topics 2a and 2b in Fig. A-2). As a result, the following research questions emerge:

RQ2a: What are the status quo and profit impacts of digital maturity in traditional industries?

RQ2b: What are the conceivable approaches to accelerate digital maturity?

These previous considerations should go beyond digitalization status assessments and take into account the impacts of digitalization on the fundamental theoretical foundations of creating advantageous operational capabilities (Koch and Windsperger, 2017; Zhao et al., 2022). These comprise the fulfilment of VRIN characteristics and the adjustment to environmental dynamics (Barney, 1991; Day and Schoemaker, 2016; Eller et al., 2020). Especially, the impacts of digitalization might be contradictory: On the one hand, digitalization causes value-creating resource positions, e.g., by lowering transaction costs of internal processes, or by complementing the company's resources in collaboration with suppliers or customers in a network (Schreieck et al., 2021; Spulber, 2018). On the other hand, exposing the resources to externals also risks making them transparent and thus easy to imitate (Sheng et al., 2013). As a consequence, digitalization seems to have an impact on the requirements for advantageous operational capabilities (VRIN characteristics and adjustment to environmental dynamics; Day and Schoemaker, 2016; Eller et al., 2020; Giustiziero et al., 2021). Current literature puts a focus on resources and capabilities that can be enablers for digitalization (Li et al., 2018; Kettinger et al., 2021), or considers the co-creation of operational capabilities in networks and ecosystems (Ceccagnoli et al. 2012; Kazadi et al., 2016). Still, these prior studies fail to draw on the fundamental theoretical foundations related to the requirements for advantageous operational capabilities. These deliberations have inevitably led to the formulation of the following research questions, addressing the research topics 3a and 3b in Fig. A-2.

RQ3a: What is the impact of digitalization on the creation of operational capabilities?

RQ3b: What are the implications for the advantageousness of operational capabilities created in times of digitalization?

Furthermore, the research on operational capabilities in times of digitalization must extend the considerations of their local emergence and use by complementing the transfer in the multinational company (Stadler et al., 2022), since this is seen as a basis for competitive advantages (Argote et al, 2022). Because operational capabilities are difficult to express with formal language, words, symbols, and numbers (Schniederjans et al., 2020), companies are anxious to overcome these barriers and facilitate their transfer activities as much as possible (Gupta and Govindarajan, 2000). Simultaneously, they need to lower the risk of disclosing the capabilities to rivals in case the transfer frequency and thus also transparency and traceability are increased excessively (Alexy et al., 2018; Ralston and Blackhurst, 2020). Balancing this "paradox" (Coff et al., 2006) is not adequately addressed in current research (Ritala and Stefan, 2021). Extant studies consider the effects of digital communication technologies on transferability, such as enterprise social media (e.g., Berraies, 2019; Nisar et al., 2019), or they explore separately how the use of digital tools raises or lowers the danger of knowledge and capability losses (Manhart and Thalmann, 2015). Others only focus on the "paradox" of simultaneous transfers of operational capabilities and their protection from the inter-organizational perspective (Contractor, 2019). Therefore, the following research questions arise in consideration of research topics 4a and 4b in Fig. A-2.

RQ4a: What is the impact of digitalization on the transfer of operational capabilities?

RQ4b: What are the implications for the protection and disclosure of operational capabilities transferred in times of digitalization?

To answer the previously derived research questions, different explanatory approaches and methods must be used. They will be briefly presented in overview in the next section before the structure of the thesis is demonstrated in Section 5.

3. Theoretical Background

For the further course of this thesis, an understanding of the theoretical relationships between digitalization and the creation and transfer of operational capabilities is necessary. In the following, fundamental explanations are outlined along a framework (see Fig. A-3).

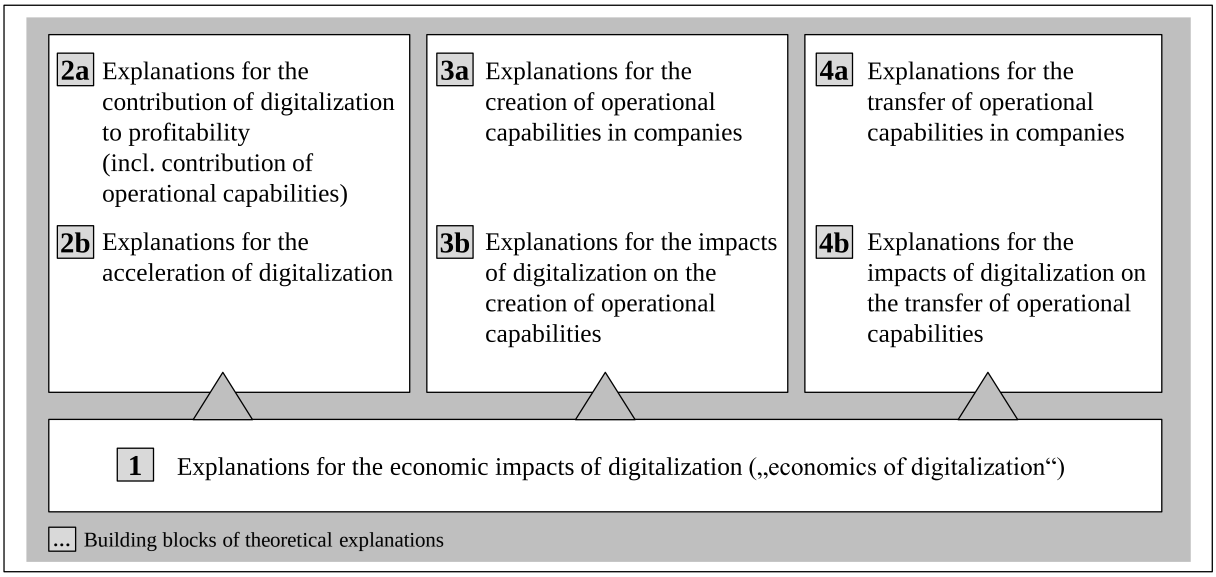

Fig. A-3: Theoretical explanations for this thesis (source: own compilation)

Ad [1]: The **economic impacts of digitalization ("economics of digitalization")** have their origins in the spread of digital internet and communication technologies (ICT), which comprise so-called SMAC technologies ("social media-, mobility-, analytics- and cloud technologies"; Evans, 2016). These technologies are regarded as basic technologies for the acquisition, storage, dissemination, and analysis of large volumes of data and their processing for decision-making (Chen et al., 2020). Their application causes "manifold sociotechnical phenomena […] in broader individual, organizational, and societal contexts", which is defined by the term of "digitalization" (Legner, 2017, p. 301).

From an economic perspective, the effects of digitalization can be explained by discontinuous change and an increase in environmental dynamics (see Fig. A-4a; Cozzolino and Rothaermel, 2018; Kane et al., 2016; Knobbe and Proff, 2020). These conditions are also often described by the acronym "VUCA", which means a market or business environment characterized by volatility, unpredictability, complexity, and ambiguity (Bennett and Lemoine, 2014; Cousins, 2018). Formerly stable market conditions are transformed into unstable market and environmental conditions as a result of technological uncertainties, e.g., when completely new customer solutions can occur in a short period (Singh and Hess, 2017).

a) Discontinuity & increasing instability of environmental dynamics	b) Reduction of interdependencies & decoupling of value activities	c) Increasing interaction & participation on digital platforms
► market conditions characterized by velocity, unpredictability, complexity, & ambiguity	► lower transaction costs in internal & external coordination ► higher scope in goal conflicts	► alignment in traditional networks & ecosystems ► new intelligent customers solutions & business models

Fig. A-4: Impacts of digitalization (source: own compilation)

With regard to organizational processes and structures, the effects of digitalization can be explained by economic interdependence and coordination (Ruiz-Alba et al., 2020; Victor and Blackburn, 1987) according to the "decision-oriented organization theory" (Laux and Liermann, 2005; Tasic et al., 2019). Particularly along with the primary, supporting, and infrastructure activities in Porter's (1985) value chain a "process of managing dependencies among activities" (Malone and Crowston, 1994, p. 87) is referred to as coordination (Burton and Obel, 2018), which is causing transaction costs (Williamsson, 1985). By the introduction of digital technologies, the interfaces between activities along the value chain get standardized (Gulot et al., 2020), e.g., by establishing transmission standards in the case of data transfer (Fontana et al., 2009). This reduces interdependencies between primary and supporting activities (see Fig. A-4b; Cano-Kollmann et al., 2016; Cyert and March 1963) but also interdependencies at interfaces with external partners (Nasiri et al., 2020) and allows decision-making units to act more independently and make partial decisions on their own to a certain extent (Weyer et al., 2015). As a consequence, by decoupling value activities transaction cost advantages can be achieved regarding both, internal and external coordination (cf. Hagiu and Wright, 2015).

Furthermore, cost-effective coordination can mitigate conflicting goals, such as flexibility and efficiency (Cenamor et al., 2017), e.g., companies can implement modular production systems which respond spontaneously to fluctuating customer demands because of quick and automated communication between machines or employees (Lu et al., 2020).

Apart from this, the impacts of digitalization can be explained by the technical development of digital platforms (Wagner et al., 2021; Gawer, 2014) and the theory of two-sided or multi-sided markets (see Fig. A-4c; Hagiu and Wright, 2015). Digital platforms act as intermediaries between two interacting parties in the sense of processing common transactions, such as between buyers and sellers (Rochet and Tirole, 2003), or these platforms support to create innovations together ("innovation platforms"; Cusumano et al., 2019) if the actors span a network with high interactions. Then, complementarities (cf. Huth, 2015) or network synergies (cf. Jacobides et al., 2018; Hannah and Eisenhardt, 2018) between at least three groups of actors emerge through joint value creation of the network partners (e.g., Brandenburger and Stuart, 2007; Dyer et al., 2018), or also in the case of customer “value co-creation” (cf. Vargo and Lusch, 2008) and value capture in competition (“value capture”; e.g., Gans and Ryall, 2017) according to cooperative and non-cooperative game theory. Therefore, the total value in these so called “ecosystems” (Adner, 2017) is higher than the sum of the individual values (Gawer, 2014).

Ad [2a]: The **impacts of digitalization can increase the profitability** of the entire organization (cf. Bodrožić and Adler, 2022; Fitzgerald et al., 2014; Hess et al., 2016) because digital technologies and the profound economic impacts (see Ad [1]) cause improvements or completely new creations of processes, products and services, and business models (Appio et al., 2021). This has far-reaching effects on profitability (see Fig. A-5), e.g., if manufacturing processes are made more efficient through the analysis of data (Wang et al., 2021) or additional revenues are generated by completely new process solution, i.e., if customer interaction data is used for customized outputs (Zhan et al., 2018). Improvements of the company’s products and services can increase profitability, if data is transferred within a product system or to another system (or in the case of completely new products and services by enabling interaction from at least three systems; Proff, 2019). These products and services also enable to improve (or completely create from scratch) business models depending on the degree of change in the product- and service-, as well as financial-oriented decision components of the business model (see Proff, 2019). Completely new and data driven business models (Ritter and Pedersen, 2020) showed particularly high profit impacts in recent studies (Bouwman et al., 2019; Hartmann et al., 2016), e.g., if vehicle data is used for additional offerings by the car manufacturer or third-party providers (Seiberth and Gründinger, 2018)

In this context, according to the resource- and competence-based view, operational capabilities based on strategic resources are fundamental for the profit effects of digitalization (see Fig. A-5; Barney, 1991; Collis, 1994; Sanchez and Heene, 1997; Uzunca, 2018). Even if companies in possession of these resources can generate scarcity and differential rents, also called Ricardo rents (cf. Schwerhoff et al., 2019), the superiority of resources and related rents is affected by the firm’s environmental dynamics (Schreieck et al., 2021). That is, the profound technological changes of digitalization (Parida et al., 2019; Proff, 2019) jeopardize the suitability of companies’ existing resource base to the surrounding market dynamics (Birkinshaw et al., 2016). Addressing this, the competence-based view explains how knowledge-based resources such as human capital or know-how (Sanchez and Heene, 1997; Uzunca, 2018) represent a transformable knowledge base, which is called competencies or operational capabilities (Argyres, 2021; Schulze and Brusoni, 2022). These operational capabilities help the firm "to perform a coordinated set of tasks, utilizing organizational resources, to achieve a particular end result" (Helfat and Peteraf, 2003, p. 999), and emerge via learning processes in dynamic environments as a result of continuous adaptation and innovation (cf. Rasche, 1994). Thus, digital operational capabilities enable companies to create innovative products and services, and address customer interests better than competitors (Mikalef et al., 2020). As a result, if the companies create (digital) operational capabilities they achieve time-limited monopoly rents (cf. Aghion et al., 2015) that go beyond the previous scarcity and differential rents.

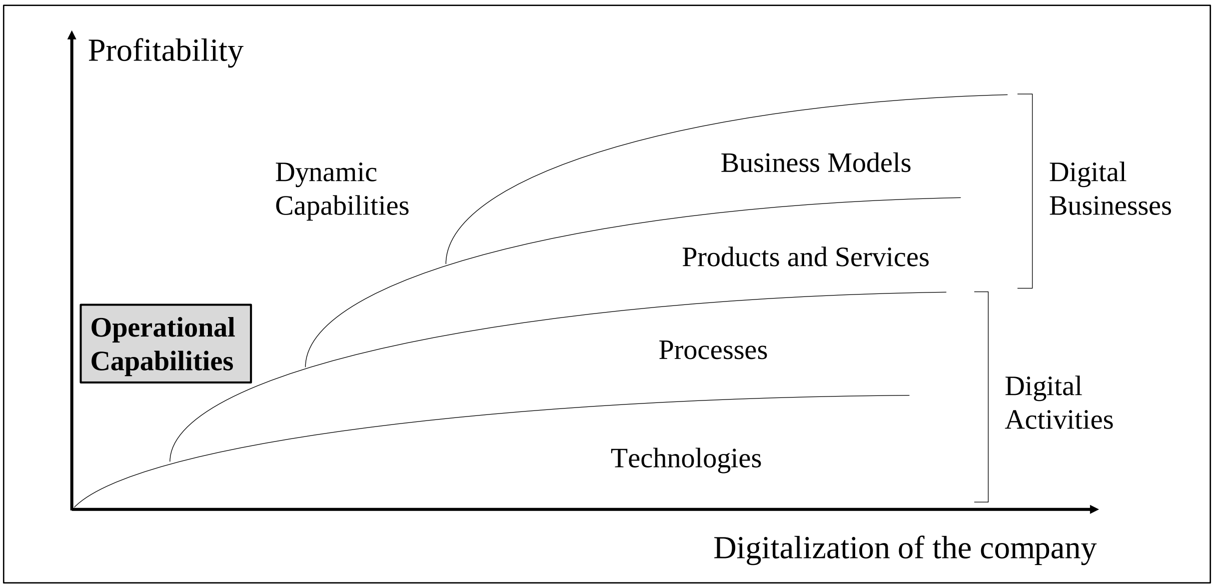

Fig. A-5: Impact of digitalization on profitability (source: in adaption to Proff et al., 2021, p. 63)

Ad [2b]: The digital impacts highlighted so far can be **starting points for accelerating digitalization**. That is, the improvements or radical changes of processes, products and services, or business models, caused by digital technologies, build a setting of dimensions how to respond to digitalization (Li et al., 2018; Matarazzo et al., 2021). Even more, the operational capabilities (and the dynamic capabilities) need to complement these dimensions, since they are the prerequisite for processes, products and services, and business models (Matt et al., 2015; Li, 2020). In consequence, "digital activities" and "digital businesses", as well as the underlying capabilities can be seen as operational and strategical opportunities for improving the status quo of digitalization (Reis et al., 2018) which is represented by the digital maturity (Kane et al., 2016). Since operational capabilities can contribute to the generation of economic rents (see Ad [2a]), their creation, in particular in the context of this thesis, is important to increase profitability (Coen and Maritan, 2011), and needs to be explained in the following.

Ad [3a]: The **creation of operational capabilities** is related to the characteristics of the underlying resources, especially, knowledge-based resources such as human capital, know-how or patents (Alexy et al., 2018). In consequence, strong operational capabilities can be created, if the company successively fulfils the following requirements for their resources (see Fig. A-6a).

At first, (I.) the company deploys resources, *that create value on the market.* These are *scarce or rare and thus valuable resources*, (see Barney, 1991; Nason and Wiklund, 2018), which are a) suitable to the company's aims, and b) achieve a high perceived value on the market (Ambrosini and Bowman, 2009). Then, the company should fall back on (II.) resources which *show limited tradeability and imitability* (see Barney, 1991). This requires (a) tacitness, which means that hidden knowledge is not discovered by replication and cannot be precisely identified and assessed (cf. Shamsie and Mannor, 2013; Nelson and Winter 1982). It also requires (b) high complexity of the individual components from the company-specific resource base, e.g., stakeholder relationships or the culture of the company (cf. Dierickx and Cool, 1989). And there is (c) a high specificity of the resource position needed that causes significant transaction costs when extracting it from the group (Un and Asakawa, 2015). Then, finally, (III.) the company adapts their capabilities constantly over time (cf. Grant, 1988; Thiele, 1997, pp. 54-55) by *adjusting them to the dynamics of the environment* (see Schreieck et al., 2021). This requires "organizational learning" (Argote et al., 2021; Argyris, 1982), such as optimization of management processes in a stable environment ("single-loop learning"; Reychav et al., 2016), change of management processes in an evolving environment ("double-loop learning"; Henly-Shepard et al., 2015), and the radical change of management processes in dynamic environments ("deutero learning"; Visser, 2007).

Ad [3b]: The **creation of operational capabilities is affected by digitalization** (see Fig. A-6c), which can be explained by comparing the requirements I. to III. (see Ad [3a]; Fig. A-6a) and the economic impacts of digitalization (see Ad [1]; Fig. A-6b). The increasing instability of the environmental dynamics is about to weaken the value of the resource position on the market (Lenka et al., 2016; Tushman and Anderson, 1986), e.g., if customer requirements are shifted because of new technological opportunities (see requirement I.; Kamalaldin et al., 2020). As a result, the adjustment of the resource position with these new environmental conditions may also rise in importance (see requirement III.). Furthermore, because digitalization improves coordination within the organization and in the communication with external partners (Hagiu and Wright, 2015), resources and their interconnections within the company become more transparent (Ritala and Stefan, 2021). In this context, simplified coordination lowers the tacitness of the resource position (see requirement II.; Bennis, 2013), and also can mitigate the complexity of their integration into the organization (Ethiraj and Levinthal, 2004). This can be reinforced if the company is participating in value-creating networks or ecosystems. By interaction with external stakeholders, the resources and capabilities are disclosed to the network (Bouncken and Kraus, 2022). Since these resources are then opposed to external parties they will lose specificity, complexity, and tacitness (Ghadge et al., 2019; Pil and Cohen, 2006, p. 999). But companies can also decide to bring in resources voluntarily and create new operational capabilities together with other participants (Kazadi et al., 2016). Such co-created ("co-creation"; cf. Vargo and Lusch, 2008) operational capabilities can have a higher value on the market than it is possible by the company's resource position alone (Adner and Euchner, 2014).

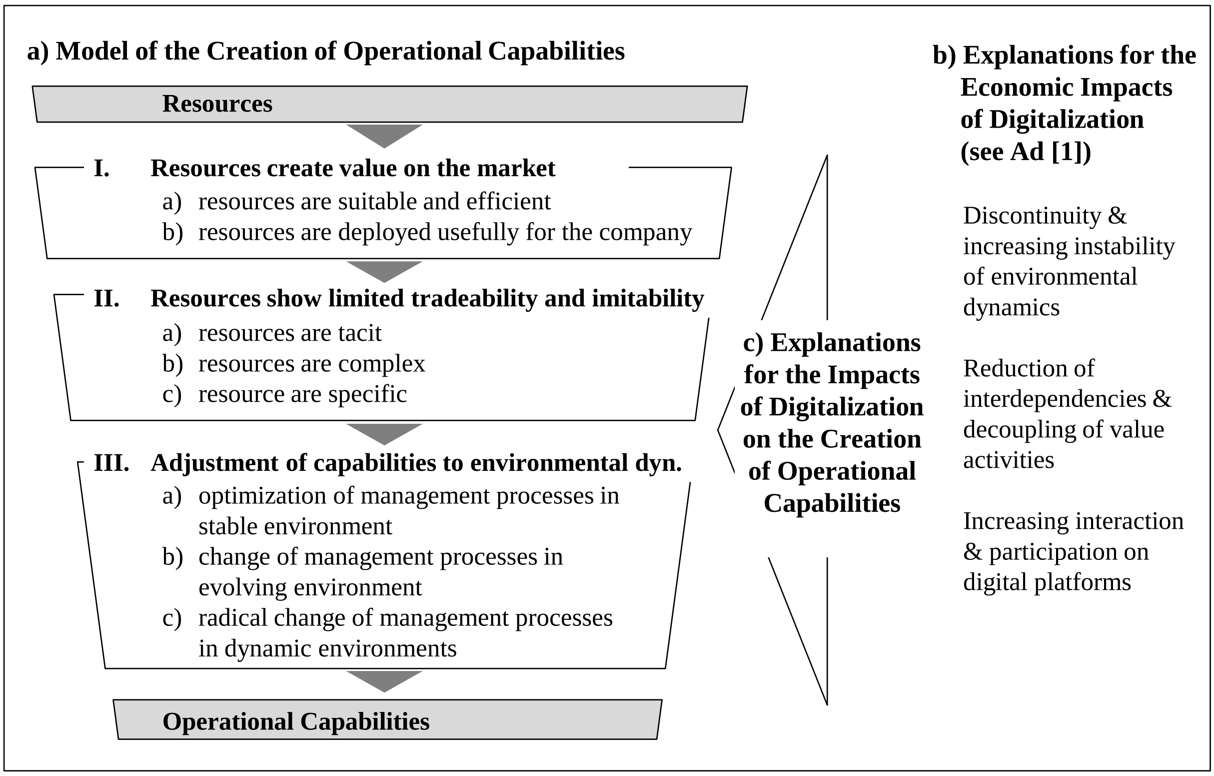

Fig. A-6: Model for the creation of operational capabilities (source: in adaption to Proff, 2007)

Ad [4a]: The explanations for the creation of operational capabilities can be expanded to the **transfer of operational capabilities** within the multinational organization (see Liu et al., 2022), since operational capabilities can be even more advantageous if they are moved between headquarters and subsidiaries or peer-to-peer between subsidiaries (Faems et al., 2020). Then, in cross-business activities, these capabilities can, on the one hand, be a gateway to new markets

(Hamel, 1994). Or, on the other hand, their recombination creates completely new ideas or solutions (Argote et al., 2022). This generates additional economies of scope (Zahavi and Lavie, 2013) enabling the company to leverage a locally originated capability in a second or even more applications. Their transfer can be explained by the sharing of human capital (Unger et al., 2011). That is, operational capabilities are transferable within the company if they have the character of a quasi-public good (Audretsch and Link, 2019; Sahito et al., 2020), which means that these capabilities, different from public goods (Jefferson, 1998), cannot be transferred as often as desired (see Fig. A-7).

Instead, they lose their value with each additional transfer because of rising transaction costs, e.g., for transcription and documentation (Buchanan, 1965; Markus, 2001; Lambert, 2017).

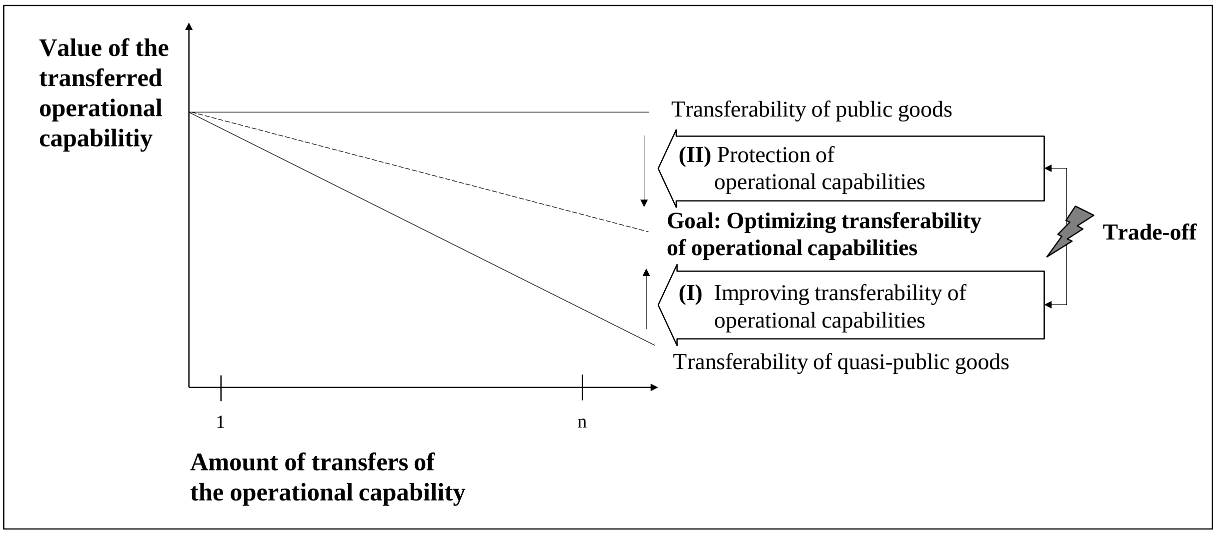

Fig. A-7: Trade-off in the transfer of operational capabilities (source: own compilation)

Companies want to increase transferability within the organization, e.g., by simplifying codification but they must avoid disclosure of operational capabilities to the outside, and thus avoid the danger that the operational capabilities will become public goods accessible to all (Jefferson, 1998). This trade-off is also known as a “paradox” (Coff et al., 2006; Ritala and Stefan, 2021) and is becoming even more acute in times of digitalization.

Ad [4b]: In this context, the **impact of digitalization on the transfer of operational capabilities** can be explained by the intensification of transfer impact factors (Di Stefano and Micheli, 2022). Companies can increase transferability by giving more autonomy to the transfer stakeholders (“decentralization of transfer decision”; Eklund, 2022; Rangus and Slavec, 2017) as well as by implementing communication mechanisms with rich information processing ability (“information richness”; Daft and Lengel, 1986). However, they must consider too much autonomy and rich information spreading can cause uncontrolled and dissipated transfers within the organization (Ritala et al., 2018), and thus risking transparency to external parties (Ralston and Blackhurst, 2020; Ritala and Stefan, 2021). This balance needs to be redefined, since digitalization creates more scope for decision-making of organizational units and employees, e.g., if they communicate in large enterprise knowledge management teams (Murphy and Sashi, 2018). Therefore, decisions become more decentralized, and subsidiaries or individuals have more freedom to learn from other subsidiaries and local partners, and gain knowledge and capabilities more easily (Rangus and Slavec, 2017; Balboni et al., 2017). But strong decentralization of decision-making can increase the danger of capabilities to become transparent to external companies (Hurmelinna-Laukkanen 2011), e.g., if data is transferred via standard interfaces with partners (Weyer et al., 2015) or if there is no clear commitment to the transfer of fresh operational capabilities to the headquarter (Hutchings and Michailova, 2004). Digitalization also enables extensive, two-way communication among members of the organization, which could include private and social topics and issues (Lehmkuhl and Jung, 2013). This can improve the relationship and transfer of resources between platform attendees in multilateral relationships by building strong and weak social ties (Valenzuela et al., 2018). But more scope for action in interaction can also increase the danger of capabilities becoming transparent for external companies (Hurmelinna-Laukkanen 2011), which amplifies the risk of loss of operational capabilities (Krylova et al., 2016), e.g., if there are rich information processing mechanisms set up with local partners (Sheng, 2019). Thus, the conflicts regarding the extent of information richness and decentralization need to be further explained in this thesis.

The explanations of this section build the theoretical basis of the empirical studies and the research methods applied in the Chapters B, C, and D. These methods are presented briefly in the following chapter.

4. Methodology

To answer the research questions of this thesis quantitative and qualitative methods were applied (see Fig. A-8). Therefore, the research setting thus followed a multi-method research approach (cf. Johnson et al., 2007; Mingers, 2003), but separated the method's application into three articles (see Chapters B, C, and D).

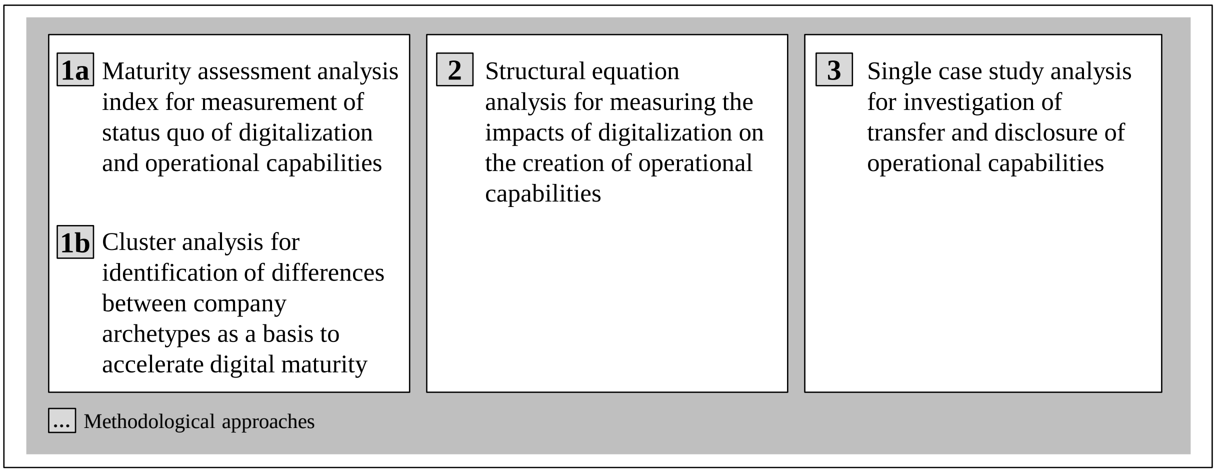

Fig. A-8: Research methods in this thesis (source: own compilation)

Ad [1a]: The **maturity assessment analysis** belongs to the methods of evaluation and improvement of organizational performances (Zanon et al., 2021). In this context, “maturity” primarily means the “evolutionary progress in the demonstration of a specific ability or in the accomplishment of a target from an initial to a desired or normally occurring end stage” (Mettler, 2011). Typical performance factors to be assessed in management research are, e.g., cost, quality, time to market, or endowment of resources and capabilities (Wendler, 2012).

By drawing on an established modelling approach (see Fig. A-9; Paulk et al., 1993), this thesis’ maturity assessment started with the identification of the “domain” (Lahrmann and Marx, 2010) of investigation, which is “digital maturity”. Using theoretical research, domain-related factors were derived to build the components of the maturity model (de Bruin and Rosemann, 2007; Duffy, 2001) based on the responses to digitalization: “digital activities”, “digital businesses”, “operational capabilities”, and “dynamic capabilities” (see Ad [2a and 2b] in Section 3). Sub-components and the underlying items were defined, whereby higher stages were built cumulatively on the preceding stages (de Bruin et al., 2005), and items were measured on a Likert 7-point scale ranging from 1 “completely disagree” to 7 “totally agree” (Ifenthaler and Egloffstein, 2020; Joshi et al., 2015).

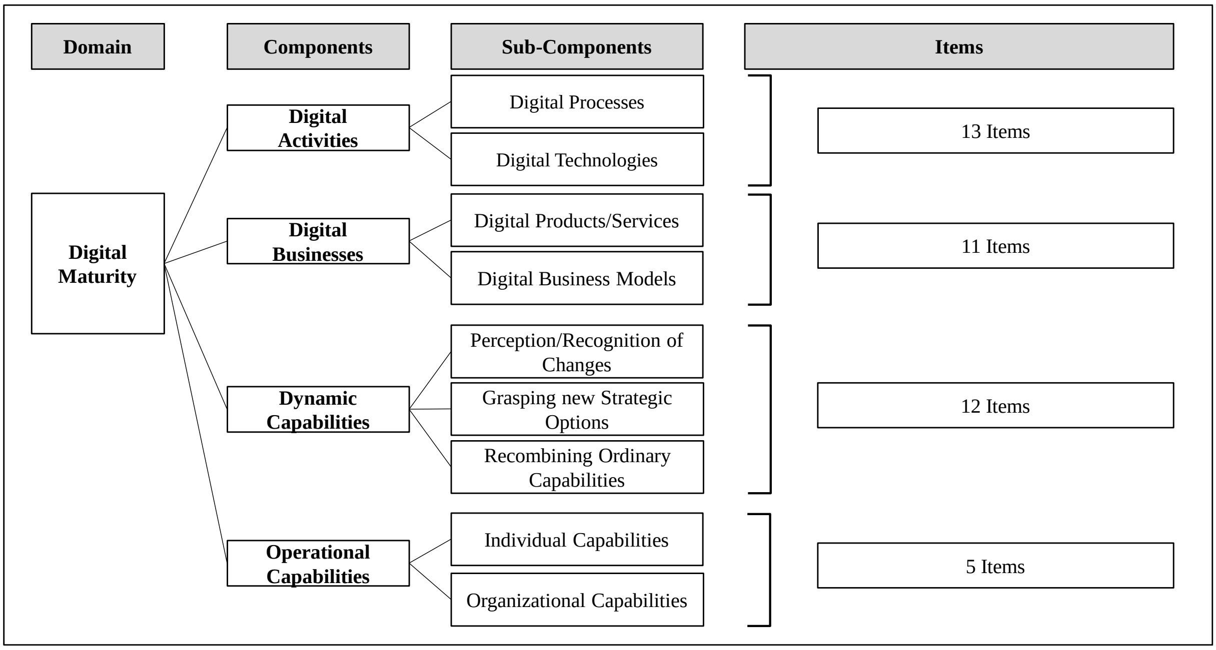

Fig. A-9: Structure of the maturity assessment model (source: own compilation in adaption to Curtis et al., 2009)

These kind of maturity assessments often result in an averaged overall maturity score, which is combined from the maturity levels of all components such as an index (Alghail et al., 2021). This approach is widely accepted and builds the basis for many assessments in research (de Bruin et al., 2005, p. 11; Ifenthaler et al., 2019), where the domain such as "digitalization" is not yet well understood (De Carolis et al., 2017). For the data collection and analysis, the maturity assessment in Chapter B is based on a quantitative online survey, which was conducted at German traditional companies including sectors of industrial goods, and - services, chemicals and pharma, and automotive (Schumacher et al., 2019). A total of 160 complete data sets was assessed. This sample size is suitable for regression analysis, which was applied between strategical and operational dimensions of digital maturity (Green, 1991). In this context, the quality criteria of Cronbach's alpha, and coefficients of determination (R^2, and adjusted R^2) were met (Miles, 2005; Schmitt, 1996).

Ad [1b]: By applying **cluster analysis**, comparable groups of respondents with similar maturity levels could be built (Romesburg, 2004; Zambelli, 2016) by drawing on a widely used hierarchical approach (Murtagh and Contreras, 2012). This can be understood as an agglomerative ("bottom up"; Gupta and Kumar, 2021) sequence of partitioning from n clusters containing a single individual data point to one cluster containing all the individual data points (Landau and Chis Ster, 2010). In literature, criteria for merging clusters are established, which consider the mutual location of individual data points in a multidimensional variable setting based on proximity measures (Wiedenbeck and Züll, 2010). A common measure is the euclidian distance between data points and is used in Chapter D of this thesis (Pandit and Gupta, 2011). Following a linkage criterion according to variance-based methodologies, such as the "Ward methodology", clusters with the smallest increase in total variance were formed to a new cluster (Kirenz, 2020). The clustering was stopped based on the elbow criterion, which is used for its simplicity (Bholowalia and Kumar, 2004). It indicates the ideal number of clusters by a bend ("elbow") in the curve built by the error sum of squares and the number of clusters (Syakur et al., 2018). A total of six clusters could be identified representing companies with digital maturity ranging from digital "laggards" to "champions". These final company archetypes were subjected to a comparative group analysis ("benchmarking"; Proença and Borbinha, 2016). Therefore, the clusters were compared on the level of sub-components and recommendations for improvement were given (de Bruin et al., 2005). By doing so, paths to the ideal target through comparison with best practices and competitors' solutions could be demonstrated (Pöppelbuß and Röglinger, 2011; Röglinger et al., 2012).

Ad [2]: The procedure of **structural equation analysis** belongs to the structure-testing procedures of quantitative social and economic sciences (Hair et al., 2017; Weiber and Mühlhaus, 2014; Ringle et al., 2020). Therefore, this methodology was selected for hypothesis-testing in Chapter C, since it can involve a range of statistical evaluation methods, e.g., multiple regression analysis (Hair et al., 2017), discriminant analysis, and factor analysis (Schreiber et al., 2006; Weiber and Mühlhaus, 2014).

In this context, a structural equation model was developed (see Fig. A-10) that consists of two sub-models: An outer structural model captured the relationships between the impacts of digitalization (independent variables; see Ad [1] in Section 3) and the requirements of the creation of operational capabilities (intervening variables; see Ad [2a]) as well as their advantageousness (dependent variables). However, should they also explain a downstream endogenous variable, they can be referred to as intervening variables (MacKinnon et al., 2002). These dependencies are represented by arrows and reflect the previously established hypotheses under specification of path coefficients which show the strength of the effects (γ_{1-n}, δ_{1-n}; Nitzl, 2016). The inner measurement models represent the relationship between the variables of the structural model as well as the assigned and empirically directly measurable items of the constructs ($a_i - g_i$; e.g., Ko and Stewart, 2002). the expression of the latent and endogenous variables determines the measurement indicators ("reflective" measuring model), while measurement indicators determine the latent variables of the intervening variables ("formative" measuring model; Diamantopoulos and Siguaw, 2006; Freeze and Raschke, 2007).

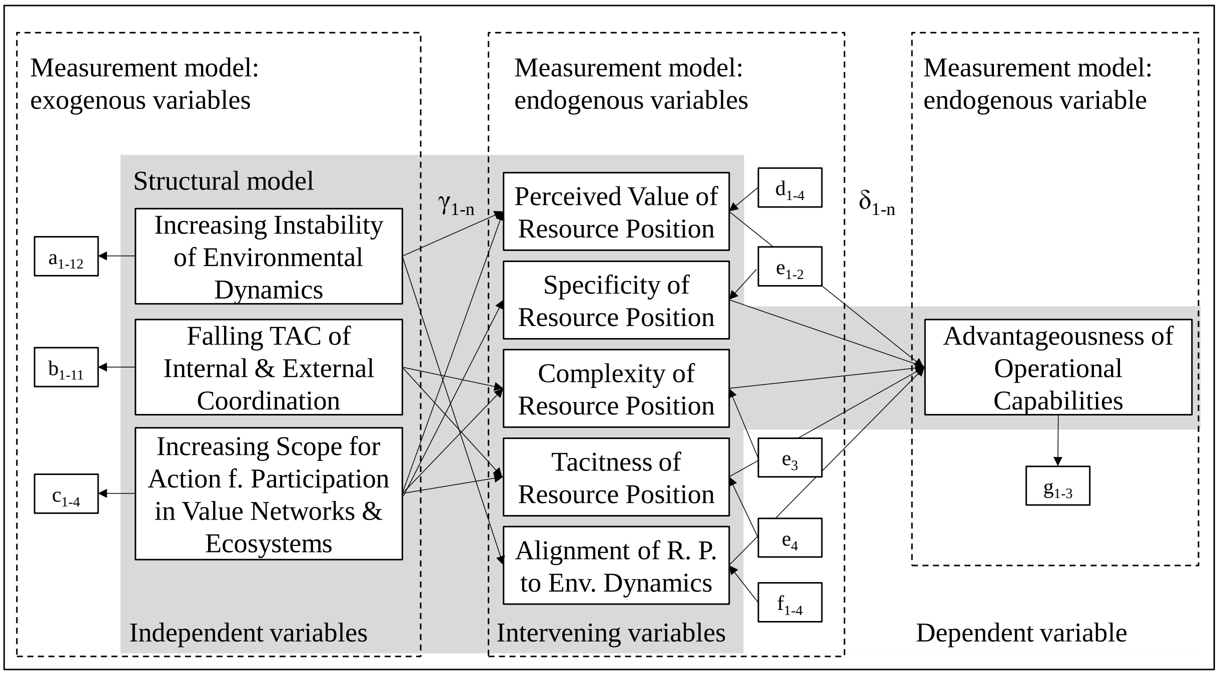

Fig. A-10: Generic structural equation model (source: own compilation based on Backhaus et al., 2015)

The evaluation of the model followed the variance-based analysis methods (partial least square approach, "PLS"; Carrión et al., 2017), which means that the latent variables are investigated using linear functions of the items (Roldán and Sánchez-Franco, 2012). The sample was built of 160 complete data sets stemming from quantitative online surveys in capital intensive German industries, such as industrial products, electronics, chemicals, automotive, and logistics. Because the sample size was smaller than n = 200 and formative and reflective measurement models occurred simultaneously, the variance-based procedure was chosen (Hair et al., 2017). The individual latent constructs were determined via software in partial multiple regressions of the indicators (Sarstedt and Cheah, 2019). In that way, path coefficients were calculated to show the strength of the relationships between the latent variables and their significance (predictive relevance), which can be used to make statements about the hypothesized relationships (Lowry and Gaskin, 2014). Subsequently, the goodness of fit of the inner and outer model was evaluated. Depending on the specification of the measurement model (reflective or formative) the validity (e.g., construct validity, indicator validity; Strauss and Smith, 2009) and reliability (e.g., convergence validity and discriminant validity; Hair et al., 2012), as well as the absence of multicollinearity (Grewal et al., 2004) were checked when evaluating the outer measurement model. Regarding the inner structural models, an assessment was made of the coefficient of determination and the effect size (Ali et al, 2018).

Ad (3): The **single case study analysis** methodology belongs to the qualitative methods of social and economic sciences (Mayring, 2014; Harding, 2018) and can build a deep understanding of a complex phenomenon by answering questions about "how", "what", and "why" (Alam, 2021; Yin, 2009). That is, a single case study is an appropriate methodology in this thesis (Hussein, 2009), since the investigation of the transfer of operational capabilities in Chapter D included socio-technical phenomena (Peltokorpi and Vaara, 2014), and difficult-to-access, novel, and particularly complex cases (Flyvbjerg, 2006) in the sense of an "in-depth study" (Mees-Buss et al., 2019). That is, why single case studies with an inductive character often can contribute to theory development ("grounded theory"; Glaser and Strauss, 2017).

Within this thesis, data was obtained from ten interviews with employees from a German multinational manufacturing company (Gläser and Laudel, 2010). The respondents are experts with factual and experiential knowledge related to the social element of capability transfers (Johnson et al., 2019; King et al., 2018). A systematic structuring of information was applied to identify patterns in the transcribed material based on consecutive coding approaches (see Garud et al., 2020; Hong and Minbaeva, 2022). Text passages ("codes"; Vaismoradi et al., 2016) were identified from transcribed interview material ("open coding", Garud, 2020), were grouped ("axial coding", Priest et al., 2002) with the help of a software tool (MAXQDA; Khandkar, 2009). And finally, categories with similarities in content (Langley, 1999; Strauss, 1987) were formed ("selective coding", Priest et al., 2002). By cycling between coded data and theoretical constructs ("constant comparison method"; Corbin and Strauss, 1990) new theoretical relationships were revealed (e.g., Busch and Barkema, 2021).

Case studies have a high validity especially if they fulfill quality criteria (Bryman et al., 2008). Construct validity was improved by triangulation (Meijer et al., 2002) and the use of multiple sources of evidence, that is, documents, archival data, and artifacts, observations were collected for further analysis (see Busch and Barkema, 2021; Khanagha et al., 2020). Key informants were involved reviewing the reports (Martins et al., 2015). The internal validity was improved because the internal coherence of findings and concepts was systematically related or was achieved by explanation building (Gibbert et al., 2008). Higher external validity was realized, i.a., by comparing the results with literature and by clearly delineating the validity of the results (Riege, 2003). The reliability was ensured by generating protocols, archiving data, and independent analysis of the data material by other researchers (Smith and McGannon, 2018; Riege, 2003).

The theoretical foundations from Section 3 and the methodological approaches outlined here in this Section 4 compose the fundamentals for the empirical studies that have been conducted. Their integration into the overall structure of this thesis is shown below.

5. Structure of the Thesis

The research questions of Section 2 are addressed by a consecutive structure of four chapters in this thesis (see Fig. A-11). After the introduction and overview of the underlying explanations as well as the research methods used (see Section 3 and 4), the core of this thesis now consists of three articles that address the derived research questions:

Chapter B: Sommer, S. and Proff, H. (2022): Digital Maturity in the German Traditional Industries – Status Quo, Profit Impact, Paths of Acceleration. Accepted for publication in: *International Journal of Innovation & Technology Management.*

Chapter C: Sommer, S. (2021): Assessing the Impact of Digitalization on Operational Capabilities. Published in: *International Journal of Business Strategy*, Vol. 21 (1), pp. 5-24.

Chapter D: Sommer, S. (2022): How to Transfer Operational Capabilities in Multinational Companies without Disclosure: Optimizing Decentralization and Information Richness in Times of Digitalization. Published in: *International Journal of Business Science and Applied Management*, Vol. 17 (3), pp. 49-65.

Finally, a conclusion is given in Chapter E. Therein, the results of the research studies are summarized, the interrelationship of underlying findings is demonstrated as well as limitations and outlooks are presented.

Chapter A	Introduction	
Chapter B	**Article:**	**Digital Maturity in the German Traditional Industries – Status Quo, Profit Impact, and Paths of Acceleration**
	Obectives:	(1) Assessment of digital maturity in traditional industries and its impact of digital maturity on profitability; (2) identification of approaches to improve digital maturity
	Approach:	Development of a maturity assessment index (with four sub-indices); quantitative empirical research and survey on 160 German companies (industrial goods, automotive, chemicals and pharma, and industrial services); cluster analysis for identification of archetypes
Chapter C	**Article:**	**Assessing the Impact of Digitalization on Operational Capabilities**
	Objective:	(1) Investigation of the impact of digitalization on requirements for advantageous operational capabilities; (2) implications for the advantageousness of operational capabilities in times of digitalization
	Approach:	Hypothesis testing by quantitative empirical research with structural equation modelling and survey on 200 German companies from capital-intensive industries (automotive, chemicals, electronics, industrial products, logistics, and others)
Chapter D	**Article:**	**How to Transfer Operational Capabilities in Multinational Companies without Disclosure: Optimizing Decentralization and Information Richness in Times of Digitalization.**
	Objectives:	(1) Investigation of the impact of digitalization on the transfer of operational capabilities by optimization of: (I) decentralization of decision-making, and (II) information richness of communication mechanisms; (2) implications for the simultaneous facilitation and protection of transfers of operational capabilities in times of digitalization
	Approach:	Qualitative in-depth case study of a German manufacturing company; qualitative content analysis with open coding and constant comparison method
Chapter E	Conclusion	

Fig. A-11: Structure of the thesis (source: own compilation)

References

Addo, A. (2022): Orchestrating a digital platform ecosystem to address societal challenges: A robust action perspective. In: *Journal of Information Technology*, June 2022.

Adner, R. (2017): Ecosystems as Structure. In: *Journal of Management*, Vol. 43 (1), pp. 39-58.

Adner, R., Euchner, J. (2014): Innovation ecosystems. In: *Research-Technology Management*, Vol. 57 (6), pp. 10-14.

Adner, R., Liebermann, M. (2021): Disruption Through Complements. In: *Strategy Science*, Vol. 6 (1), pp. 91-109.

Aghion, P., Howitt, P., Prantl, S. (2015): Patent rights, product market reforms, and innovation. In: *Journal of Economic Growth*, Vol. 20 (3), pp. 223-262.

Agostini, L., Nosella, A. (2020): The adoption of Industry 4.0 technologies in SMEs: results of an international study. In: *Management Decision*, Vol. 58 (4), pp. 625-643.

Alam, M. K. (2021): A systematic qualitative case study: questions, data collection, NVivo analysis and saturation. In: *Qualitative Research in Organizations and Management*, Vol. 16 (1), pp. 1-31.

Alexy, O., West, J., Klapper, H., Reitzig, M. (2018): Surrendering control to gain advantage: Reconciling openness and the resource-based view of the firm. In: *Strategic Management Journal*, Vol 39 (6), pp. 1704-1727.

Alghail, A., Yao, L., Abbas, M., Baashar, Y. (2021). Assessment of knowledge process capabilities toward project management maturity: an empirical study. In: *Journal of Knowledge Management*, Vol. 26 (5), pp. 1207-1234.

Ali, F., Rasoolimanesh, S. M., Sarstedt, M., Ringle, C. M., Ryu, K. (2018): An assessment of the use of partial least squares structural equation modeling (PLS-SEM) in hospitality research. In: *International Journal of Contemporary Hospitality Management*, Vol. 30 (1), pp. 514-538.

Alves, M. F. R., Vastola, V., Vasconcelos Ribeiro Galina, S., Zollo, M. (2021): When Reflection Hurts: The Effect of Cognitive Processing Types on Organizational Adaptation to Discontinuous Change. In: *Organization Science* (ahead of print).

Ambrosini, V., Bowman, C. (2009): What are dynamic capabilities and are they a useful construct in strategic management? In: *International Journal of Management Reviews*, Vol. 11 (1), pp. 29-49.

Appio, F. P., Frattini, F., Petruzzelli, A. M., Neirotti, P. (2021): Digital Transformation and Innovation Manahement: A Synthesis of Existing Research and an Agenda for Future Studies. In: *Journal of Product Innovation Management*, Vol. 38 (1), pp. 4-20.

Argote L., Lee, S., Park, J. (2021): Organizational Learning Processes and Outcomes: Major findings and future research directions. In: *Management Science*, Vol. 67 (9), pp. 5301-5967.

Argote, L., Guo, J., Park, S.-S., Hahl, O. (2022): The Mechanisms and Components of Knowledge Transfer: The Virtual Special Issue on Knowledge Transfer Within Organizations. In: *Organization Science*, Vol. 33 (3), pp. 1232-1249.

Argyres, N. (2021): Virtual Special Issue: The Organizational Economics of Organizational Capability Development. In: *Organization Science*, Vol. 32 (2), pp. 522-525.

Argyris, C. (1982): Reasoning, learning and action: Individual and organizational. San Francisco, CA, Jossey-Bass.

Audretsch, D. B., Link, A. N. (2019): Embracing an entrepreneurial ecosystem: an analysis of the governance of research joint ventures. In: *Small Business Economics*, Vol. 52 (2), pp. 429-436.

Backhaus K., Erichson B., Weiber R. (2015): Strukturgleichungsanalyse - Fortgeschrittene Multivariate Analysemethoden. Berlin, Springer Gabler.

Balboni, B., Marchi, G., Vignola, M. (2017): Knowledge transfer in the context of buyer–supplier relationship: An analysis of a supplier's customer portfolio. In: *Journal of Business Research*, Vol. 80, pp. 277-287.

Barney, J. (1991): Firm Resources and Sustained Competitive Advantage. In: *Journal of Management*, Vol. 17 (1), pp. 99-120.

Barwise, P., Watkins, L. (2018): The Evolution of Digital Dominance. How and Why we got to GAFA. In: Moore, M. and Tambini, D. (eds.): *Digital Dominance: The Power of Google, Amazon, Facebook, and Apple*. Oxford, Oxford University Press, pp. 21-49.

Benner, M. J., Waldfogel, J. (2020): Changing the Channel: Digitization and the Rise of “Middle Tail” Strategies. In: *Strategic Management Journal* (ahead of print).

Bennett, N., Lemoine, G. J. (2014): What a difference a word makes: Understanding threats to performance in a VUCA world. In: *Business Horizons*, Vol. 57 (3), pp. 311-317.

Bennis, W. (2013): Leadership in a digital world: embracing transparency and adaptive capacity. In: *Management Information Systems Quarterly*, Vol. 37 (2), pp. 635–636.

Berraies, S. (2019): The effect of enterprise social networks use on exploitative and exploratory innovations: Mediating effect of sub-dimensions of intellectual capital. In: *Journal of Intellectual Capital*, Vol 20 (3), pp. 426-452.

Bholowalia, P., Kumar, A. (2014): EBK-Means: A Clustering Technique based on Elbow Method and K-Means in WSN. In: *International Journal of Computer Applications*, Vol. 105 (9), pp. 17-24.

Birkinshaw, J., Zimmermann, A., Raisch, S. (2016): How do firms adapt to discontinuous change? Bridging the dynamic capabilities and ambidexterity perspectives. In: *California Management Review*, Vol. 58 (4), pp. 36-58.

Björkdahl, J. (2020): Strategies for Digitalization in Manufacturing Firms. In: *California Management Review*, Vol. 62 (4), pp. 17-36.

Bodrožić, Z., Adler, P. S. (2022). Alternative Futures for the Digital Transformation: A Macro-Level Schumpeterian Perspective. In: *Organization Science*, Vol. 33 (1), pp. 105-125.

Bouncken, R. B., Kraus, S. (2022): Entrepreneurial ecosystems in an interconnected world: emergence, governance and digitalization. In: *Review of Managerial Science*, Vol. 16, pp. 1–14.

Bouwman, H., Nikou, S., de Reuver, M. (2019): Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs? In: *Telecommunications Policy*, Vol. 43 (9), 101828.

Brandenburger, A., Stuart, H. (2007): Biform games. In: *Management Science*, Vol. 53 (4), pp. 537-549.

Brennen, J. S., Kreiss, D. (2016): Digitalization. In: Jensen, K. B., Rothenbuhler, E.W., Pooley, J. D., Craig, R. T. (eds.): *The International Encyclopedia of Communication Theory and Philosophy*. Chichester, Wiley-Blackwell, pp. 556-566.

Bryman, A., Becker, S., Sempik, J. (2008): Quality criteria for quantitative, qualitative and mixed methods research: A view from social policy. In: *International Journal of Social Research Methodology*, Vol. 11 (4), pp. 261-276.

Buchanan, J. M. (1965): An economic theory of clubs. In: *Economica*, Vol. 32 (125), pp. 1-14.

Burton, R. M., Obel, B. (2018): The science of organizational design: fit between structure and coordination. In: *Journal of Organization Design*, Vol. 7 (1), pp. 1-13.

Busch, C., Barkema, H. (2021): From necessity to opportunity: Scaling bricolage across resource-constrained environments. In: *Strategic Management Journal*, Vol. 42 (4), pp. 741-773.

Cano-Kollmann, M., Cantwell, J., Hannigan, T. J., Mudambi, R., Song, J. (2016): Knowledge connectivity: An agenda for innovation research in international business. In: *Journal of International Business Studies*, Vol. 47 (3), pp. 255-262.

Carrión G. C., Nitzl C., Roldán J. L. (2017): Mediation Analyses in Partial Least Squares Structural Equation Modeling: Guidelines and Empirical Examples. In: Latan H., Noonan R. (eds.): *Partial Least Squares Path Modeling*. Cham, Springer.

Ceccagnoli, M., Forman, C., Huang, P., Wu, D. (2012): Cocreation of Value in a Platform Ecosystem! The Case of Enterprise Software. In: *Management Information Systems Quarterly*, Vol. 36 (1), pp. 263-290.

Cenamor, J., Rönnberg, S., Parida, V. (2017): Adopting a platform approach in servitization: Leveraging the value of digitalization. In: *International Journal of Production Economics*, Vol. 192, pp. 54-65.

Chen, S., Zhang, L., Tang, Y., Shen, C., Kumar, R., Yu, K., Tariq, U., Bashir, A. K. (2020): Indoor temperature monitoring using wireless sensor networks: A SMAC application in smart cities. In: *Sustainable Cities and Society*, Vol. 61.

Coen, C. A., Maritan, C. A. (2011): Investing in capabilities: The dynamics of resource allocation. In: *Organization Science*, Vol. 22 (1), pp. 99-117.

Coff, R. W., Coff, D. C., Eastvold, R. (2006): The Knowledge-Leveraging Paradox: How to Achieve Scale without Making Knowledge Imitable. In: *Academy of Management Review*, Vol. 31 (2), pp. 452-465.

Collis, D. J. (1994): Research note: how valuable are organizational capabilities? In: *Strategic Management Journal*, Vol. 15 (S1), pp. 143-152.

Commuzzi, M., Patel, A. (2016): How organisations leverage big data: A maturity model. In: *Industrial Management & Data Systems*, Vol. 116 (8), pp. 1468-1492.

Contractor, F. J. (2019): Can a firm find the balance between openness and secrecy? Towards a theory of an optimum level of disclosure. In: *Journal of International Business Studies*, Vol. 50, 261-274.

Corbin, J. M., Strauss, A. (1990): Grounded theory research: Procedures, canons, and evaluative criteria. In: *Qualitative Sociology*, Vol. 13 (1), pp. 3-21.

Cousins, B. (2018): Design thinking: Organizational learning in VUCA environments. In: *Academy of Strategic Management Journal*, Vol. 17 (2), pp. 1-18.

Cozzolino, A., Rothaermel, F. T. (2018): Discontinuities, competition, and cooperation: Coopetitive dynamics between incumbents and entrants. In: *Journal of Strategic Management*, Vol. 39 (12), pp. 3053-3085.

Cusumano, M. A., Gawer, A., Yoffie, D. B. (2019): The business of platforms: Strategy in the age of digital competition, innovation, and power. New York, Harper Business.

Cyert, R., March, J. (1963): A Behavioral Theory of the Firm. Englewood Cliffs, NJ, Prentice-Hall.

Daft, R. L., Lengel, R. H. (1986): Organizational information requirements, media richness and structural design. In: *Management Science*, Vol. 32 (5), pp. 513-644.

Day, G. S., Schoemaker, P. J. H. (2016): Adapting to Fast-Changing Markets and Technologies. In: *California Management Review*, Vol. 58 (4), pp. 59-77.

De Bruin, T., Rosemann, M. (2007): Using the Delphi Technique to Identify BM Capability Areas. In: *Australasian Conference on Information Systems (ACIS) 2007 Proceedings*, Vol. 42, pp. 643-653.

De Bruin, T., Rosemann, M., Freeze, R., Kaulkarni, U. (2005): Understanding the Main Phases of Developing a Maturity Assessment Model. In: Bunker, D., Campbell, B., Underwood, J. (eds.): *Australasian Conference on Information Systems (ACIS) 2005. Australasian Chapter of the Association for Information Systems*, pp. 8-19.

De Carolis, A., Macchi, M., Negri, E., Terzi, S. (2017): A Maturity Model for Assessing the Digital Readiness of Manufacturing Companies. In: Lödding H., Riedel R., Thoben KD., von Cieminski G., Kiritsis D. (eds): *Advances in Production Management Systems. The Path to Intelligent, Collaborative and Sustainable Manufacturing, APMS 2017, IFIP Advances in Information and Communication Technology,* Vol. 513, Cham, Springer.

Deeken, M., Fuchs, T. (2018): Agiles Management als Antwort auf die Herausforderungen der Digitalisierung. Praktische Erkenntnisse und Gestaltungshinweise für die Bankenbranche. Wiesbaden, Springer.

Di Stefano, G., Micheli, M. R. (2022): To Stem the Tide: Organizational Climate and the Locus of Knowledge Transfer. In: *Organization Science* (ahead of print).

Diamantopoulos, A., Siguaw, J. A. (2006): Formative versus reflective indicators in organizational measure development: A comparison and empirical illustration. In: *British Journal of Management*, Vol. 17 (4), pp. 263-282.

Dierickx, I., Cool, K. (1989): Asset stock accumulation and the sustainability of competitive advantage. In: *Management Science*, Vol. 35 (12), pp. 1415-1524.

Dikmen, M., Burns, C. (2017): Trust in autonomous vehicles: The case of Tesla Autopilot and Summon. In: *IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, pp. 1093-1098.

Duffy, J. (2001): Maturity models: Blueprints for e-volution. In: *Strategy and Leadership*, Vol. 29 (6), pp. 19-26.

Dyer, J. H., Singh, H., Hesterly, W. S. (2018): The relational view revisited: A dynamic perspective on value creation and value capture. In: *Strategic Management Journal*, Vol. 39 (12), pp. 3140-3162.

Eklund, J. C. (2022): The knowledge-incentive tradeoff: Understanding the relationship between research and development decentralization and innovation. In: *Strategic Management Journal* (ahead of print).

Eller, R., Alford, P., Kallmünzer, A., Peters, M. (2020): Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. In: *Journal of Business Research*, Vol. 112, pp. 119-127.

Ethiraj, S. K., Levinthal, D. A. (2004): Modularity and Innovation in Complex Systems. In: *Management Science*, Vol. 50 (2), pp. 159-173.

Evans, N. D. (2016): Future Skills. In: *ITNOW*, Vol. 58 (1), pp. 50-51.

Faems, D., Bos, B., Noseleit, F. (2020): Multistep Knowledge Transfer in Multinational Corporation Networks: When do subsidiaries benefit from unconnected sister alliances? In: *Journal of Management*, Vol. 46 (3), pp. 414-442.

Fitzgerald, M., Kruschwitz, N., Bonnet, D., Welch, M. (2014): Embracing digital technology: A new strategic imperative. In: *MIT Sloan Management Review*, Vol. 55 (2), pp. 1-12.

Flyvbjerg, F. W. (2006): Five misunderstandings about case-study research. In: *Qualitative Inquiry*, Vol. 12 (2), pp. 219-245.

Fontana, R., Nuvolari, A., Verspage, B. (2009): Mapping technological trajectories as patent citation networks. An application to data communication standards. In: *Economics of Innovation and New Technology*, Vol. 18 (4), pp. 311-336.

Freeze, R., Raschke, R. L. (2007): An assessment of formative and reflective constructs in IS research. In: *European Conference on Information Systems (ECIS) 2007 Proceedings*, Vol. 171, pp. 1481-1492.

Freiling, J, Fichtner, H. (2010): Organizational Culture as the Glue between People and Organization: A Competence-based View on Learning and Competence Building. In: *German Journal of Human Resource Management*, Vol. 24 (2), pp. 152-172.

Fuchs, C. (2021): Social media: A critical introduction, London, Sage.

Gans, J., Ryall, M. D. (2017): Value capture theory: A strategic management review. In: *Strategic Management Journal*, Vol. 38, pp. 17-41.

Garud, R., Kumaraswamy, A., Roberts, A., Xu, L. (2020): Liminal movement by digital platform-based sharing economy ventures: The case of Uber Technologies. In: *Strategic Management Journal*, Vol. 43 (3), pp. 1-29.

Gaur, A. S., Ma, H., Ge, B. (2019): MNC strategy, knowledge transfer context, and knowledge flow in MNEs. In: *Journal of Knowledge Management*, Vol. 23 (9), pp. 1885-1900.

Gawer, A. (2014): Bridging different perspectives on technological platforms: Towards an integrative framework. In: *Research Policy*, Vol. 43 (7), pp. 1239-1249.

Gawer, A., Cusumano, M. A. (2014): Industry Platforms and Ecosystem Innovation. In: *The Journal of Product Innovation Management*, Vol. 31, pp. 417-433.

Ghadge, A., Weiß, M., Caldwell, N. D., Wilding, R. (2019): Managing cyber risk in supply chains: a review and research agenda. In: *Supply Chain Management: An International Journal*, Vol. 25 (2), pp. 223-240.

Gibbert, M., Ruigrok, W., Wicki, B. (2008): What passes as a rigorous case study? In: *Strategic Management Journal*, Vol. 29 (13), pp. 1465-1474.

Giustiziero, G., Kretschmer, T., Somaya, D., Wu, B. (2021): Hyperspecialization and hyperscaling: A resource-based theory of the digital firm. In: *Strategic Management Journal* (ahead of print).

Glaser, B. G., Strauss, A. L. (2017): The discovery of grounded theory: Strategies for qualitative research. London, Routledge.

Gläser, J., Laudel, G. (2010): Experteninterviews und qualitative Inhaltsanalyse als Instrumente rekonstruierender Untersuchungen. Wiesbaden, VS Verlag für Sozialwissenschaften.

Google Trends (2022): Google Trends for "Digitalization", Retrieved from: *https://trends.google.de/trends/explore?q=digitalization* [accessed 30 July 2022].

Grant, R. M. (1988): Research notes and communications on 'dominant logic', relatedness and the link between diversity and performance. In: *Strategic Management Journal*, Vol. 9, pp. 639-642.

Green, S. B. (1991): How many subjects does it take to do a regression analysis. In: *Multivariate Behavioral Research*, Vol. 26 (3), pp. 499-510.

Grewal, R., Cote, J. A., Baumgartner, H. (2004): Multicollinearity and measurement error in structural equation models: Implications for theory testing. In: *Marketing Science*, Vol. 23 (4), pp. 519-529.

Gulot, G., Orzes, G., Sartor, M., Nassimbeni, G. (2020): The future of manufacturing: A Delphi-based scenario analysis on industry 4.0. In: *Technological Forecasting & Social Change*, Vol. 157, 120092.

Gupta, A. K., Govindarajan, V. (2000): Knowledge flows within multinational corporations. In: *Strategic Management Journal*, Vol. 21 (4), pp. 473-496.

Gupta, S., Kumar, P. (2021): A constrained agglomerative clustering approach for unipartite and bipartite networks with application to credit networks. In: *Information Sciences*, Vol. 557, 332-354.

Hagiu, A., Wright, J. (2015): Multi-sided platforms. In: *International Journal of Industrial Organization*, Vol. 43 (1), pp. 162-174.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M. (2014): A Primer on Partial Least Squares (PLS) Structural Equation Modeling. Los Angeles, Sage.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Thiele, K. O. (2017): Mirror, mirror on the wall: a comparative evaluation of composite-based structural equation modeling methods. In: *Journal of the Academy of Marketing Science*, Vol. 45, pp. 616–632.

Hair, J. F., Sarstedt, M., Ringle, C. M., Mena, J. A. (2012): An assessment of the use of partial least squares structural equation modeling in marketing research. In: *Journal of the Academy of Marketing Science*, Vol. 40 (3), pp. 414-433.

Hamel, G. (1994): The concept of core competence. In: Hamel, G., Heene, A. (eds.): *Competence-based Competition*, New York, Wiley.

Hannah, D. P., Eisenhardt, K. M. (2018): How firms navigate cooperation and competition in nascent ecosystems. In: *Strategic Management Journal*, Vol. 39 (12), pp. 3163-3192.

Harding, J. (2018): Qualitative data analysis: From start to finish. London, Sage.

Hartmann, P. M., Zaki, M., Feldmann, N., Neely, A. (2016): Capturing value from big data–a taxonomy of data-driven business models used by start-up firms. In: *International Journal of Operations & Production Management*, Vol. 36 (10), 1382-1406.

Hebbert, L. (2017): Digital Transformation: Build your Organization's Future for the In-Novation. London, Bloomsbury Publishing Plc.

Helfat, C. E., Eisenhardt, K. M. (2004): Inter-temporal economies of scope, organizational modularity, and the dynamics of diversification. In: *Strategic Management Journal*, Vol. 25 (13), pp. 1217-1232.

Helfat, C. E., Peteraf, M. A. (2003): The dynamic resource-based view: capability lifecycles. In: *Strategic Management Journal*, Vol. 24 (10), pp. 997-1010.

Henly-Shepard, S., Gray, S. A., Cox, L. J. (2015): The use of participatory modelling to promote social learning and facilitate community disaster planning. In: *Environmental Science & Policy*, Vol. 45, pp. 109-122.

Hess, T., Matt, C., Benlian, A., Wiesböck, F. (2016): Options for formulating a digital transformation strategy. In: *Management Information Systems Quarterly Executive*, Vol. 15 (2), pp. 123-139.

Hong, H., Minbaeva, D. (2021): Multiculturals as strategic human capital resources in multinational enterprises. In: *Journal of International Business Studies*, Vol. 53, pp. 95-125.

Hurmelinna-Laukkanen, P. (2011): Enabling collaborative innovation – knowledge protection for knowledge sharing. In: *European Journal of Innovation Management*, Vol. 14 (3), pp. 303-321.

Hussein, A. (2009): The use of triangulation in social sciences research. In: *Journal of Comparative Social Work*, Vol. 4 (1), pp. 106-117.

Hutchings, K., Michailova, S. (2004): Facilitating knowledge sharing in Russian and Chinese subsidiaries: the role of personal networks and group membership. In: *Journal of Knowledge Management*, Vol. 8 (2), pp. 84-94.

Huth, S. (2015): Synergiemanagement im intra-organisationalen Netzwerk. Hamburg, Dr. Kovac.

Ifenthaler, D., Egloffstein, M. (2020): Development and Implementation of a Maturity Model of Digital Transformation. In: *TechTrends*, Vol. 64, pp. 302–309.

Jacobides, M. G, Cennamo, C., Gawer, A. (2018): Towards a theory of ecosystems. In: *Strategic Management Journal*, Vol. 39 (8), pp. 2255-2276.

Jefferson, G. H. (1998): China's state enterprises: public goods, externalities, and Coase. In: *The American Economic Review*, Vol. 88 (2), pp. 428-432.

Johnson, D. R., Scheitle, C. P., Ecklund, E. H. (2019): Beyond the In-Person Interview? How Interview Quality Varies Across In-person, Telephone, and Skype Interviews. In: *Social Science Computer Review*, Vol. 39 (6), pp. 1142-1158.

Johnson, R. B., Onwuegbuzie, A. J., Turner, L. A. (2007): Towards a definition of mixed methods research. In: *Journal of Mixed Methods Research*, Vol. 1 (2), pp. 112-133.

Joshi, A., Kale, S., Chandel, S., Pal, D. K. (2015): Likert Scale: Explored and Explained. In: *British Journal of Applied Science & Technology*, Vol. 7 (4), pp. 396-403.

Kamalaldin, A., Linde, L., Sjödin, D., Parida, V. (2020): Transforming provider-customer relationships in digital servitization: A relational view on digitalization. In: *Industrial Marketing Management*, Vol. 89, pp. 306-325

Kane, G. C., Buckley, N., Kiron, D., Phillips, A. N., Palmer, D. (2016): Aligning the Organization for Its Digital Future. In: *MIT Sloan Management Review and Deloitte University Press*, Vol. 58 (1), pp. 1-30.

Kapoor, R., Bigdeli, A. Z., Dwivedi, Y. K., Schroeder, A., Beltagui, A., Baines, T. (2021): A socio-technical view of platform ecosystems: Systematic review and research agenda. In: *Journal of Business Research*, Vol. 128 (C), pp. 94-108.

Karhade, P., Dong, J. Q. (2021): Innovation Outcomes of Digitally Enabled Collaborative Problemistic Search Capability. In: *Management Information Systems Quarterly*, Vol. 45 (2), pp. 693-718.

Kazadi, K., Lievens, A., Mahr, D. (2016): Stakeholder co-creation during the innovation process: Identifying capabilities for knowledge creation among multiple stakeholders. In: *Journal of Business Research*, Vol. 69 (2), pp. 525-540.

Kettinger, W. J., Ryoo, S. Y., Marchand, D. A. (2021): We're engaged! Following the path to a successful information management capability. In: *The Journal of Strategic Information Systems*, Vol. 30 (3), 101681.

Khanagha, S., Ansari, S., Paroutis, S., Oviedo, L. (2020): Mutualism and the dynamics of new platform creation: A study of Cisco and fog computing. In: *Strategic Management Journal* (ahead of print).

Khandkar, S. (2009): Open coding. Retrieved from: *http://pages.cpsc.ucalgary.ca/~saul/wiki/uploads/CPSC681/opencoding*.pdf [accessed 7 February 2022]

King, N., Horrocks, C., Brooks, J. (2018): Interviews in qualitative research. London, Sage.

Kirenz, J. (2020): Hierarchische Clusteranalyse mit Ward in R. Retrieved from: *https://www.kirenz.com/post/2020-05-21-r-hierarchische-clusteranalyse/* [accessed 10 August 2022]

Knobbe, F., Proff, H. (2020): Digitalization and dynamic capabilities in the automotive industry - Measuring discontinuous change abilities of automotive suppliers. In: International *Journal of Automotive & Technology Management*, Vol. 20 (4), pp. 436-456.

Ko, D.-W., Stewart, W. P. (2002): A structural equation model of residents' attitudes for tourism development. In: *Tourism Management*, Vol. 23 (5), pp. 521-530.

Koch, T., Windsperger, J. (2017): Seeing through the network: Competitive advantage in the digital economy. In: *Journal of Organization Design*, Vol. 6 (6), pp. 1-30.

Krylova, K. O., Vera, D., Crossan, M. (2016): Knowledge transfer in knowledge intensive organizations: the crucial role of improvisation in transferring and protecting knowledge. In: *Journal of Knowledge Management*, Vol. 20 (5), pp. 1045-1064.

Kumar, V., Loonam, J., Allen, J. P., Sawyer, S. (2016): Exploring enterprise social systems & organisational change: implementation in a digital age. In: *Journal of Information Technology*, Vol. 31 (2), pp. 97-100.

Kuusisto, M. (2017): Organizational effects of digitalization: A literature review. In: *International Journal of Organization Theory & Behavior*, Vol. 20 (3), pp. 341-362.

Lahrmann G., Marx F. (2010): Systematization of Maturity Model Extensions. In: Winter R., Zhao J. L., Aier S. (eds.): *Global Perspectives on Design Science Research. Lecture Notes in Computer Science*, Vol. 6105, Berlin, Springer.

Lambert, T. (2017): How to Regulate: A Guide for Policymakers. Cambridge, Cambridge University Press.

Landau, S., Chis Ster, I. (2010): Cluster Analysis: Overview. In: *International Encyclopedia of Education*, Vol. 3, pp. 72–83.

Langley, A. (1999): Strategies for theorizing from process data. In: *Academy of Management Review*, Vol. 24, pp. 691–710.

Laux, H., Liermann, F. (2005): Zielkomponenten organisatorischer Gestaltung: Die Determinanten nachgeordneter Objekt-, Organisations- und Kommunikationsentscheidungen und Möglichkeiten ihrer Steuerung. In: Laux, H., Liermann, F. (eds.): *Grundlagen der Organisation: Die Steuerung von Entscheidungen als Grundproblem der Betriebswirtschaftslehre*. Berlin, Springer, pp. 131-149.

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N., Ahlemann, F. (2017): Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community. In: *Business & Information Systems Engineering*, Vol. 59 (4), pp. 301–308.

Lehmkuhl, T., Jung, R. (2013): Towards Social CRM - Scoping the concept and guiding research. In: *26th Bled eConference 'eInnovations: challenges and impacts for individuals, organizations and society'*.

Lenka, S., Parida, V., Wincent, J. (2016): Digitalization Capabilities as Enablers of Value Co-Creation in Servitizing Firms. In: *Psychology & Marketing*, Vol. 34 (1), pp. 92-100.

Li, F. (2020): The digital transformation of business models in the creative industries: A holistic framework and emerging trends. In: *Technovation*, Vol. 92, 102012.

Li, L., Su, F., Zhang, W. (2017): Digital transformation by SME entrepreneurs: A capability perspective. In: *Information Systems Journal*, Vol. 28 (6), pp. 1129-1157.

Li, S., Xu, L. D., Zhao, S. (2018): 5G Internet of Things: A survey. In: *Journal of Industrial Information Integration*, Vol. 10, pp. 1–9.

Lin, C.-H., Sanders, K. (2017): HRM and innovation: a multi-level organisational learning perspective. In: *Human Resource Management Journal*, Vol. 27 (2), pp. 300-317.

Lioukas, C. S., Reuer, J. J., Zollo, M. (2015): Effects of Information Technology Capabilities on Strategic Alliances: Implications for the Resource-Based View. In: *Journal of Management Studies*, Vol. 53 (2), pp. 161-183.

Liu, X., Zhang, L., Gupta, A., Zheng, X., Wu, C. (2022): Upper echelons and intra-organizational learning: How executive narcissism affects knowledge transfer among business units. In: *Strategic Management Journal* (ahead of print).

Lowry, P. B., Gaskin, J. (2014): Partial Least Squares (PLS) Structural Equation Modeling (SEM) for Building and Testing Behavioral Causal Theory: When to Choose It and How to Use It. In: *IEEE Transactions on Professional Communication*, Vol. 57 (2), pp. 123-146.

Lu, Y., Liu, C., Wang, K. I.-K., Huang, H., Xu, X. (2020): Digital Twin-driven smart manufacturing: Connotation, reference model, applications and research issues. In: *Robotics and Computer-Integrated Manufacturing*, Vol. 61, 101837.

Machado, C. G., Winroth, M. P., Dener, E. H., da Silva, R. (2020): Sustainable manufacturing in Industry 4.0: an emerging research agenda. In: *International Journal of Production Research*, Vol. 58 (5), pp. 1462-1484.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., Sheets, V. (2002): A comparison of methods to test mediation and other intervening variable effects. In: *Psychological Methods*, Vol. 7 (1), pp. 83–104.

Malone, T. W., Crowston, K. (1994): The interdisciplinary study of coordination. In: *ACM Computing Surveys*, Vol. 26 (1), pp. 87-119.

Manhart, M., Thalmann, S. (2015): Protecting organizational knowledge: a structured literature review. In: *Journal of Knowledge Management*, Vol. 19 (2), pp. 190-211.

Markus, M. L. (2001): Toward a Theory of Knowledge Reuse: Types of Knowledge Reuse Situations and Factors in Reuse Success. In: *Journal of Management Information Systems*, Vol. 18 (1), pp. 57-93.

Martins, J., Marques, A., Sarmento, H., da Costa, F. C. (2015): Adolescents' perspectives on the barriers and facilitators of physical activity: a systematic review of qualitative studies. In: *Health Education Research*, Vol 30 (5), pp. 742–755.

Matarazzo, M., Penco, L., Profumo, G., Quaglia, R. (2021): Digital transformation and customer value creation in Made in Italy SMEs: A dynamic capabilities perspective. In: *Journal of Business Research*, Vol. 123, pp. 642-656.

Matt, C., Hess, T., Benlian, A. (2015): Digital transformation strategies. In: *Business & Information Systems Engineering*, Vol. 57 (5), pp. 339-343.

Mayring, P. (2014): Qualitative content analysis: theoretical foundation, basic procedures and software solution. Klagenfurt. Available at Social Science Open Access Repository (SSOAR). Retrieved from: *https://nbn-resolving.de/urn:nbn:de:0168-ssoar-395173* [accessed 24 January 2022].

Mees-Buss, J., Welch, C., Westney, E. D. (2019): What happened to the transnational? The emergence of the neo-global corporation. In: *Journal of International Business Studies*, Vol. 50, pp. 1513-1543.

Mehrizi, M. R., Nicolini, D., Modol, J. R. (2022): How Do Organizations Learn from Information System Incidents? A Synthesis of the Past, Present, and Future. In: *Management Information Systems Quarterly*, Vol. 46 (1), pp. 531-590.

Meijer, P. C., Verloop, N., Beijaard, D. (2002): Multi-method triangulation in a qualitative study on teachers' practical knowledge: An attempt to increase internal validity. In: *Quality and Quantity*, Vol. 36 (2), pp. 145-167.

Mettler, T. (2011): Maturity assessment models: a design science research approach. In: *International Journal of Society Systems Science*, Vol. 3, (1-2), pp. 81.

Mikalef, P., Krogstie, J., Pappas, I. O., Pavlou, P. (2020): Exploring the relationship between big data analytics capability and competitive performance: The mediating roles of dynamic and operational capabilities. In: *Information & Management,* Vol. 57 (2), 103169.

Miles, J. (2014). R-squared, adjusted R-squared. Encyclopedia of Statistics in Behavioral Science. New Jersey, Wiley.

Mingers, J. (2003): The paucity of multimethod research: a review of the information systems literature. In: *Information Systems Journal*, Vol. 13, pp. 233-249.

Murphy, M., Sashi, C. M. (2018): Communication, interactivity, and satisfaction in B2B relationships. In: *Industrial Marketing Management*, Vol. 68, pp. 1-12.

Murtagh, F., Contreras, P. (2012): Algorithms for hierarchical clustering: an overview. In: *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, Vol. 2 (1), pp. 86-97.

Nasiri, M., Ukko, J., Saunila, M., Rantala, T. (2020): Managing the digital supply chain: The role of smart technologies. In: *Technovation*, Vol. August-September, pp. 96-97.

Nason, R. S., Wiklund, J. (2018): An Assessment of resource-based theorizing on firm growth and suggestions for the future. In: *Journal of Management*, Vol. 44 (1), pp. 32-60.

Negoita, B., Rahrovani, Y., Lapointe, L., Pinsonneault, A. (2021): Distributed IT championing: A process theory. In: *Journal of Information Technology*, Vol. 37 (1), pp. 2-30.

Nelson, R. R., Winter, S. G. (1982): An Evolutionary Theory of Economic Change. Cambridge, Belknap Press/Harvard University Press.

Nisar, T. M., Prabhakar, G., Strakova, L. (2019): Social media information benefits, knowledge management and smart organizations. In: *Journal of Business Research*, Vol. 94 (C), pp. 264 - 272.

Nitzl, C. (2016): The use of partial least squares structural equation modelling (PLS-SEM) in management accounting research: Directions for future theory development. In: *Journal of Accounting Literature*, Vol. 37, pp. 19-35.

Ostmeier, E., Strobel, M. (2022). Building skills in the context of digital transformation: How industry digital maturity drives proactive skill development. *Journal of Business Research*, 139, pp. 718-730.

Øvrelid, E., Bygstad, B. (2019): The role of discourse in transforming digital infrastructures. In: *Journal of Information Technology*, Vol. 34 (3), pp. 221-242.

Ozcan, A. (2014): Mobile phones democratize and cultivate next-generation imaging, diagnostics and measurement tools. In: *Lab on a Chip*, Vol. 14 (17), pp. 3187-3194.

Pandit, S., Gupta, S. (2011): A comparative study on distance measuring approaches for clustering. In: *International Journal of Research in Computer Science*, Vol. 2 (1), pp. 29-31.

Papa, A., Dezi, L., Gregori, G. L., Mueller, J., Miglietta, N. (2018): Improving innovation performance through knowledge acquisition: the moderating role of employee retention and human resource management practices. In: *Journal of Knowledge Management*, Vol. 24 (3), pp. 589-605.

Parida, V., Sjödin, D., Reim, W. (2019): Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. In: *Sustainability*, Vol. 11 (2), p. 391.

Paulk, M. C., Curtis, B., Chrissis, M. B., Weber, C. V. (1993): Capability maturity model, version 1.1. In: *IEEE Software*, Vol. 10 (4), pp. 18-27.

Peltokorpi, V., Vaara, E. (2014): Knowledge transfer in multinational corporations: Productive and counterproductive effects of language sensitive recruitment. In: *Journal of International Business Studies*, Vol. 45, pp. 600-622.

Pil, F. K., Cohen, S. K. (2006): Modularity: Implications for Imitation, Innovation, and Sustained Advantage. In: *Academy of Management Review*, Vol. 31 (4), pp. 995–1011.

Pöppelbuß, J., Röglinger, M. (2011): What makes a useful maturity model? A framework of general design principles for maturity models and its demonstration in business process management. In: *European Conference on Information Systems* (*ECIS) 2011 Proceedings*, Vol. 19, 28-40.

Porter, M. E. (1985): Competitive advantage. Creating and sustaining superior performance. New York, Free Press.

Priest, H., Roberts, P., Woods, L. (2002): An overview of three different approaches to the interpretation of qualitative data. Part 1: Theoretical issues. In: *Nurse Researcher*, Vol. 10 (1), pp. 30-42.

Proença, D., Borbinha, J. (2016): Maturity Models for Information Systems - A State of the Art. In: *Procedia Computer Science*, Vol. 100, pp. 1042-1049.

Proff, H. (2007): Dynamische Strategien. Wiesbaden, Springer Gabler.

Proff, H. (2019): Multinationale Automobilunternehmen in Zeiten des Umbruchs – Herausforderungen, Geschäftsmodelle, Steuerung. Wiesbaden, SpringerGabler.

Proff, H., Ahrens, C., Neuroth, W., Proff, H., Knobbe, F., Szybisty, G., Sommer, S. (2021): Accelerating Digitalization: Chancen der Digitalisierung erkennen und nutzen. London, Springer Nature.

Rahmati, P., Tafti, A., Westland, J. C., Hidalgo, C. (2021): When all products are digital: Complexity and intangible value in the ecosystem of digitizing firms. In: *Management Information Systems Quarterly*, Vol. 45 (3), pp. 1025-1058.

Ralston, P., Blackhurst, J. (2020): Industry 4.0 and resilience in the supply chain: a driver of capability enhancement or capability loss? In: *International Journal of Production Research*, Vol. 58 (16), pp. 5006-5019.

Rangus, K., Slavec, A. (2017): The interplay of decentralization, employee involvement and absorptive capacity on firms’ innovation and business performance. In: *Technological Forecasting and Social Change*, Vol. 120, pp. 195-203.

Rasche, C. (1994): Der „Resource-Based-View“ - Eine Neuorientierung im strategischen Management. In: Wettbewerbsvorteile durch Kernkompetenzen. Wiesbaden, Deutscher Universitätsverlag, pp. 35-90.

Reis J., Amorim, M., Melão, N., Matos, P. (2018): Digital Transformation: A Literature Review and Guidelines for Future Research. In: Rocha, A., Adeli, H., Reis, L. P., Constanzo, S. (eds.) *Trends and Advances in Information Systems and Technologies. WorldCIST’18 2018. Advances in Intelligent Systems and Computing*, Vol. 745, Cham, Springer.

Remane, G., Hanelt, A., Wiesboeck, F., Kolbe, L. M. (2017): Digital Maturity in Traditional industries - an Exploratory Analysis. In: *European Conference on Information Systems, ECIS* (p. 10).

Reychav, I., Kumi, R., Sabherwal, R., Azuri, J. (2016): Using tablets in medical consultations: Single loop and double loop learning processes. In: *Computers in Human Behavior*, Vol. 61, pp. 415-426.

Riege, A. M. (2003): Validity and reliability tests in case study research: a literature review with “hands-on” applications for each research phase. In: *Qualitative Market Research: An International Journal*, Vol. 6 (2), pp. 75-86.

Riemer, K., Johnston, R. B. (2019): Disruption as worldview change: A Kuhnain analysis of the digital music revolution. In: *Journal of Information Technology*, Vol. 34 (4), pp. 350-370.

Ringle, C. M., Sarstedt, M., Mitchell, R., Gudergan, S. P. (2020): Partial least squares structural equation modelling in HRM research. In: *The International Journal of Human Resource Management*, Vol. 31 (2), pp. 1617-1643.

Ritala, P., Husted, K., Olander, H., Michailnova, S. (2018): External knowledge sharing and radical innovation: the downsides of uncontrolled openness. In: *Journal of Knowledge Management*, Vol. 22 (5), pp. 1104-1123.

Ritala, P., Stefan, I. (2021): A paradox within the paradox of openness: The knowledge leveraging conundrum in open innovation. In: *Industrial Marketing Management*, Vol. 93, pp. 281-292.

Ritter, T., Pedersen, C. L. (2020): Digitization capability and the digitalization of business models in business-to-business firms: Past, present, and future. In: *Industrial Marketing Management*, Vol. 86, pp. 180-190.

Rochet, J. C., Tirole, J. (2003): Platform competition in two-sided markets. In: *Journal of the European Economic Association*, Vol. 1 (4), pp. 990-1029.

Röglinger, M., Pöppelbuß, J., Becker, J. (2012): Maturity models in business process management. In: *Business Process Management Journal*, Vol. 18 (2), pp. 328-346.

Roldán, J. L., Sánchez-Franco, M. J. (2012): Variance-based structural equation modeling: Guidelines for using partial least squares in information systems research. In: Mora, M., Gelman, O., Steenkamp, A. L., Raisinghani, M. (eds.): *Research Methodologies, Innovations and Philosophies in Software Systems Engineering and Information Systems*. Hershey, IGI Global, pp. 193-221.

Romesburg, H. C. (2004): Cluster Analysis for Researchers. North Carolina, Lulu Press.

Ruiz-Alba, J. L., Guesalaga, R., Ayestarán, R., Morales Mediano, J. (2020): Interfunctional coordination: the role of digitalization. In: *Journal of Business & Industrial Marketing*, Vol. 35 (3), pp. 404-419.

Sahito, N., Han, H., Thi Nguyen, T. V., Kim, I., Hwang, J., Jameel, A. (2020): Examining the quasi-public spaces in commercial complexes. In: *Sustainability*, Vol. 12 (5), pp. 1-16.

Sanchez, R. (1996): Strategic product creation: Managing new interactions of technology, markets, and organizations. In: *European Management Journal*, Vol. 14 (2), pp. 121-138.

Sanchez, R., Heene, A. (1997): Strategic learning and knowledge management. Chichester, Wiley.

Sarstedt, M., Cheah, J.-H. (2019): Partial least squares structural equation modeling using SmartPLS: A software review. In: *Journal of Marketing Analytics*, Vol. 7 (3), pp. 196–202.

Schmitt, N. (1996): Uses and abuses of coefficient alpha. In: *Psychological Assessment*, Vol. 8, (4), pp. 350–353.

Schniederjans, D. G., Curado, C., Khalajhedayati, M. (2020): Supply chain digitisation trends: An integration of knowledge management. In: *International Journal of Production Economics*, Vol. 220, 107439.

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., King, J. (2006): Reporting structural equation modeling and confirmatory factor analysis results: A review. In: *The Journal of Educational Research*, Vol. 99 (6), pp. 323-338.

Schreieck, M., Wiesche, M., Krcmar, H. (2021): Capabilities for value co-creation and value capture in emergent platform ecosystems: A longitudinal case study of SAP’s cloud platform. In: *Journal of Information Technology*, Vol. 36 (4), pp. 365-390.

Schulze, A., Brusoni, S. (2022): How dynamic capabilities change ordinary capabilities: Reconnecting attention control and problem-solving. In: *Strategic Management Journal* (ahead of print).

Schumacher, A., Nemeth, T., Sihn, W. (2019): Roadmapping towards industrial digitalization based on an Industry 4.0 maturity model for manufacturing enterprises. In: *Procedia Cirp*, Vol. 79, pp. 409-414.

Schwab, K. (2017): The fourth industrial revolution. New York, Crown Business.

Schwerhoff, G., Edenhofer, O., Fleurbaey, M. (2019): Taxation of economic rents. In: *Journal of Economic Surveys*, Vol. 34 (2), pp. 398-423.

Seiberth, G., Gründinger, W. (2018): Data-driven business models in connected cars, mobility services and beyond. In: *BVDW Research*, Vol. 1, p. 5-44.

Shamsie, J., Mannor, M. J. (2013): Looking inside the dream team: Probing into the contributions of tacti knowledge as an organizational resource. In: *Organization Science*, Vol. 24 (2), pp. 319-644.

Sheng, M. L. (2019): Foreign tacit knowledge and a capabilities perspective on MNEs' product innovativeness: Examining source-recipient knowledge absorption platforms. In: *International Journal of Information Management*, Vol. 44, pp. 154-163.

Singh, A., Hess, T. (2017): How chief digital officers promote the digital transformation of their companies. In: *Management Information Systems Quarterly Executive*, Vol. 16 (1).

Singh, S. K., El-Kasser, A.-N. (2019): Role of big data analytics in developing sustainable capabilities. In*: Journal of Cleaner Production*, Vol. 213, pp. 1264-1273.

Smith, B., McGannon, K. R. (2018): Developing rigor in qualitative research: Problems and opportunities within sport and exercise psychology. In: *International Review of Sport and Exercise Psychology*, Vol. 11 (1), pp. 101-121.

Spulber, D. F. (2018): The Economics of Markets and Platforms. In: *Journal of Economics & Management Strategy*, Vol. 28 (1), pp. 159-172.

Stadler, C., Helfat, C. E., Verona, G. (2022): Transferring Knowledge by Transferring Individuals: Innovative Technology Use and Organizational Performance in Multiunit Firms. In: *Organization Science* (ahead of print).

Strauss, A. L. (1987): Qualitative analysis for social scientists. Cambridge, Cambridge University Press.

Strauss, M. E., Smith, G. T. (2009): Construct validity: Advances in theory and methodology. In: *Annual Review of Clinical Psychology*, Vol. 5, pp. 1-25.

Syakur, M. A., Khotimah, B. K., Rochman, E. M. S., Satoto, B. D. (2018): Integration k-means clustering method and elbow method for identification of the best customer profile cluster. In: *IOP Conference Series: Materials Science and Engineering*, Vol. 336 (1).

Tan, B., Pan, S. L., Lu, X., Huang, L. (2015): The role of IS capabilities in the development of multi-sided platforms: The digital ecosystem strategy of Alibaba.Com. In: *Journal of the Association for Information Systems*, Vol. 16 (4), pp. 248–280.

Tasic, J., Tantri, F., Amir, S. (2019): Modelling Multilevel Interdependencies for Resilience in Complex Organisation. In: *Complexity*, Vol. 2019, 1-23.

Teece, D. J. (1980): Economies of Scope and the scope of the enterprise. In: *Journal of Economic Behavior & Organization*, Vol. 1 (3), pp. 223-247.

Teece, D. J. (2018): Business models and dynamic capabilities. In: *Long Range Planning*, Vol. 51 (1), pp. 40-49.

Teichert, R. (2019): Digital transformation maturity: A systematic review of literature. In: *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 67 (6), pp. 1673-

Thiele, M. (1997): Kernkompetenzorientierte Unternehmensstrukturen. Ansätze zur Neugestaltung von Geschäftsbereichsorganisationen, Wiesbaden, Springer.

Thomas, V. J., Maine, E. (2019): Market entry strategies for electric vehicle start-ups in the automotive industry – Lessons from Tesla Motors. In: *Journal of Cleaner Production*, Vol. 235 (20), pp. 653-663.

Thordsen, T., Murawski, M., Bick, M. (2020): How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models. In: *Responsible Design, Implementation and Use of Information and Communication Technology*: 19th IFIP WG 6.11 Conference on e-Business, e-Services, and e-Society, Skukuza, South Africa, April 6–8, 2020, Proceedings, Part I, Vol. 12066, pp. 358–369.

Troise, C., Corvello, V., Ghobadian, A., O'Regan, N. (2022): How can SMEs successfully navigate VUCA environment: The role of agility in the digital transformation era. In: *Technological Forecasting and Social Change*, Vol. 174, 121227.

Tushman, M. L., Anderson, P. (1986): Technological Discontinuities and Organizational Environments. In: *Administrative Science Quarterly*, Vol. 31 (3), pp. 439-465.

Un, C. A., Asakawa, K. (2015): Types of R&D Collaborations and Process Innovation: The Benefit of Collaborating Upstream in the Knowledge Chain. In: *Journal of Product Innovation Management*, Vol. 32 (1), pp. 138-153.

Unger, J. M., Rauch, A., Frese, M., Rosenbusch, N. (2011): Human capital and entrepreneurial success: A meta-analytical review. In: *Journal of Business Venturing*, Vol. 26 (3), pp. 341-358.

Uzunca, B. (2018): A Competence-Based View of Industry Evolution: The Impact of Submarket Convergence on Incumbent-Entrant Dynamics. In: *Academy of Management Journal*, Vol. 61 (2), pp. 738-768.

Vaismoradi, M., Jones, J., Turunen, H., Snelgrove, S. (2016): Theme development in qualitative content analysis and thematic analysis. In: *Journal of Nursing Education and Practice*, Vol. 6 (5), pp. 100-110.

Valenzuela S., Correa, T., de Zuniga, H.G. (2018): Ties, Likes, and Tweets: Using Strong and Weak Ties to Explain Differences in Protest Participation Across Facebook and Twitter Use. In: *Political Communication*, Vol. 35 (1), pp. 117-134.

Vargo, S. L., Lusch, R. F. (2008): Service-dominant logic: continuing the evolution. In: *Journal of the Academy of Marketing Science*, Vol. 36, pp. 1-10.

Vecchiato, R. (2017): Disruptive innovation, managerial cognition, and technology competition outcomes. In: *Technological Forecasting and Social Change*, Vol. 116, pp. 116-128.

Victor, B., Blackburn, R. S. (1987): Interdependence: An alternative conceptualization. In: *Academy of Management Review*, Vol. 12 (3), pp. 486-498.

Vise, D. A. (2018): The Google Story. United Kingdom, Pan MacMillan.

Visser, M. (2007): Deutero-learning in organizations: A review and a reformulation. In: *Academy of Management Review*, Vol. 32 (2), pp. 659-667.

Wade, M., Hulland, J. (2004): Review: The Resource-Based View and Information Systems Research: Review, Extension, and Suggestions for Future Research. In: *Management Information Systems Quarterly*, Vol. 28 (1), pp. 107-142.

Wagner, G., Preser, J., Paré, G. (2021): Exploring the boundaries and processes of digital platforms for knowledge work: A review of information systems research. In: *The Journal of Strategic Information Systems*, Vol. 30 (4), 101694.

Waldfogel, J. (2017): How Digitization Has Created a Golden Age of Music, Movies, Books, and Television. In: *Journal of Economic Perspectives*, Vol. 31 (3), pp. 195-214.

Wang, J., Xu, C., Zhang, J., Zhong, R. (2021): Big data analytics for intelligent manufacturing systems: A review. In: *Journal of Manufacturing Systems*, Vol. 62, pp. 738-752.

Weiber, R., Mühlhaus, D. S. (2014): Strukturgleichungsmodellierung - Eine anwendungsorientierte Einführung in die Kausalanalyse mit Hilfe von AMOS, SmartPLS und SPSS. Berlin, Springer Gabler.

Wendler, R. (2012): The maturity of maturity model research: A systematic mapping study. In: *Information and Software Technology*, Vol. 54 (12), pp. 1317-1339.

Weyer, S., Schmitt, M., Ohmer, M., Gorecky, D. (2015): Towards Industry 4.0 – Standardization as the crucial challenge for highly modular, multi-vendor production systems. In: *IFAC-PapersOnline*, Vol. 48, pp. 579-584.

Wiedenbeck, M., Züll, C. (2010): Clusteranalyse. In: Wolf, C., Best, H. (eds) Handbuch der sozialwissenschaftlichen Datenanalyse. VS Verlag für Sozialwissenschaften.

Williamson, O. E. (1985): The Economic Institutions of Capitalism. New York, The Free Press.

Williamson, O.E. (1975): Markets and hierarchies, New York, Free Press.

Wu, Y.-L., Li, E. Y. (2018): Marketing mix, customer value, and customer loyalty in social commerce: A stimulus-organism-response perspective. In: *Internet Research*, Vol. 28 (1), pp. 74-104.

Yang, L., Huo, B., Tian, M., Han, Z. (2021): The impact of digitalization and inter-organizational technological activities on supplier opportunism: the moderating role of relational ties. In: *International Journal of Operations & Production Management*, Vol. 41 (7), pp. 1085-1118.

Yin, R. K. (2009): Case study research: Design and methods. Thousand Oaks, CA, Sage.

Zahavi, T., Lavie, D. (2013): Intra-industry diversification and firm performance. In: *Strategic Management Journal*, Vol. 34 (8), pp. 978-998.

Zambelli, A. E. (2016): A data-driven approach to estimating the number of clusters in hierarchical clustering. In: *F1000Res*, Vol. 2016 (5), pp. 1-13.

Zanon, L. G., Ulhoa, T. F., Esposto, K. F. (2021). Performance measurement and lean maturity: congruence for improvement. In: *Production Planning & Control*, Vol. 32 (9), pp. 760-774.

Zhan, Y., Tan, K. H., Li, Y., Tse, Y. K. (2018): Unlocking the power of big data in new product development. In: *Annals of Operations Research*, Vol. 270 (1), pp. 577-595.

Zhao, Y., Zhang, T., Dasgupta, R. K., Xia (2022): Narrowing the age-based digital divide: Developing digital capability through social activities. In: *Information Systems Journal* (ahead of print).

Chapter B: Digital Maturity in the German Traditional Industries – Status Quo, Profit Impact, and Paths of Acceleration

Accepted for Publication in International Journal of Innovation and Technology Management

Stefan Sommer (corresponding author)
University of Duisburg-Essen (Germany)
stefan.sommer@uni-due.de
Lotharstraße 1, 47057 Duisburg, Germany

Heike Proff
University of Duisburg-Essen (Germany)
heike.proff@uni-due.de
Lotharstraße 1, 47057 Duisburg, Germany

Abstract

Digitalization is driving discontinuous changes in traditional industries such as in sectors of industrial goods, automotive, chemicals and pharma, and industrial services. However, many affected companies are slow to adapt their businesses. Digital maturity concerns the status quo of digitalization in these companies and must be pursued if the company is to remain competitive. By drawing on theory-based responses to digitalization, a maturity assessment index was derived. A quantitative survey generated 160 complete data sets from German companies operating in traditional industries. The findings suggest a medium level of digital maturity. Six archetypes of digitalized organizations and a positive impact on profits were identified. These results provide indications of five generic paths for increasing digital maturity.

Keywords: digitalization; discontinuous change; digital maturity assessment, traditional industries

1. Introduction

Digitalization causes discontinuous [Cozzolino and Rothaermel (2018)] and often disruptive changes [Acciarini et al. (2020); Buck et al. (2021); Hinterhuber (2022)] in companies' processes, products and services, and business models [Porter and Heppelmann (2014)]. These change-related processes have fundamentally transformed industries [Rogers (2016)] such as the music, television, video, and newspaper sectors after years of stability [Cozzolino and Rothaermel (2018)], and it is now also affecting capital-intensive traditional companies, that are, companies in sectors such as industrial goods, automotive, chemicals and pharma, and industrial services [e.g., Agostini and Nosella (2020); Ghosh et al. (2022)]. If these companies are to remain competitive, they need high levels of digital maturity to respond to these discontinuous changes [Aggarwal et al. (2016); Schallmo et al. (2021)]. In this context, the term "digital maturity" can be understood as referring to the status of a company's reaction to digitalization [Groos et al. (2022); Chanias and Hess (2016)], meaning completeness, perfection, or readiness to make the necessary adaptations to the new digital conditions [Kiron et al. (2016); Gürdür et al. (2019)].

Improvements in digital maturity in the traditional industries have been less rapid than in e.g., the software industry [Stolfa et al. (2019)] because these companies have had many years of success [Rahmati et al. (2021)] and have not yet recognized the economic advantages of digitalization [Fitzgerald et al. (2014)], while in some cases, managers still do not know enough about the necessary processes and setups [Hebbert (2017)]. As a result, they are failing to respond holistically to digitalization [Hess et al. (2016); Bumann and Peter (2019)] and, instead, they start with isolated and experimental applications [Tumbas et al. (2017)], wasting valuable adaptation time [Singh and Hess (2017)].

Existing research on the digital maturity of affected companies has focused solely on specific aspects of digitalization or has been based on case studies [Gimpel et al. (2018)]. Digital maturity assessment methods are often compiled from existing studies or derived from practice [Thordsen et al. (2020)]. However, companies must assess their digital maturity by taking into account the theory-based responses to digitalization [Koch and Windsperger (2017)]. In this context, empirical pattern detection is vital and the connection to the companies' overall success has to be further investigated to improve digital maturity [Gudergan et al. (2019)].

This study, accordingly, used quantitative data from 160 German traditional companies to answer the following research questions:

(1) What is the status quo of digital maturity in traditional industries?

(2) What patterns or archetypes can be identified in the digitalization process?

(3) Does digital maturity correlate with a company's success (profit impact)*?*

(4) What are the conceivable approaches to improving digital maturity?

This article is structured as follows. In Chapter 2, digitalization and digital maturity are defined. Chapter 3 discusses the appropriate responses to digitalization. Chapter 4 explains the research methodology used to create a maturity index and measures the digital maturity level and builds clusters of archetypes of the digitalized companies. The findings presented in Chapter 5 show the current extent of digital maturity (the status quo) and the indications of economic success (profit impact) at 160 traditional German companies. Approaches for improving digital maturity in each of the clusters are discussed in Chapter 6. The conclusion of the paper is presented in Chapter 7.

2. Theoretical Background

2.1 Digitalization

The term "digitalization" encompasses more than the technical conversion of analog information into digital formats (which is described by the term "digitization") [Schallmo and Williams (2018)]. Digitalization involves new socio-technical phenomena [Yoo et al. (2012), and related to this, [Knobbe and Proff (2020)], according to Gartner Glossary [2018], "is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities." Thus, digitalization affects the organization from a technological and economic – "techno-economic" [Perez (2010)] – perspective, which is based on the rapid development of technologies such as social media, mobile data communication, analytics, and cloud computing (SMAC technologies) [Brennen and Kreis (2016); Evans (2016); Sengupta et al. (2021)].

Concerning the technological perspective, these digital technologies, such as mobile communications, cause the interfaces between the activities along Porter's value chain to become standardized [Gulot et al. (2020); Porter (1985)]. The primary activities (i.e., manufacturing, logistics, and distribution) and supporting activities (i.e., procurement and R&D) of a company's operations become less independent and can consequently be more easily detached from each other [Lardo et al. (2020)]. This enables companies to manage internal and external coordination at lower transaction costs [cf. Hagiu and Wright (2015); Williamson (1975)] and, for that reason, make processes more efficient – for example, modular production systems can respond spontaneously to fluctuating customer demands because of quick and automated communication between machines or employees [Lu et al. (2020)]. Standardized software interfaces also enable companies to create digital platforms [Bonina et al. (2021)], which can be used by more than two market players [Kapoor et al. (2021)]. This kind of connectedness increases interaction between players and leads to smart customer solutions and innovative business models that cannot be provided by one market player alone (see "theory of two- or multi-sided markets") [Gawer (2014)]). Economic profits are derived from complementarity in networks [Jacobides et al. (2018)], which are called "structural" ecosystems [Adner (2017); Kapoor (2018)]. That is, the standardization of interfaces in times of digitalization provides more scope for coordination and interaction between internal units and with partners and can be seen as the origin of profound shifts in processes, services, and business models [Apostolov and Coco (2021); Parida et al. (2019), Porter and Heppelmann (2014)].

However, from the perspective of market dynamics, the emergence of digital technologies is leading to socio-technical shifts which are influencing the stability of the market and triggering discontinuous changes. That is, digitalization affects market dynamics in what Davis et al. [2009] have extracted as a multi-dimensional construct comprising volatility, unpredictability, complexity, and ambiguity (VUCA) [Bennett and Lemoine (2014); Mack and Khare (2016)]. Thus, in times of digitalization, VUCA conditions jeopardize the suitability of companies' existing capabilities to their surrounding conditions [Birkinshaw et al. (2016)]. In consequence, new capabilities are required for taking strategic action [Eggers and Kaplan (2013)].

2.2 Digital Maturity

The term "maturity" is often also used interchangeably with "readiness" [Gürdür et al. (2019)] or "stages of growth" [Prananto et al. (2003)]. Maturity in general means "evolutionary progress in the demonstration of a specific ability or in the accomplishment of a target from an initial to a desired or normally occurring end-stage" [Mettler (2011) p. 83]. In business research, "maturity" describes the specific status of a performance factor [Carvalho et al. (2018)], such as cost, quality, or time to market [Vaz et al. (2019)]. "Digital maturity" is not uniformly defined and is seen as a "relative and subjective" construct [Mettler and Pinto (2018)]. According to Kiron et al. [2016], it is the ongoing process of adaptation to a changing landscape, allowing a company to compete effectively in a new and increasingly digital environment. Thus, companies must respond to the effects of digitalization by increasing their digital maturity [Berghaus et al. (2016); Kiron et al. (2016)]. This adaptation requires the affected organization to mobilize its specific capabilities to cope with digitalization [Agarwal et al. (2021); Rossmann (2018)] while adapting its processes, products, and business models to the new business environment conditions [Chanias and Hess (2016)]. The digital maturity approach thus also includes aspects of change management, which can be described as a structured approach to facilitating a transition from a current to a future state [Balogun and Hailey (2008)] and relies on models for measurement of progress [Bellantuono et al. (2021)]. Hence, digital maturity measurement fits into the larger picture of change management in response to VUCA conditions, because it supports planning and implementing the change [Pearse (2017)] by using structured frameworks or models. These comprise dimensions or categories of different organizational issues where maturity needs to be improved [Teichert (2019)]. Thus, the maturity frameworks offer “a way to make an object of interest’s progress towards a target state tangible across various management research disciplines” [Remane et al. (2017), p. 3]. In many cases, these models are derived from practical experiences or exploratory research [e.g., Remane et al. (2017)]. Others are a compilation and aggregation of measurement dimensions taken from existing models [Webster and Watson (2002)]. Consequently, previous research has neglected to provide a theoretical foundation for the assessment of digital maturity [Teichert (2019)].

On that account, the current study understands digital maturity as a response to the key effects of digitalization: namely, greater scope in the coordination of and interaction between internal and external organizational units as well as VUCA conditions during the course of the discontinuous change (see section 2.1). As existing maturity models and studies are not based on a theoretical derivation [Lahrmann et al. (2011); Mettler (2011)], this study’s maturity dimensions are based on broadly accepted theories being connected with a reaction to digitalization [see Cleven et al. (2014)]. Thus, it follows a “conceptual approach” [Lasrado et al. (2015)], emphasizing a strong theoretical foundation instead of reusing existing, previous maturity models.

3. Responses to Digitalization and How to Improve Digital Maturity

3.1 Changing Processes and Technologies

On the operational level, companies can take advantage of improved internal and external coordination and interaction in a traditional business by **changing (i.e., optimizing) their existing processes** in all functional areas [e.g., Coreynen et al. (2017); Zhang et al. (2022)]. However, continuous and often minor adaptations are not sufficient under conditions of disruptive digitalization. A comprehensive, and disruptive, redesign of the scope of corporate action is necessary. Such process innovations not only create competitive advantages in the supply chain [Nabhani et al. (2018)], but they can also create customer benefits in all operational activities [Berman (2012)]. They create cost-cutting potential [Nabhani et al. (2018)] in the existing areas of the value chain (R&D, production, and marketing and sales) and can generate additional revenues by increasing customer contact [Coreynen et al. (2017)]. To realize the potential of lower transaction costs in internal coordination and interactions, it is necessary to **change the technologies**: companies must install systems for manufacturing execution (MES) [Mantravadi and Møller (2019)]; managing product lifecycles (PLM) [Stark (2020)]; and collecting, processing, and storing data (“Big Data”) [Wang et al. (2021)]. These systems improve the standardization of the interfaces between the individual activities of the company and thus increase efficiency (see also the term “Industry 4.0”) [Kumar et al. (2021)].

3.2 Changing the Products and Services, and Business Models

In addition, from a strategic perspective, companies can benefit from the digitalization-related scope of coordination and interaction in the traditional business by **changing (i.e., integrating) their products and services** [e.g., Oberländer et al. (2022); Porter and Heppelmann (2014)]. Under disruptive digitalization, minor adaptations or incremental changes to products and services are not sufficient [Teichert (2019)]. New and comprehensively (disruptively) changed customer solutions can occur [Singh and Hess (2017)] when goods and services become “smart offerings”, simply by the interaction of their underlying technical infrastructure. In this case, the “smart offering” creates and exchanges data with other systems, e.g., when cars communicate via the internet (thanks to standardized communication interfaces, as discussed in section 2.1).

In addition, digitalization-based coordination and interaction on technical platforms in structural ecosystems is a prerequisite for **new, innovative business models** [e.g., El Sawy and Pereira (2013); Kiron et. al. (2016); Li et al. (2022)]. Under disruptive digitalization, adaptations and incremental changes in business models [Mitchel and Coles (2003)] are not sufficient; rather, newly developed or comprehensively changed business models are needed. Business models are usually defined by individual components [Johnson et al. (2008)] – such as the value architecture, value proposition, and profit model [e.g., Foss and Saebi (2017)] – all of which complement resource allocation and competitive advantages as components of competitive strategies [e.g., Aaker (2013)]. Digitalization affects all aspects of business models, hence it improves the profit model [Ritter and Pedersen (2020)], especially when companies collaborate in ecosystems and co-create value with partners [Adner (2017)].

3.3 Mobilizing Dynamic Capabilities

To increase their digital maturity, companies must respond to discontinuous changes in times of digitalization (see section 2.2). They must mobilize their capabilities to take strategic action [Eggers and Kaplan (2013)] as these capabilities enable them to find paths to digital maturity [Kamalaldin et al. (2020)]. From previous research, it can be deduced that companies under VUCA conditions require **dynamic capabilities** if they are **to become resilient to new environmental dynamics** [Hamel and Valikangas (2003); Teece (2018)]. Dynamic capabilities enable the company’s resource base to be reconfigured to sustain the competitive advantages necessary in environments characterized by high velocity [Canhoto et al. (2021); Lynch (2019); Makadok (2001); Teece et al. (1997)] and technological change [Lavie (2006)], while also preserving strategic flexibility [Konlechner et al. (2018)]. These capabilities comprise the ability to perceive environmental changes (“sensing”) [Baden-Fuller and Teece (2020); Teece (2007)]; to capture strategic opportunities through decision-making structures, processes, and incentives (“seizing”) [Teece (2007)]; and to maintain competitiveness in the market by extending, combining, protecting, and – if necessary – reconfiguring operational capabilities (“reconfiguring”) [Teece (2007)]. Thus, dynamic capabilities help companies to, firstly, respond to new environmental situations through the surveillance of emerging technologies [Nielsen (2006)] and, secondly, support the development of new customer solutions [Legner et al. (2017)]. More flexibility and adaptability were necessary, for example, in times of the COVID-19 pandemic, as companies with superior digital technologies were able to maintain their communication with customers or even develop new products, such as in the field of telemedicine or digital healthcare [Liu et al. (2022); Saputra et al. (2022)].

3.4 Mobilizing Operational Capabilities

Because digitalization affects the foundations of a successful business, which are processes, products and business models, companies need to renew the underlying **(digital) operational capabilities** [Lenka et al. (2017); Proksch et al. (2021)]. While dynamic capabilities are to be understood as higher-order capabilities [Zollo and Winter (2002)], operational capabilities are zero-level [Winter (2003)], which enables the firm “to perform a coordinated set of tasks, utilizing organizational resources” to achieve a result [Helfat and Peteraf (2003)]. On the one hand, they comprise the capabilities of employees within the company, that is personnel with unique working routines or leadership skills [Teece (2014)]; parallels with the generic strategy of leadership from change management are the result [By (2020)]. On the other hand, operational capabilities include the capabilities on the organizational level, that is capabilities owned and controlled by the company arising in the complex, company-specific interactions and processes [Gold and Malhotra (2001)]. As operational capabilities are not transparent to externals [Teece (2018)] they feature limited substitutability and imitability.

4. Research Methodology

4.1 Empirical Setting

The present study follows the common approach to the assessment of maturity and draws on an index solution [e.g., Goldstein and Eley (2014); Kromann et al. (2020)]. The responses to digitalization derived theoretically and presented in Chapter 3 provided the basis of the sub-indices for measuring digital maturity (see Fig. B-1) [de Bruin et al. (2005); Pöppelbuß and Röglinger (2011)]. Consequently, the digital maturity index (DMI) comprises (1) the digital activity index, taking into account the responses in processes and technologies; (2) the digital business index, covering the necessary changes in products and services and business models; (3) the dynamic capabilities index, which considers the mobilization of necessary capabilities to enable the organization's adaptation to discontinuous change; and (4) the operational capability index, including the mobilization of operational capabilities from an individual and organizational perspective.

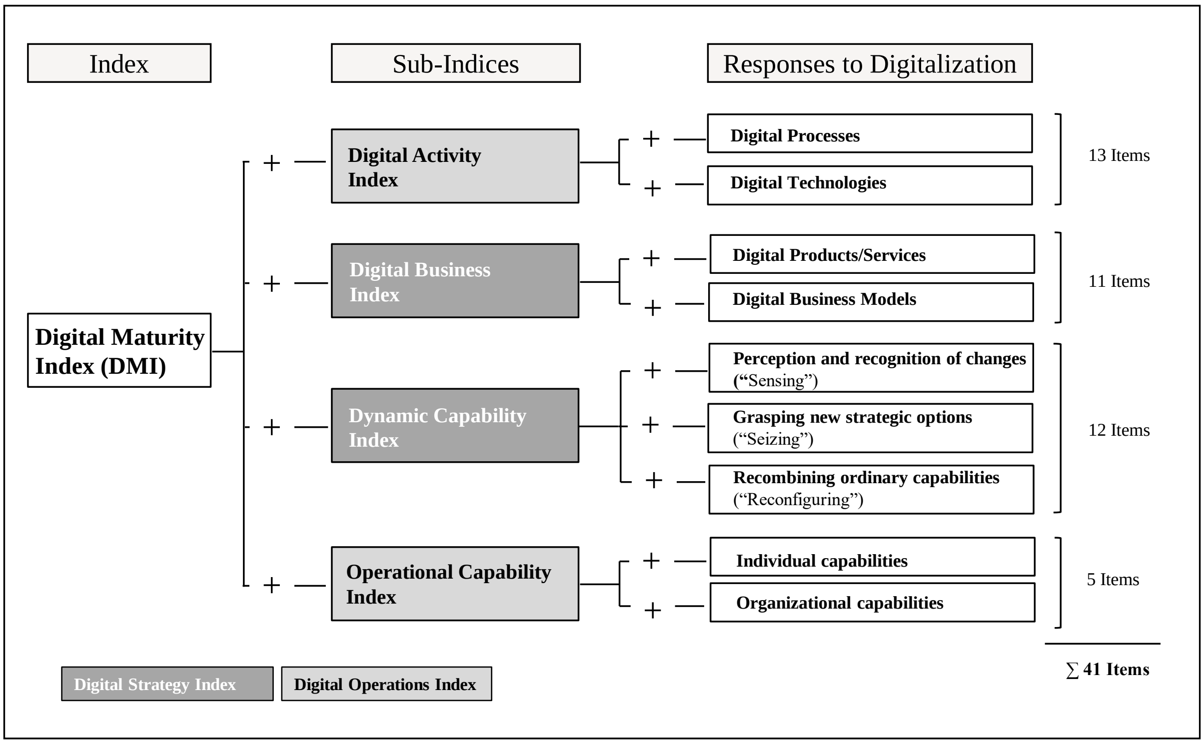

Fig. B-1: Digital Maturity Index (source: own compilation)

The responses to digitalization were operationalized as latent constructs [cf. Grant and Verona (2015)] and measured using a total of 41 items (see Appendix). A seven-point Likert scale, from 1 (no digitalization) to 7 (full digitalization), was applied, allowing a metric scale to be assumed and the average of the items to be calculated [Luftman (2006); Solar et al. (2013)]. This followed the "maturity level approach" commonly used in assessment models such as the "capability maturity model" (CMM) [Paulk et al. (1993)]. In addition, the impact of digital maturity on the operating result (EBIT) was examined in seven steps and found to range from 0 to more than 25% [De Toni et al. (2017); Zatta and Kolisch (2014)].

4.2 Data Collection and Analysis

A pre-test [Stockemer (2018)] was conducted at 30 German companies. The actual survey was then disseminated to German firms in a cross-sectional empirical study. This involved 215 companies selected at random, each with a turnover of more than EUR 100 million. A total of 160 complete data sets were analyzed, consequently providing a sufficiently large sample size [Cohen (1992)]. Almost three-quarters (71%) of the participants had a turnover of more than EUR 500 million, and 18% more than EUR 10 billion. Some 65% of the companies in the study had fewer than 10,000 employees and 22% had more than 20,000. A quarter (26%) of the respondents were working at the board or top-management level (CxO level), and 74% were one management level below. More than a third (38%; n=60) of the respondents worked in the industrial goods sector (e.g., mechanical engineering, consumer goods, and plant construction), 19% (n=31) in the automotive industry, 17% (n=27) in the chemicals and pharma industry, and 26% (n=42) for industrial service providers (transport and logistics, and engineering and energy service providers).

Statistical analysis was conducted by calculating the average of the equally weighted sub-indices [Farrel and Gallagher (2014); Jovanović and Filipović (2016); Macchi and Fumagalli (2013)]. A cluster analysis [Romesburg (2004)] was performed using the "Ward method" [Murtagh and Legendre (2014)], based on Euclidean distance between points [Székely (2005)]. The ideal number of clusters was identified as six, using the elbow criterion [Bholowalia and Kumar (2014)] to build archetypes of companies with a similar status quo in terms of their strategic and operational digital maturity (see Fig. B-1 in section 4.1). The maturity levels of the individual items in all cluster groups were compared, and "gap analysis" was applied to derive paths to improve digital maturity (see Fig. B-6 in the Appendix) [cf. Dutta et al. (2020); Colli et al. (2018)].

5. Findings

5.1 Digital Maturity in the Surveyed Companies

To address the first research question, it is noted that the status quo of digital maturity in the German traditional industries had an average DMI value of 3.92, indicating room for potential improvement. According to previous research on digitalization, digital maturity must be accelerated in both strategic and operational dimensions [Reis et al (2018)]. A comparison of the maturity of the longer-term strategic orientation (digital strategy) – captured as a combination of the digital business index and the dynamic capability index – and the maturity of the shorter-term, operational orientation – captured via the digital activity index and the operational capability index (Fig. B-1) – shows a strong significant correlation ($p < 0.001$) between strategic and operational orientation, with an R^2 of 0.83 (cf. Fig. B-2), that is 83% of the variance is explained by the model. The adjusted R^2 is 0.82, indicating the proportion of variation explained by the regression line is 82%, which demonstrates that the estimated regression fits the relationship between strategic and operational orientation and does not contain a too large number of variables [Miles (2005)]. Companies with a high digital strategic maturity also have strong operational digital positioning and vice versa. However, the German companies surveyed were also more strategically than operationally aligned with digital maturity (intercept of regression line at 0.11).

The analysis revealed a wide scatter in the statements by the companies regarding their current digital maturity. With the help of cluster analysis, six archetypes of companies at different levels of digital maturity were identified, indicating the extent of strategic and operational digitalization (see section 4.1) [cf. Guenzi and Habel (2020)]. In response to the second research question, the archetypes are as follows: *digital champions*, *digital high potentials*, *digital innovators*, *digital optimizers*, *digital followers*, and *digital laggards* (see Fig. B-2).

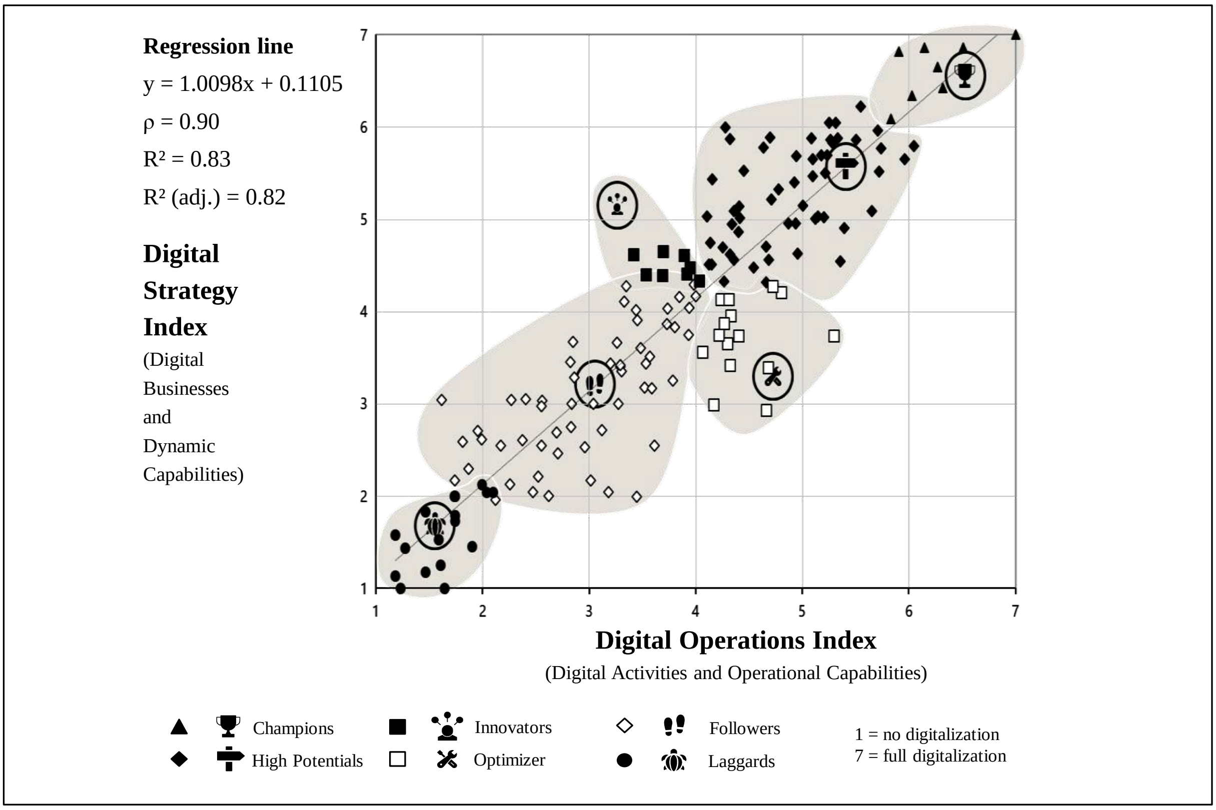

Fig. B-2: Archetypes of digital companies (source: own compilation)

Table B-1 shows the averages for digital maturity and the individual sub-indices of the six archetypes of digital companies. Across all archetypes, a moderate digital maturity was revealed in both the overall index (3.92 on a scale of 1 [no digitalization] to 7 [full digitalization]) and all four sub-indices (between 3.68 and 4.08). The internal consistency of the sub-indices is given due to their Cronbach's alpha being > 0.7 [Schmitt (1996)].

Average per Archetype	**Dynamic Capability Index**	**Digital Business Index**	**Operational Capability Index**	**Digital Activity Index**	**Digital Maturity (Total)**
Cronbach's alpha	**α = 0.92**	**α = 0.90**	**α = 0.83**	**α = 0.86**	
Digital Champions	6.74	6.52	6.43	6.08	6.44
Digital High Potentials	5.29	5.25	5.08	4.70	5.08
Digital Innovators	4.51	4.47	4.20	3.33	4.13
Digital Optimizers	3.83	3.60	4.53	4.37	4.08
Digital Followers	3.22	2.94	3.16	2.82	3.04
Digital Laggards	1.68	1.51	1.62	1.62	1.61
Total	**4.08**	**3.91**	**4.01**	**3.68**	**3.92**
1 = no digitalization; 7 = full digitalization					

Tab. B-1: Overview of digital maturity and the individual sub-indices for the six archetypes of digital companies (source: own compilation)

In contrast, there were major differences between the six archetypes in terms of the extent of their digital maturity, with a DMI ranging from 1.61 for *digital laggards* to 6.44 for *digital champions*. According to the findings in Table D-1, digital maturing from one archetype to another requires simultaneous progress in many dimensions (indices).

Turning to the control variables, it was found that when digital maturity was assessed in relation to the size of the company (as measured by turnover), there was a very clear scale effect. The larger companies, with turnovers of more than EUR 10 billion, had already oriented themselves more strongly toward digitalization, both overall (average DMI of 4.40) and in all sub-indices, while the medium-sized companies (with turnovers of EUR 500 million to 10 billion) had an average DMI of 3.84. In turn, the large and medium-sized companies were both more "digitally mature" than the small companies defined as those with turnovers of between EUR 100 and 500 million (average DMI of 2.79). This evidence shows that large companies were more likely to have the financial resources to invest in expensive digital technologies, while the small companies' flexibility and speed could not compensate for their comparative lack of financial strength.

Especially in the three sectors of industrial goods, industrial services as well as chemicals and pharma, there were few *digital champions* or *laggards*, a large number of *digital high potentials* and *followers*, and few *digital innovators* or *optimizers* (see Tab. B-2). However, noticeable is the higher number of *digital followers* and *laggards* in the automotive sector (45%).

Archetype	Industrial Goods	Industrial Services	Chemicals/ Pharma	Automotive
Digital Champions	3%	6%	4%	3%
Digital High Potentials	38%	44%	48%	13%
Digital Innovators	7%	6%	7%	3%
Digital Optimizers	12%	6%	7%	10%
Digital Followers	37%	31%	22%	45%
Digital Laggards	3%	6%	12%	26%

Tab. B-2: Relative share of archetypes of digital companies in different sectors in Germany (source: own compilation)

This shows that the large automotive industry in Germany is lagging in digitalization to a certain extent, which may be explained by the fact that companies here have long time profited strongly from their traditional business, but now cannot focus on digitalization exclusively because they need to divide up their resources for the development of electric cars and related technologies.

5.2 EBIT Impact

Addressing the third research question, the survey results shed light on the correlation between digital maturity (the DMI) and the profit impact of digitalization (EBIT impact). A correlation of this kind is evident (cf. Fig. B-3) in the EBIT intervals (0%, 1 to 5%, 6 to 10%, etc.). If the average of the DMI index values of the companies in an EBIT interval is correlated with the average EBIT in the EBIT interval, this results in a correlation coefficient of 0.96. Therefore, the quality of the linear regression is very high, with an R^2 of 0.94 and an adjusted R^2 of 0.93. Results show strong significance ($p < 0.001$).

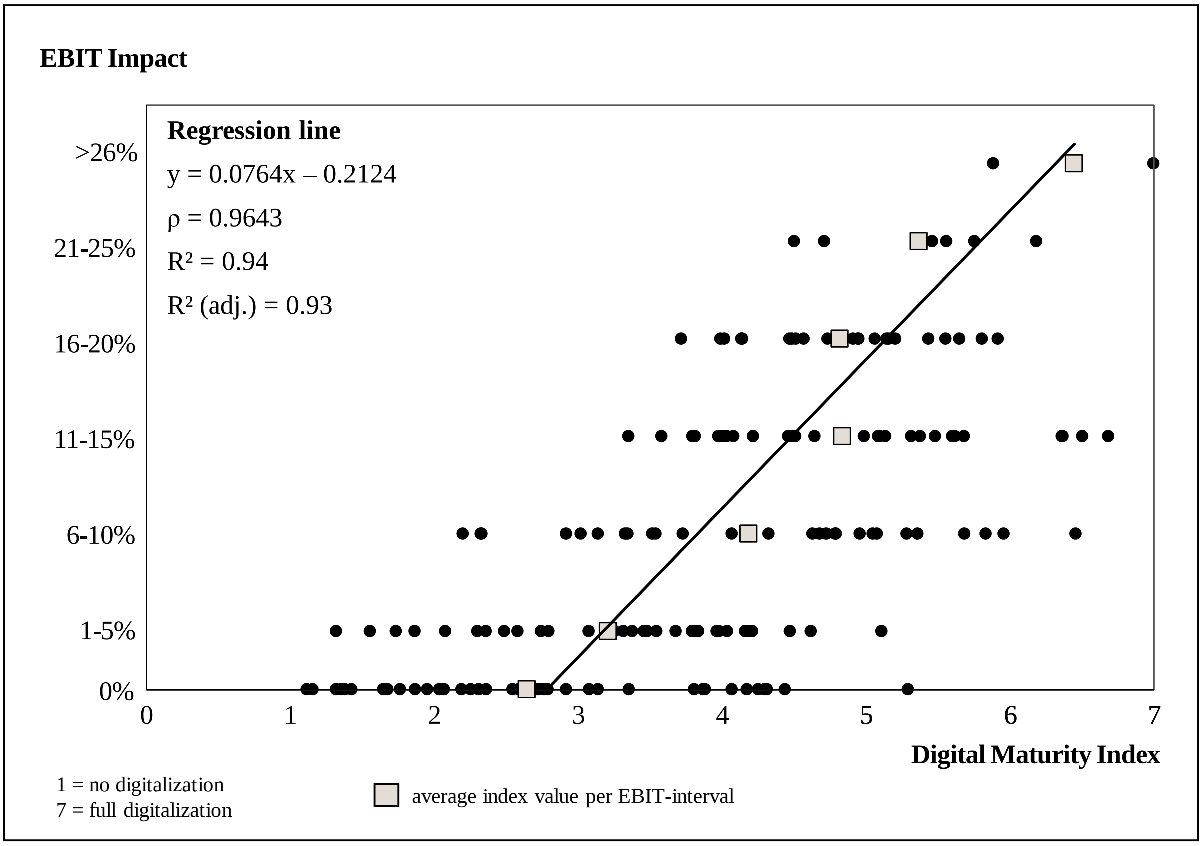

Fig. B-3: EBIT impact of digital maturity (source: own compilation)

The 26% of the surveyed companies had not yet seen any EBIT impact and estimated their digital maturity at the lowest levels (average of 2.75 on a scale of 7). A further 19% of the surveyed companies had seen only a very small EBIT impact (between 1% and 5%) and they likewise assessed their digital maturity as very low, at an average of 3.2. The 18%, 17%, and 14% of companies that rated their EBIT impact as 6–10%, 11–15%, and 16–20%, respectively, also rated their digital maturity significantly higher, at 4.4 or – in two cases – 5. Only 6% of the surveyed companies noted a strong EBIT impact of 21–25% or more than 25%, but they also rated their digital maturity the highest (an average of 5.3 or 6.5 on a scale of 7). In summary, there is a large proportion of the respondents (44%), which had achieved a maximum EBIT impact of 5%.

For the archetypes, it could be shown that the *digital champions* and *digital potentials* achieved the highest improvements in profitability with 16% and 14% respectively (see Tab. B-3). In contrast, *innovators* with an average of 7% EBIT improvement and *optimizers* with 10% EBIT improvement fall somewhat behind. It can be observed that the *optimizers* achieve a higher profitability improvement because their processes are already more efficient in comparison to the *innovators*, who primarily invested strategically. For *followers* and *laggards*, the EBIT improvements are lowest at 5% and 1%.

Archetype	EBIT improvement (averaged)
Digital Champions	16%
Digital High Potentials	14%
Digital Innovators	7%
Digital Optimizers	10%
Digital Followers	5%
Digital Laggards	1%

Tab. B-3: EBIT improvements of the archetypes of digital companies (source: own compilation)

It emerged that an EBIT impact can only be proven once a minimum level of digital maturity has been achieved (from a minimum DMI index value of 2.75 on a scale of 1–7). This means that digitalization efforts must attain a critical minimum level before an economic effect sets in or that a certain bandwidth in the reactions to digitalization is required. This also fits with the results shown in section 5.1, according to which larger companies (measured by sales) also achieve better DMI results. Their chances are higher of achieving EBIT improvements since they have greater investment resources at their disposal [Machin and Van Reenen (1993)]. In addition, a control shows that companies with a high share of their revenue coming from digital services and products (measured in seven intervals of 0%, 1-10%, 11-20%, etc. and up to > 50%) also achieve higher EBIT improvements (coefficient of 0.62, $R^2 = 0.38$, R^2 (adj.) = 0.37, $p < 0.001$).

This also explains the high levels of dissatisfaction with individual and isolated digital pilot projects that can be found in smaller companies causing no EBIT impact as well as the general need for smaller companies to catch up [Buer et al. (2021)].

Considering the overall effects of the EBIT improvement, the results confirm the perception that digitalization has strong potential but is currently implemented much too rarely and to an extent too limited in Germany.

6. Paths for Improving Digital Maturity

Archetypes of digital companies were derived from the findings (see Chapter 5). The companies' status quo regarding the values of the 41 items were compared to identify the largest gaps and potential levers for improving digital maturity (see Appendix). Therefore, to address the fourth research question, 11 improvement paths were found for the various strategic and operational orientations. *Digital laggards*, for example, have the option to make stepwise improvements in all four sub-indices, but they should focus on (1) the introduction of market analysis and (2) structured decision-making. They should (3) increase the support from their top management and (4) adapt their product or service architecture. In addition, (5) the introduction of PLM technology is recommended to integrate all information about the products' life cycles (see Appendix). By doing so, they can move onto path L.1 in Figure B-4, moving toward the level of *digital followers*. In total, 11 paths were identified (paths L.1 to P.1 in Fig. B-4), and these were grouped into five generic key tasks for improving digital maturity:

(1) optimizing the management of digitalization (path L.1 to increase the digital maturity of *digital laggards* so they might attain the level of *digital followers*);

(2) either defining the (market) strategies for digitalization (path L.2 of *digital laggards* or F.1 of *digital followers* to attain the level of *digital innovators*),

(3) or optimizing the operational activities (path L.3 of *digital laggards* or F.2 of *digital followers* to attain the level of *digital optimizers*);

(4) building digital capabilities (path F.3 of *digital followers*, path I.1 of *digital innovators* or path O.1 of *digital optimizers* to attain the level of *digital high potentials*); and

(5) optimizing business models, possibly with partners in structural ecosystems (path P.1 of *digital high potentials*, path I.2 of *digital innovators*, and path O.2 of *digital optimizers* to ultimately attain the level of *digital champions*).

Figure B-4, therefore, supports the claim of Rogers [2016] that digitalization is less about technologies and more about strategies and new ways of thinking. Digitally mature companies (*digital innovators, high potentials*, and *champions*), on that account, also have strongly marked dynamic capabilities of seizing (grasping new strategic options) and changing their business models (particularly in the value architecture and value proposition). They employ exceptional digital talents, as can be observed at the car manufacturer Tesla, which is developing autonomous cars [Dikmen and Burns (2017)]. These companies, e.g., such as Apple or Google, are collaborating in ecosystems with shared value-added and superordinate value propositions, being supported by top management and the digital corporate culture [Grover et al. (2022)].

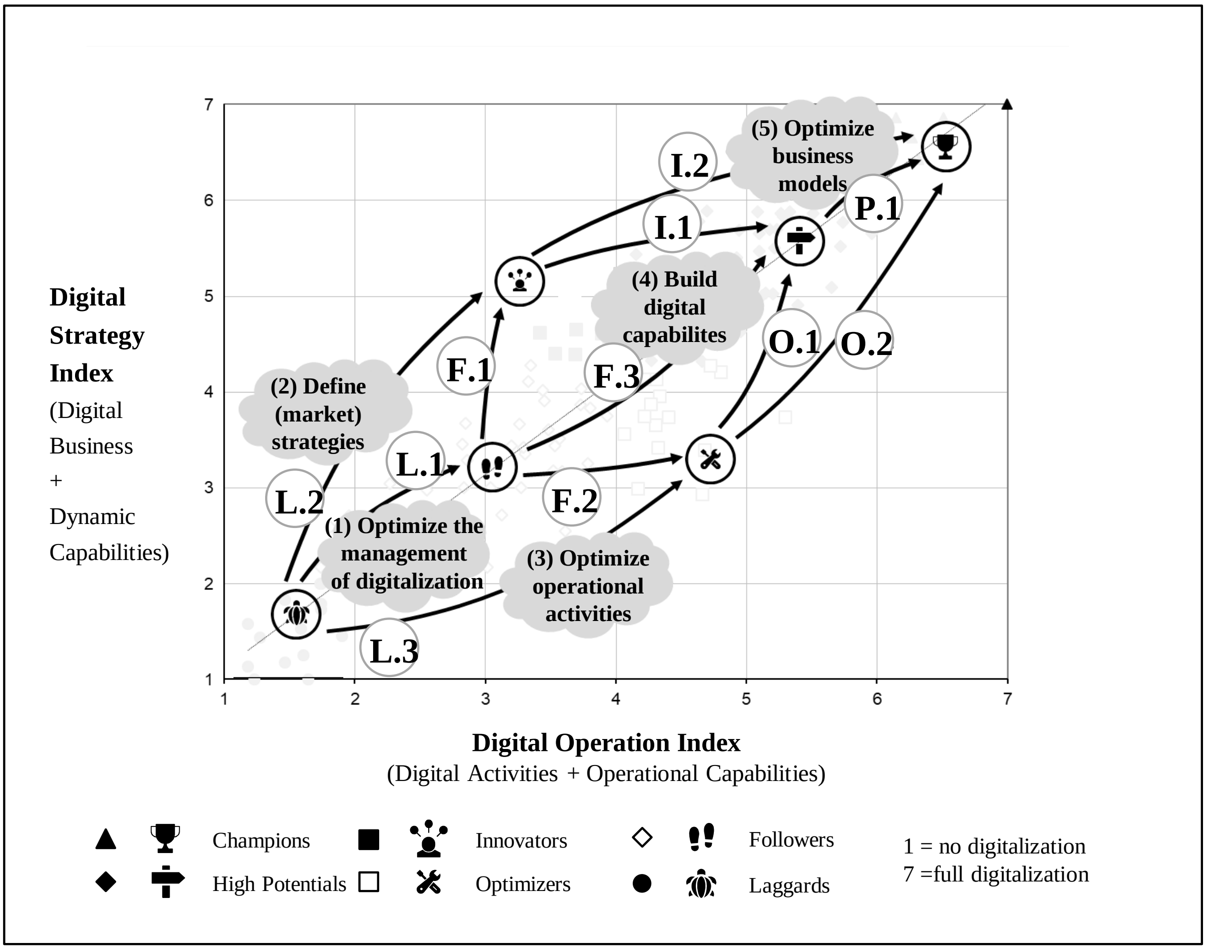

Fig. B-4: Paths of accelerating digital maturity (source: own compilation)

7. Conclusion

This study assessed the status quo of digital maturity in German traditional industries. The sample's average DMI of 3.91 (out of 7) indicates that responses to digital disruption need to be accelerated. Furthermore, EBIT potential has not yet been realized as this only appears after major upfront investments. The results indicate that responses to digitalization should begin simultaneously – with processes, products and services, business models, as well as capabilities. Cost reductions and revenue increases should be driven forward gradually, and digitalization can only be pushed as a whole – not through individual pilots. Responding to digital disruption in the traditional industries is, then, a comprehensive task.

The digital maturity paths distinguished in this study could help companies in these traditional industries to quickly tap into the opportunities of digitalization. This applies all the more given the COVID-19 pandemic and subsequent economic crisis, both of which have accelerated digitalization by pushing companies to realize both the importance of digitally linked value-added processes for suppliers and manufacturers and of digital business models for maintaining interactions with customers when the classic distribution is not an option.

The results may not be generalizable because they originate from German companies only. More participants should be added, from different countries and different industries, including an extension to other sectors enabling a more in-depth investigation of country-specific and industry-specific peculiarities. In addition, methods for structural analysis of multivariate data can be applied, e.g., constrained principal component analysis, to investigate the correlation of the maturity sub-indices based on size or industry classes and to analyze the underlying structure (e.g., factor structure) of sets of variables and simultaneously the interrelationships among those underlying structures [Hunter and Takane, 2002].

On this basis, a dynamic theory of digitalization could be developed, translating the sequence of actions along the path toward greater digital maturity (Fig. B-4) into a dynamic adaptation hypothesis [e.g., Porter (1991)], thereby describing the evolution of industry structures [cf. Menzel and Kammer (2019)].

Appendix

The Four Sub-Indices

(1) The Digital Activity Index comprises 13 items relating to the change of processes and technologies in pursuit of greater scope for coordination and interaction. This includes items for the implementation of new digital processes: (1) end-to-end supply chains; (2) R&D; (3) planning; (4) procurement; (5) production; (6) logistics; (7) ramp-up; and (8) customer orders (adapted to the value chain of Porter [1985]). In addition, the index is operationalized with items for the implementation of new technologies: (9) real-time data generation; (10) data analytics [Comuzzi and Patel (2016)]; (11) central integrated IT systems; (12) MES systems; and (13) PLM systems [Mantravadi and Møller (2019)].

(2) The Digital Business Index concerns the digitalization of products and services and business models. It comprises 11 items, adapted from Foss and Saebi [2017] and Johnson et al. [2008]: (1) increased share of digital products and services; (2) digital value proposition to customers; (3) flexibilization of product and service value architecture; (4) improvement of digital competitive advantage; (5) change of resource use; (6) increased interaction with other systems; and (7) changes in product and service architecture. The ecosystem-related items were operationalized through the adaptation of Adner [2017] and Valdez-de-Leon [2016]: (8)

ecosystem definition; (9) building of multilateral interactions; (10) creation of an overarching value-creating network; and (11) creation of a superordinate value proposition.

(3) The dynamic capability index captures the extent of companies' dynamic capabilities in times of digitalization. It is based on an operationalization by Teece [2007], consisting of the following items: (1) identification of new technologies; (2) surveillance of new technologies; (3) identification of new competitor technologies; (4) analysis of target market; (5) development of new customer solutions; (6) structured decision-making; (7) redefinition of the enterprise boundaries; (8) building of stakeholder loyalty; (9) knowledge management; (10) improvement of governance; (11) decentralization of new tasks; and (12) development of alliance capability.

(4) The operational capability index captures the digitalization of operational capabilities (on the individual and organizational levels). Hence, the following items are included: (1) number of digital talents [Teece (2018)]; (2) implementation of a clear digitalization roadmap; and (3) use of scorecards for digitalization [Hess et al. (2016)], as well as (4) a digital corporate culture and (5) support from top management [Hall [1993]).

Questionnaire Extract

Please give us your assessment of the following statement:

In times of digitalization…	I completely disagree 1	2	3	Partially 4	5	6	I completely agree 7
…the interaction of your company's services with other systems increased (e.g., infrastructure, customers, other companies).	○	○	○	○	○	○	○
…the service architecture of your company (product or service architecture) was changed.	○	○	○	○	○	○	○
… fixed circle of partners were defined with whom your company cooperates.	○	○	○	○	○	○	○
…your company entered into relationships with suppliers, cooperation partners, or customers that cannot be broken down into bilateral interactions.	○	○	○	○	○	○	○
…your company bindingly aligned to a cross-company value creation structure?	○	○	○	○	○	○	○
…an overarching customer solution was created in your company by combining multiple value propositions from different companies, which would not be possible without collaboration.	○	○	○	○	○	○	○
…the use of resources in your company (R&D and investment budget) changed.	○	○	○	○	○	○	○
…the competitive agility in your company changed.	○	○	○	○	○	○	○
…a more flexible configuration of the company's value architecture was created.	○	○	○	○	○	○	○
…the company's customer-specific approach was improved.	○	○	○	○	○	○	○
…the share of your company's digital services in total sales has increased.	○	○	○	○	○	○	○

In times of digitalization…	≤0%	1-5%	6-10%	11-15%	16-20%	21-25%	>25%
…the EBIT has improved of	○	○	○	○	○	○	○

Fig. B-5: Questions for the digital business index and EBIT impact (source: own compilation)

Derivation of Paths to Improve Digital Maturity

Improvement paths (examples of *digital laggards* and *digital followers*): the *followers'* current status quo is the values in the outer data circle. In parallel, they can be seen as target values of the *laggards*. The figure below lists the five largest differences between the two archetypes. Here, improvements in the digital-maturity level are particularly necessary. According to Fig. B-6, *digital laggards* must (1) change the product and service architecture; introduce (2) structured decision-making and (3) market analysis; (4) implement PLM technology; and (5) increase support from top management.

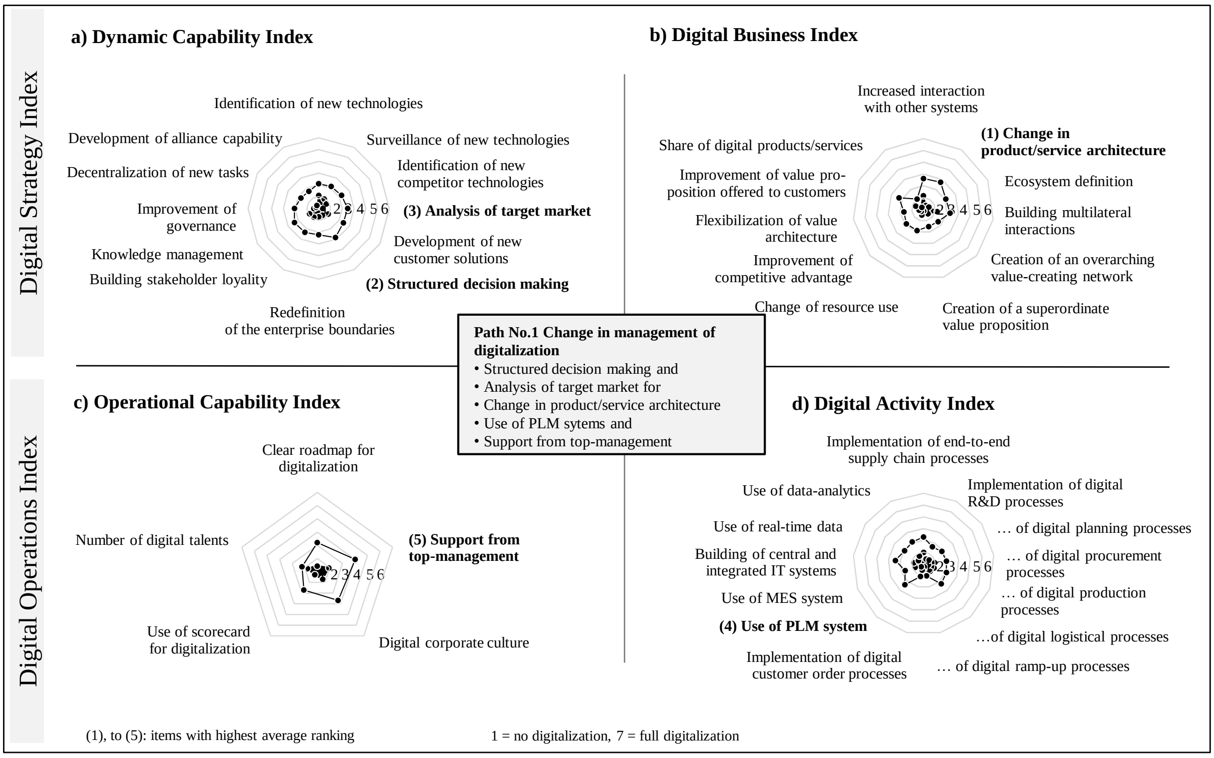

Fig. B-6: Paths from digital laggard to digital follower (source: own compilation)

References

Aaker, D.A. (2013). Strategic Market-Management. New York, John Wiley & Son.

Acciarini, C., Brunetta, F. and Boccardelli, P. (2021). Cognitive biases and decision-making strategies in times of change: a systematic literature review. Management Decision, 59, 3: 638-652. https://doi.org/10.1108/MD-07-2019-1006

Adner, R. (2017). Ecosystem as Structure: an actionable construct for strategy. Journal of Management, 43, 1: 39-58. https://doi.org/10.1177/0149206316678451

Agarwal, G.K., Magnusson, M. and Johanson, A. (2021). Edge AI driven technology advancements paving way towards new capabilities. International Journal of Innovation and Technology Management, 18, 1. https://doi.org/10.1142/S0219877020400052

Aggarwal, V.A., Posen, H.E. and Workiewicz, M. (2016). Adaptive capacity to technological change: A microfoundational approach. Strategic Management Journal, 38, 6: 1212-1231. http://dx.doi.org/10.2139/ssrn.2559226

Agostini, L. and Nosella, A. (2020). The adoption of Industry 4.0 technologies in SMEs: results of an international study. Management Decision, 58, 4: 625-643. 10.1108/MD-09-2018-0973

Apostolov, M. and Coco, N. (2021). Digitalization-Based Innovation – A Case Study Framework. International Journal of Innovation and Technology Management, 18, 5. https://doi.org/10.1142/S021987702050025X

Baden-Fuller, C. and Teece, D.J. (2020). Market sensing, dynamic capability, and competitive dynamics. Industrial Marketing Management, 89: 105-106. 10.1016/j.indmarman.2019.11.008

Balogun, J. and Hailey, V. H. (2008). Exploring strategic change. Pearson Education.

Bellantuono, N., Nuzzi, A., Pontrandolfo, P. and Scozzi, B. (2021). Digital transformation models for the I4. 0 transition: Lessons from the change management literature. Sustainability, 13, 23: 1-40. https://doi.org/10.3390/su132312941

Bennett, N., Lemoine, J. (2014). What VUCA really means for you. Business Horizons, 57, 1: 311-317. https://ssrn.com/abstract=2389563

Berghaus, S., Back, A. (2016). Stages in digital business transformation: results of an empirical maturity study. Mediterranean Conference on Information Systems Proceedings, 22. http://aisel.aisnet.org/mcis2016/22

Berman, S. and Marshall, A. (2014). The next digital transformation: from an individual-centered to an everyone-to-everyone economy. Strategy & Leadership, 42, 5: 9-17. 10.1108/SL-07-2014-0048

Birkinshaw, J., Zimmermann, A. and Raisch, S. (2016). How do firms adapt to discontinuous change? Bridging the dynamic capabilities and ambidexterity perspectives. California Management Review, 58, 4: 36-58. https://doi.org/10.1525/cmr.2016.58.4.36

Bonina, C., Koskinen, K., Eaton, B. and Gawer, A. (2021). Digital platforms for development: Foundations and research agenda. Information Systems Journal, 31, 6: 869-902. https://doi.org/10.1111/isj.12326

Bholowalia, P. and Kumar, A. (2014). EBK-Means: A Clustering Technique based on Elbow Method and K-Means in WSN. International Journal of Computer Applications, 105, 9: 17-24.

Brennen, J.S. and Kreiss, D. (2016). Digitalization. The international encyclopedia of communication theory and philosophy: 1-11. https://doi.org/10.1002/9781118766804.wbiect111

Buck, C., Marques, C. P., Rosemann, M. (2021). Eight Building Blocks for Managing Digital Transformation. International Journal of Innovation and Technology Management, 18, 5. https://doi.org/10.1142/S0219877021500231

Buer, S.V., Strandhagen, J.W., Semini, M. and Strandhagen, J.O. (2021). The digitalization of manufacturing: investigating the impact of production environment and company size. Journal of Manufacturing Technology Management, 32, 3: 621-645. https://doi.org/10.1108/JMTM-05-2019-0174

Bumann, J. and Peter, M.K. (2019). Action fields of digital transformation–a review and comparative analysis of digital transformation maturity models and frameworks. In: Verkuil, A. H., Hinkelmann, K., Aeschbacher, M. (eds.): Digitalisierung und andere Innovationsformen im Management. Basel, Edition Gesowip: pp. 13-40.

By, R. T. (2020). Organizational change and leadership: Out of the quagmire. Journal of Change Management, 20, 1: 1-6. https://doi.org/10.1080/14697017.2020.1716459

Canhoto, A. I., Quinton, S., Pera, R., Molinillo, S. and Simkin, L. (2021). Digital strategy aligning in SMEs: A dynamic capabilities perspective. The Journal of Strategic Information Systems, 30, 3: 101682. https://doi.org/10.1016/j.jsis.2021.101682

Carvalho, J.V., Rocha, Á and Abreu, A. (2017). Maturity models of healthcare information systems and technologies: a literature review. Journal of Medical Systems, 40, 6: 1-10. 10.1007/s10916-016-0486-5

Cleven, A.K., Winter, R., Wortmann, F. and Mettler, T. (2014). Process management in hospitals: an empirically grounded maturity model. Business Research, 7, 2: 191-216. https://doi.org/10.1007/s40685-014-0012-x

Chanias, S. and Hess, T. (2016). How digital are we? Maturity models for the assessment of a company's status in the digital transformation. Management Report Institut für Wirtschaftsinformatik und Neue Medien, 2016, 2: 1-14.

Cohen, J. (1992). Statistical power analysis. Current Directions in Psychological Science, 1, 3: 98-101. https://doi.org/10.1111/1467-8721.ep10768783

Colli, M., O. Madsen, Berger, U., Møller, C., Wæhrens, B.V. and Bockholt, M. (2018). Contextualizing the outcome of a maturity assessment for Industry 4.0. IFAC-PapersOnLine, 51, 11: 1347-1352. https://doi.org/10.1016/j.ifacol.2018.08.343

Comuzzi, M. and Patel, A. (2016). How organisations leverage big data: A maturity model. Industrial Management & Data Systems, 116, 8: 1468-1492. 10.1108/IMDS-12-2015-0495

Coreynen, W., Matthyssens, P. and Van Bockhaven, W. (2017). Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers. Industrial Marketing Management, 60: 42-53. 10.1016/j.indmarman.2016.04.012

Cozzolino, A. and Rothaermel, F.T. (2018). Discontinuities, competition, and cooperation: Coopetitive dynamics between incumbents and entrants. Journal of Strategic Management, 39, 12: 3053-3085. https://doi.org/10.1002/smj.2776

Davis, J.P., Eisenhardt, K.M. and Bingham, C.B. (2009). Optimal structure, market dynamism, and the strategy of simple rules. Administrative Science Quarterly, 54, 3: 413-452. https://doi.org/10.2189/asqu.2009.54.3.413

De Bruin, T., Freeze, R., Kaulkarni, U. and Rosemann, M. (2005). Understanding the main phases of developing a maturity assessment model. Proceedings of the 16th Australasian Conference on Information Systems, Sydney, Australia: 1-10. https://aisel.aisnet.org/acis2005/109

De Toni, D., Milan, G.S., Saciloto, E. and Larentis, F. (2017). Pricing strategies and levels and their impact on corporate profitability. Revista de Administração, 52, 120-133. 10.1016/j.rausp.2016.12.004.

Dikmen, M., Burns, C. (2017). Trust in autonomous vehicles: The case of Tesla Autopilot and Summon. IEEE International Conference on Systems, Man, and Cybernetics (SMC): 1093-1098. 10.1109/SMC.2017.8122757

Dutta, G., Kumar, R., Sindhwani, R. and Singh, R.K. (2020): Digital transformation priorities of India’s discrete manufacturing SMEs–a conceptual study in perspective of Industry 4.0. Competitiveness Review: An International Business Journal, 30, 3: 289-314. 10.1108/CR-03-2019-0031

Eggers, J.P. and Kaplan, S. (2009). Cognition and renewal: Comparing CEO and organizational effects on incumbent adaptation to technical change. Organization Science, 20, 2: 461-477. https://doi.org/10.1287/orsc.1080.0401

El Sawy, O.A. and Pereira, F. (2013). Digital business models: Review and synthesis, Business modeling in the dynamic digital space, eds. O.E. El Sawy, F. Pereira SpringerBriefs in Digital Spaces: 13-20.

Evans, N.D. (2016). Future skills. ITNOW, 58, 1: 50-51. https://doi.org/10.1093/itnow/bww022

Farrell, M., and Gallagher, R. (2015). The valuation implications of enterprise risk management maturity. Journal of Risk and Insurance, 82, 3: 625-657. https://doi.org/10.1111/jori.12035

Fitzgerald, M., Kruschwitz, N., Bonnet, D. and Welch, M. (2014). Embracing digital technology: A new strategic imperative. MIT Sloan Management Review, 55, 2: 1-13.

Foss, N.J. and Saebi, T. (2017). Fifteen years of research on business model innovation: How far have we come, and where should we go? Journal of Management, 43, 1: 200-227. https://doi.org/10.1177/0149206316675927

Gartner Glossary (2018). Digitalization. Available at https://www.gartner.com/it-glossary/digitalization [Accessed 10 March 2022]

Gawer, A. (2014). Bridging different perspectives on technological platforms: Towards an integrative framework. Research Policy, 43, 7: 1239-1249. https://doi.org/10.1016/j.respol.2014.03.006

Ghosh, S., Hughes, M., Hodgkinson, I. and Hughes, P. (2022). Digital transformation of industrial businesses: A dynamic capability approach. Technovation, 113. https://doi.org/10.1016/j.technovation.2021.102414

Gimpel, H., Hosseini, S., Huber, R.X.R., Probst, L., Röglinger, M. and Faisst, U. (2018). Structuring Digital Transformation: A Framework of Action Fields and its Application at ZEISS. Journal of Information Technology Theory and Application, 19, 1: p. 3.

Gold, A. H., Malhotra, A. and Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. Journal of management information systems, 18, 1: 185-214. https://doi.org/10.1080/07421222.2001.11045669

Goldstein, D.B. and Eley, C. (2014). A classification of building energy performance indices. Energy Efficiency, 7: 353-375. https://doi.org/10.1007/s12053-013-9248-0

Grant, R.M. and Verona, G. (2015). What's holding back empirical research into organizational capabilities? Remedies for common problems. Strategic Organization, 13, 1: 61-74. https://doi.org/10.1177/1476127014565988

Grooss, O. F., Presser, M. and Tambo, T. (2022). Balancing Digital Maturity and Operational Performance-Progressing in a Low-digital SME Manufacturing Setting. Procedia Computer Science, 200, 495-504. https://doi.org/10.1016/j.procs.2022.01.247

Grover, V., Tseng, S.L. and Pu, W. (2022). A theoretical perspective on organizational culture and digitalization. Information & Management, 59, 4. https://doi.org/10.1016/j.im.2022.103639.

Gudergan, G., Mugge, P., Kwiatkowski, A., Abbu, H., Michaelis, T.L. and Krechting, D. (2019). Patterns of digitization - What differentiates digitally mature organizations? In IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), Valbonne Sophia-Antipolis, France: 1-8. https://doi.org/10.1080/08956308.2020.1707003

Guenzi, P. and Habel, J. (2020). Mastering the Digital Transformation of Sales. California Management Review, 62, 4: 57-85. https://doi.org/10.1177/0008125620931857

Gulot, G., Orzes, G., Sartor, M. and Nassimbeni, G. (2020). The future of manufacturing: A Delphi-based scenario analysis on industry 4.0. Technological Forecasting & Social Change, 157. https://doi.org/10.1016/j.techfore.2020.120092

Gürdür, D., El-Khoury, J., Törngren, M. (2019). Digitalizing Swedish industry: What is next?: Data analytics readiness assessment of Swedish industry, according to survey results. Computers in Industry, 105: 153-163. https://doi.org/10.1016/j.compind.2018.12.011

Hagiu, A. and Wright, J. (2015). Multi-sided platforms. International Journal of Industrial Organization, 43, 1: 162-174. http://dx.doi.org/10.2139/ssrn.2794582

Hall, R. (1993). A framework linking intangible resources and capabilities to sustainable competitive advantage. Strategic Management Journal, 14, 8: 607-618. https://doi.org/10.1002/smj.4250140804

Hamel, G. and Valikangas, I.L. (2003). The quest for resilience. Harvard Business Review, 81, 9: 52-63.

Hebbert, L. (2017). Digital Transformation: Build your Organization's Future for the In-

Novation. London, Bloomsbury Publishing Plc.

Helfat, C.E. and Peteraf, M.A. (2003). Thy dynamic resource-based view: capability lifecycles. Strategic Management Journal, 24, 10: 997-1010. https://doi.org/10.1002/smj.332

Hess, T., Matt, C., Benlian, A. and Wiesböck, F. (2016). Options for formulating a digital transformation strategy. Management Information Systems Quarterly Executive, 15, 2. 10.7892/BORIS.105447

Hinterhuber, A. (2022). Digital transformation, the Holy Grail, and the disruption of business models: An interview with Michael Nilles. Business Horizons, 65, 3: 261-265. 10.1016/j.bushor.2021.02.042

Jacobides, M.G, Cennamo, C. and Gawer, A. (2018). Towards a theory of ecosystems", Strategic Management Journal, 39, 8: 2255-2276. 10.1002/smj.2904

Johnson, M., Christensen, C. and Kargermann, H. (2008). Reinventing your business model. Harvard Business Review, 86, 12: 50-59.

Jovanović, B., and Filipović, J. (2016). ISO 50001 standard-based energy management maturity model–proposal and validation in industry. Journal of Cleaner Production, 112: 2744-2755. https://doi.org/10.1016/j.jclepro.2015.10.023

Kamalaldin, A., Linde, L., Sjödin, D. and Parida, V. (2020). Transforming provider-customer relationships in digital servitization: A relational view on digitalization. Industrial Marketing Management, 89: 306-325. https://doi.org/10.1016/j.indmarman.2020.02.004

Kapoor, R. (2018). Ecosystems: broadening the locus of value creation. Journal of Organization Design, 7, 1: 1-16. 10.1186/s41469-018-0035-4

Kapoor, R., Bigdeli, A.Z., Dwivedi, Y.K., Schroeder, A., Beltagui, A. and Baines, T. (2021). A socio-technical view of platform ecosystems: Systematic review and research agenda. Journal of Business Research, 128: 94-108. 10.1016/j.jbusres.2021.01.060

Kiron, D., Kane, G.C., Palmer, D., Phillips, A.N. and Buckley, N. (2016). Aligning the organization for its digital future. MIT Sloan Management Review, 58, 1.

Knobbe, F., and Proff, H. (2020). Digitalization and dynamic capabilities in the automotive industry Measuring discontinuous change abilities of automotive suppliers. International Journal of Automotive Technology and Management, 20, 4: 436-456.

Koch, T., and Windsperger, J. (2017). Seeing through the network: Competitive advantage in the digital economy. Journal of Organization Design, 6, 6: 1-30. https://doi.org/10.1186/s41469-017-0016-z

Konlechner, S., Müller, B. and Güttel, W.H. (2018). A dynamic capabilities perspective on managing technological change: A review, framework and research agenda. International Journal of Technology Management, 76, (3-4): 188-213.

Kromann, L., Malchow-Møller, N., Skaksen, J.R. and Sørensen, A. (2020). Automation and productivity - A cross-country, cross-industry comparison. Industrial and Corporate Change, 29, 2: 265-287. https://doi.org/10.1093/icc/dtz039

Kumar, V., Vrat, P. and Shankar, R. (2021). A Graph-Theoretic Approach to Evaluate the Intensity of Barriers in the Implementation of Industry 4.0. International Journal of Innovation and Technology Management, 18, 8. https://doi.org/10.1142/S0219877021500395

Lahrmann, G., Marx, F., Mettler, T., Winter, R. and Wortmann, F. (2011). Inductive Design of Maturity Models: Applying the Rasch Algorithm for Design Science Research. In Service-Oriented Perspectives in Design Science Research. DESRIST 2011, Lecture Notes in Computer Science, eds. Jain, H., Sinha, A.P. and Vitharana, P., Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-20633-7_13

Lardo, A., Mancini, D., Paoloni, N. and Russo, G. (2020). The perspective of capability providers in creating a sustainable I4.0 environment. Management Decision, 58, 8: 1759-1777. https://doi.org/10.1108/MD-09-2019-1333

Lasrado, L.A., Vatrapu, R. and Andersen, K.N. (2015). Maturity models development in is research: a literature review. IRIS Selected Papers of the Information Systems Research Seminar in Scandinavia, 6, 6: New York: IRIS. https://aisel.aisnet.org/iris2015/6

Lavie, D. (2006). Capability reconfiguration: An analysis of incumbent responses to technological change. Academy of Management Review, 31, 1: 153-174. https://doi.org/10.2307/20159190

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Draws, P., Mädche, A., Urbach, N. and Ahlemann, F. (2017). Digitalization: Opportunity and challenge for the business and information system engineering community. Business Information System Engineering, 59, 4: 301-308. 10.1007/s12599-017-0484-2

Lenka, S., Parida, V. and Wincent, J. (2016). Digitalization Capabilities as Enablers of Value Co-Creation in Servitizing Firms. Psychology & Marketing, 34, 1: 92-100. 10.1002/mar.20975

Li, He; Zhang, Chen; and Kettinger, William J. (2022). Digital Platform Ecosystem Dynamics: The Roles of Product Scope, Innovation, and Collaborative Network Centrality. Management Information Systems Quarterly, 46, 2: 739-770.

Liu, Z., Shi, Y.; Yang, B. (2022). Open Innovation in Times of Crisis: An Overview of the Healthcare Sector in Response to the COVID-19 Pandemic. Journal of Open Innovation Technology, Market, and Complexity, 8, 21: 1-15.

Lu, Y., Liu, C., Wang, K.I.-K., Huang, H. and Xu, X. (2020). Digital Twin-driven smart manufacturing: Connotation, reference model, applications and research issues. Robotics and Computer-Integrated Manufacturing, 61: 1-14. 10.1016/j.rcim.2019.101837

Luftman, J. (2003). Assessing IT/business alignment. Information Systems Management, 20, 4: 9-15. https://doi.org/10.1201/1078/43647.20.4.20030901/77287.2

Lynch, R. (2019). Towards an Innovation Link between Dynamic Capabilities and Sustainability Strategy: Options for Emerging Market Companies. International Journal of Innovation and Technology Management, 16, 4. https://doi.org/10.1142/S0219877019400030

Macchi, M., and Fumagalli, L. (2013). A maintenance maturity assessment method for the manufacturing industry. Journal of Quality in Maintenance Engineering, 19, 3: 295-315. 10.1108/JQME-05-2013-0027

Machin, S. and Van Reenen, J. (1993). Profit Margins and the Business Cycle: Evidence from UK Manufacturing Firms. The Journal of Industrial Economics, 41, 1: 29-50.

Mack O., and Khare, A. (2016). Perspectives on a VUCA World. In Managing in a VUCA World, eds. O. Mack, A. Khare, A. Krämer, T. Burgartz Springer, Cham: 3-19.

Makadok, R. (2001). Toward a synthesis of the resource-based and dynamic capability views of rent creation. Strategic Management Journal, 22, 5: 387-401. https://doi.org/10.1002/smj.158

Mantravadi, S. and Møller, C. (2019). An overview of next-generation manufacturing execution systems: how important is MES for industry 4.0. Procedia manufacturing, 30: 588-595. https://doi.org/10.1016/j.promfg.2019.02.083

Menzel, M.-P. and Kammer, J. (2019). Industry evolution in varieties of capitalism: A comparison of the Danish and US Turbine industries. Industrial and Corporate Change, 28: 6: 1381-1403. 10.1093/icc/dtz022

Mettler, T. (2011). Maturity assessment models: a design science research approach. International Journal of Society Systems Science, 3, 1-2: 81-98. 10.1504/IJSSS.2011.038934

Mettler, T. and Pinto, R. (2018). Evolutionary paths and influencing factors towards digital maturity: An analysis of the status quo in Swiss hospitals. Technological Forecasting and Social Change, 133: 104-117. 10.1016/j.techfore.2018.03.009

Miles, J. (2005). R-squared, adjusted R-squared. Encyclopedia of Statistics in Behavioral Science. https://doi.org/10.1002/0470013192.bsa526

Mitchell, D. and Coles, C. (2003). The ultimate competitive advantage of continuing business model innovation. Journal of Business Strategy, 24, 5: 15-22. https://doi.org/10.1108/02756660310504924

Murtagh, F. and Legendre, P. (2014). Ward's hierarchical agglomerative clustering method: which algorithms implement Ward's criterion? Journal of classification, 31, 3: 274-295. https://doi.org/10.1007/s00357-014-9161-z

Nabhani, F., Uhl, C., Kauf, F. and Shokri, A. (2018). Supply chain process optimisation via the management of variance. Journal of Management Analytics, 5, 2: 136-153. 10.1080/23270012.2018.1424571

Nielsen, A.P. (2006). Understanding dynamic capabilities through knowledge management. Journal of Knowledge Management, 10, 4: 59-71. 10.1108/13673270610679363

Oberländer, A. M., Röglinger, M. and Rosemann, M. (2021). Digital opportunities for incumbents–A resource-centric perspective. The Journal of Strategic Information Systems, 30, 3: 101670. https://doi.org/10.1016/j.jsis.2021.101670

Parida, V., Sjödin, D., Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. Sustainability, 11, 2: 391. https://doi.org/10.3390/su11020391

Paulk, M. C., Curtis, B., Chrissis, M.B. and Weber, C.V. (1993). Capability maturity model, version 1.1. IEEE Software, 10, 4: 18-27. 10.1109/52.219617

Pearse, N.J. (2017). Change Management in a VUCA World. In Visionary Leadership in a Turbulent World, eds. Elkington, R., Steege, M.V.D., Glick-Smith, J. and Breen, J.M., Emerald Publishing Limited, Bingley: 81-105. https://doi.org/10.1108/978-1-78714-242-820171005

Perez, C. (2010). Technological revolutions and techno-economic paradigms. Cambridge Journal of Economics, 34, 1: 185-202. https://doi.org/10.1093/cje/bep051

Pöppelbuß, J. and Röglinger, M. (2011). What makes a useful maturity model? a framework of general design principles for maturity models and its demonstration in business process management. In Proceedings of the 19th European Conference on Information Systems, Helsinki, Finland: 1-12.

Porter, M.E. (1985). Competitive advantage. Creating and sustaining superior performance, New York, Free Press.

Porter, M.E. (1991). Towards a dynamic theory of strategy. Strategic Management Journal, 12: 95-117. https://doi.org/10.1002/smj.4250121008

Porter, M.E. and Heppelmann, J.E. (2014). How smart, connected products are transforming competition. Harvard Business Review, 92, 11: 64-88.

Prananto, A., McKay, J. and Marshall, P. (2003). A study of the progression of e-business maturity in Australian SMEs: Some evidence of the applicability of the stages of growth for e-business model. In PACIS 2003 Proceedings, p. 5.

Proksch, D., Rosin, A. F., Stubner, S. and Pinkwart, A. (2021). The influence of a digital strategy on the digitalization of new ventures: The mediating effect of digital capabilities and a digital culture. Journal of Small Business Management: 1-29.

Rahmati, P., Tafti, A., Westland, J.C. and Hidalgo, C. (2021). When all products are digital: Complexity and intangible value in the ecosystem of digitizing firms. Management Information Systems Quarterly, 45, 3: 1025-1058. 10.25300/MISQ/2021/15384

Reis J., Amorim, M., Melão, N. and Matos, P. (2018). Digital Transformation: A Literature Review and Guidelines for Future Research. In Trends and Advances in Information Systems and Technologies. WorldCIST'18 2018. Advances in Intelligent Systems and Computing, 745.10.1007/978-3-319-77703-0_41

Remane, G., Hanelt, A., Wiesboeck, F. and Kolbe, L.M. (2017). Digital Maturity in Traditional industries - an Exploratory Analysis. In European Conference on Information Systems, p. 10.

Ritter, T. and Pedersen, C.L. (2020). Digitization capability and the digitalization of business models in business-to-business firms: Past, present, and future. Industrial Marketing Management, 86: 180-190. https://doi.org/10.1016/j.indmarman.2019.11.019

Rogers, D.L. (2016). The digital transformation playbook. Rethink your business for the digital age. New York, Columbia University Press.

Romesburg, H.C. (2004). Cluster Analysis for Researchers, North Carolina, Lulu Press.

Rossmann, A. (2018). Digital maturity: Conceptualization and measurement model. In 39th International Conference on Information Systems (ICIS 2018): 13-16.

Saputra, N., Sasanti, N., Alamsjah, F. and Sadeli, F. (2022). Strategic role of digital capability on business agility during COVID-19 era. Procedia Computer Science, 197: 326-335. https://doi.org/10.1016/j.procs.2021.12.147

Schallmo D.R.A., Lang, K., Hasler, D., Ehmig-Klassen, K., Williams, C.A. (2021). An Approach for a Digital Maturity Model for SMEs Based on Their Requirements. Digitalization. Management for Professionals, eds. D.R.A. Schallmo and J. Tidd Springer, Cham. 10.1007/978-3-030-69380-0_6

Schallmo D.R.A. and Williams, C.A. (2018). History of Digital Transformation. In Digital Transformation Now!, eds. D.R.A. Schallmo, C.A. Williams, Springer, Cham. 10.1007/978-3-319-72844-5

Schmitt, N. (1996). Uses and abuses of coefficient alpha. Psychological Assessment, 8, 4: 350–353. https://doi.org/10.1037/1040-3590.8.4.350

Sengupta, A., Lalwani, S., Goswami, S. and Srivastava, P. (2021). Reinventing HR functions with SMAC technologies-an exploratory study. Materials Today: Proceedings, 46, 10169-10174. https://doi.org/10.1016/j.matpr.2020.10.875

Singh, A. and Hess, T. (2017). How chief digital officers promote the digital transformation of their companies. Management Information Systems Quarterly Executive, 16, 1.

Solar, M., Sabattin, J. and Parada, V. (2013). A Maturity Model for Assessing the Use of ICT in School Education. Educational Technology & Society, 1, 1: 206-218. https://www.jstor.org/stable/jeductechsoci.16.1.206

Stark, J. (2020). Product Lifecycle Management (PLM). In Product Lifecycle Management, Springer, Cham.

Stockemer, D. (2018). Quantitative Methods for the Social Sciences: A Practical Introduction with Examples in SPSS and Stata, Springer. 10.1007/978-3-319-99118-4

Stolfa, J., Stolfa, S., Baio, C., Doleisi, P., Brugnoli, F. and Messnarz, R. (2019). DRIVES - EU blueprint project for the automotive sector - A literature review of drivers of change in automotive industry. Journal of Software: Evolution and Process, 32, 3: 1-16. https://doi.org/10.1002/smr.2222

Szekely, G.J. and Rizzo, M.L. (2005). Hierarchical clustering via joint between-within distances: Extending Ward’s minimum variance method. Journal of Classification, 22, 2: 151-184. https://doi.org/10.1007/s00357-005-0012-9

Takane, Y. and Hunter, M. A. (2001). Constrained principal component analysis: a comprehensive theory. Applicable Algebra in Engineering, Communication and Computing, 12, 5: 391-419.

Teece, D.J., Pisano, G. and Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 18, 7: 509-533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Teece, D.J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable)enterprise performance. Strategic Management Journal, 28, 13: 1319-1350. https://doi.org/10.1002/smj.640

Teece, D.J. (2014). The foundations of enterprise performance: Dynamic and ordinary capabilities in an (economic) theory of firms. Academy of Management Perspectives, 28, 4: 328-352. https://www.jstor.org/stable/43822373

Teece, D.J. (2018). Dynamic capabilities as (workable) management system theory. Journal of Management & Organization, 24, 3: 359-368. https://doi.org/10.1017/jmo.2017.75

Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. Acta universitatis agriculturae et silviculturae mendelianae brunensis, 67, 6: 1673-1687. 10.11118/actaun201967061673

Thordsen, T., Murawski, M. and Bick, M. (2020). How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models. In 19th IFIP WG 6.11 Conference on e-Business, e-Services, and e-Society, I3E 2020 Proceedings, Part I 12066): 358–369. 10.1007/978-3-030-44999-5_30

Tumbas, S., Berente, N. and vom Brocke, J. (2017). Three types of Chief Digital Officers and the reasons organizations adopt the role. Management Information Systems Quarterly Executive, 16, 2: 121-124. 10.22034/jhrs.2021.130495

Valdez-de-Leon, O. (2016). A digital maturity model for telecommunications service providers. Technology Innovation Management Review, 6, 8: 19-32. http://doi.org/10.22215/timreview/1008

Vaz, C.R., Selig, P.M. and Viegas, C.V. (2019). A proposal of intellectual capital maturity model (ICMM) evaluation. Journal of Intellectual Capital, 20, 2: 208-233. https://doi.org/10.1108/JIC-12-2016-0130

Wang, J., Xu, C., Zhang, Z. and Zhong, R. (2021). Big data analytics for intelligent manufacturing systems: A review. Journal of Manufacturing Systems, 62: 738-752. 10.1016/j.jmsy.2021.03.005

Webster, J. and Watson, R.T. (2002). Analyzing the past to prepare for the future: Writing a literature review. Management Information Systems Quarterly, 26, 2: 13-23. https://www.jstor.org/stable/4132319

Williamson, O.E. (1975). Markets and hierarchies, New York, Free Press. https://ssrn.com/abstract=1496220

Winter, S.G. (2003). Understanding dynamic capabilities. Strategic Management Journal. 24, 10: 991-995. https://doi.org/10.1002/smj.318

Yoo, Y., Boland, R.J., Lyytinen, K.Jr. and Majchrzak, A. (2012). Organizing for innovation in the digitized world. Organizational Science, 23, 5: 1398-1408. 10.1287/orsc.1120.0771

Zatta, D. and Kolisch, R. (2014). Profit impact of revenue management in the process industry. Journal of Revenue and Pricing Management, 13, 6: 483-507.

Zhang, Y., Westerweel, B., Basten, R. and Song, J. S. (2022). Distributed 3d printing of spare parts via ip licensing. Manufacturing & Service Operations Management. https://doi.org/10.1287/msom.2022.1117

Zollo, M. and Winter, S.G. (2002). Deliberate learning and the evolution of dynamic capabilities. Organization Science, 13, 3: 339-351. 10.1287/orsc.13.3.339.2780

Chapter C: Assessing the Impact of Digitalization on Operational Capabilities

Published in International Journal of Business Strategy, Vol. 21, Issue 1, pp. 5-24

Stefan Sommer
University of Duisburg-Essen (Germany)
stefan.sommer@uni-due.de
Lotharstraße 1, 47057 Duisburg, Germany

Abstract

In traditional management thinking, operational capabilities require to be based on valuable resources that have only limited substitutability and imitability. With digitalization, new company networks emerge and the individual network partners' operational capabilities are incorporated into the network and difficult to protect. How to capture the impact of digitalization on the requirements for these operational capabilities and how to explain the sustainable advantageousness of these capabilities are analyzed and empirically examined in a sample of 200 industrial companies. The analysis shows that more openness for value co-creation in networks is needed that can be economically sustainable within the network.

Keywords: Digitalization; operational capabilities; VRIN; environmental dynamics; transaction costs; ecosystems

1. Introduction

For creating a competitive advantage, companies need operational capabilities (Helfat/Winter, 2011 and similarly Teece, 2014), which require to be based on valuable resources that have only limited substitutability and imitability (Barney, 1991; Theeke/Lee, 2017) and can be adjusted by learning (Argyris/Schön, 1978) to the environmental dynamics (Reed/DeFilippi, 1990; Sanchez/Heene, 1997; Karna et al., 2015). The Digitalization is a technological change that not only enables and drives improvement and innovation in processes, products and services, and business models (e.g., Li et al., 2018) but also influences these operational capabilities (Lenka et al., 2016; Nasiri et al., 2020) and consequently, the requirements for them are influenced as well.

For example, because of digitalization companies are enabled to collaborate in innovative networks via platforms (e.g., Hagiu/Wright, 2015), i.e., in ecosystems (Adner, 2017, also Jacobides et al., 2018; Hannah/Eisenhardt, 2018). On the one hand, therefore, there is a better exchange between network partners (e.g., Spulber, 2018) and a common value-creating resource position can be created (Nalebuff/Brandenburger, 1997; Feldmann, 2002); on the other hand, however, the individual network partners' operational capabilities are incorporated into the network (Sheng et al., 2013) and are virtually impossible to protect (limited substitutability and imitability is at risk; Karhu et al., 2018).

Extant literature has discussed required resources and capabilities as enablers of digitalization (Cha et al., 2015; Li et al., 2018), focuses on sharing capabilities on digital platforms (Mueller et al., 2010) or the emergence of capabilities in Ecosystems (Ceccagnoli et al., 2012). But prior studies have not taken into account the conflicting effects of digitalization on operational capabilities, especially when it comes to their advantageousness. Therefore, this article attempts to capture the impact of digitalization on the requirements for these capabilities and to explain the sustainable competitive advantages and thus also the advantageousness of these capabilities.

An initial literature review will cover digitalization and its economic effects as well as operational capabilities and the requirements for them (Section 2). On this basis, hypotheses on the effects of digitalization on operational capabilities will be set up in Section 3, starting with effects on the requirements for operational capabilities, and deduced from these, effects on the advantageousness of these capabilities. The hypotheses will be verified in Section 4 at 200 German industrial companies. The article concludes with a discussion of the results and implications, limitations and an outlook on the need for further research.

2. Literature review

2.1 Digitalization and its Economic Effects

Digitalization enables the gathering, storage, analysis and transfer of large data volumes that are summarized under the term SMAC technologies: Social Media, Mobile Devices, Analytics and Cloud Computing (Peppard/Ward, 2016; Legner et al., 2017) and can therefore not only improve but also radically change business processes, products and services as well as business models (Knobbe/Proff, 2020).

Regarding its economic effects, digitalization initially causes discontinuous changes (cf. Tushman/Anderson, 1986; Kane et al., 2016) in particular in capital-intensive sectors such as the automotive industry (cf. Donada/Attias, 2015) and changes the market and/or environmental dynamics (Knobbe/Proff, 2020). It will no longer remain stable over time, (continuity or stability of environmental dynamics), but is interrupted by discontinuous change ("discontinuity" [Nadler/Tushman, 1989, p. 196] or "instability" [Klein, 1977, p. 9] in the environmental dynamics, frequently as a one-time occurrence. Digitalization causes long-term, discontinuous changes, which lead to new basic technologies over a protracted period (Kane et al., 2016).

Digitalization also enables and drives the standardisation of interfaces between individual business activities along Porter's (1985) value chain in the traditional business. It thus allows a reduction in the restrictive mutual interdependencies among the primary activities of manufacturing, logistics and distribution and the sequential interdependencies with supporting activities, particularly procurement and R&D (Cyert/March, 1963; Wang et al., 2016). These activities can therefore be uncoupled, and the decision-making units can take partial decisions independently (Sturgeon, 2019). That saves time and reduces the transaction costs of internal coordination (cf. Hagiu/Wright, 2015) and also of external coordination in the traditional business (Williamson, 1985; Banalieva/Dhanaraj, 2019).

Digitalization simultaneously creates interfaces between companies in the form of technical platforms, across which more than two market players can interact stably, and therefore increases these players' interaction (Gawer/Cusumano, 2014). Increased collaboration can lead to smart customer solutions and innovative business models which in many cases cannot be provided by one market player alone. This is explained by the theory of two- or multi-sided markets. According to this theory the dense interaction of complementary market partners, each representing their interests on platforms (Hagiu/Wright, 2015, p. 163), creates positive effects in intra-organizational networks, in that the overall benefit in the network is greater than the sum of the individual benefits (Gawer/Cusumano, 2014). This creation of economic benefits is referred to as complementarity (Jacobides et al., 2018; Hannah/Eisenhardt 2018). The benefits arise in special networks, so-called ecosystems (Adner, 2017, Jacobides et al., 2018, Garcia-Martinez et al., 2018), in which a fixed circle of partners in a multilateral relationship is aligned to a cross-company value creation network in order to create a higher value proposition. These benefits are described by value creation in cooperation with the network partners ("value co-creation"; e.g., Vargo/Lusch, 2008) and by the appropriation of value in competition ("value capture"; Gans/Ryall, 2017), and are explained by biform games (e.g., Nalebuff/Brandenburger, 1997).

2.2 Requirements for Operational Capabilities in Strategic Management

According to the competence-based view, operational capabilities (Helfat/Winter, 2011) or ordinary capabilities (e.g., Teece, 2014) are the basis of competitive advantages. The concept of capability is not clearly defined in the literature. For Helfat/Peteraf (2003), it includes all "organizational capabilities", i.e., those "to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result". According to Helfat/Winter (2011), companies are enabled by their operational capabilities "to perform an activity on an on-going basis using more or less the same techniques on the same scale to support existing products and services for the customer population" (p. 1244). These operational capabilities are also understood as resources which create competitive advantages (e.g., Teece, 2014, p. 329). According to the resource-based view in strategic management, these resources are distributed unequally among companies and, if properly used, can therefore generate special rents from existing resources and from efficiency (Barney, 1991; Peteraf, 1993).

According to Barney (1991), "VRIN" resources create competitive advantages if they

- are "**v**aluable" and "**r**are" and therefore create value in the market and
- are "**i**mperfectly imitable" and "**n**on-substitutable ".

Limited substitutability and imitability cause "causal ambiguity" (Reed/deFilipi, 1990) as a lack of clarity about the presumed causal relationship between resource input and offerings to the customers through specific, complex and tacit resources. Specific resources create less value in a next-best use outside the company according to transaction cost theory (Williamson, 1985), complex resources make it impossible to adopt individual components in isolation (e.g., Dierickx/Cool, 1989, p. 1508) and tacit resources cannot be imitated by reverse engineering (Nelson/Winter, 1982). In addition, operational capabilities also have to

- be adjusted to environmental dynamics by organizational learning (e.g., Argyris/Schön, 1978) (cf. Sanchez/Heene, 1997; Proff, 2005) to secure long-term competitive advantages (Lim et al., 2018).

Value creation in the market, limited substitutability and imitability (through specificity, complexity, and tacitness), and adjustment with the environmental dynamics are therefore the key requirements for operational capabilities.

Digitalization causes falling internal and external transaction costs and a simpler cross-company exchange via platforms, but this conflicts with some requirements for advantageous resources. That should now be examined more closely.

3. Hypotheses Development

Hypotheses are now derived here on the effects of digitalization on the requirements for operational capabilities (Section 3.1) and, moreover, on the advantages of these capabilities (Section 3.2). The derived hypotheses are then empirically tested in Section 4.

3.1 Effects of Digitalization on the Requirements for Operational Capabilities

(1) Effects of the Instability of Environmental Dynamics during Digitalization

The discontinuous changes caused by digitalization (Kane et al., 2016) increase the instability of the environmental dynamics (Davis et al., 2009; see section 2.1). Such discontinuities create information deficits and consequently uncertainty (Hoppmann et al., 2016), jeopardizing the operational capabilities (Tushman/Anderson, 1986). The discontinuous technological changes alter customers' wishes (Kamalaldin et al., 2020) which can no longer be fulfilled with the existing resource position (Lenka et al., 2016). Due to this, environmental dynamics even the capital-intensive industries with less strong and frequent changes now also have to react to the increased instability of the environmental dynamics with very marked deutero learning (Argyris/Schön, 1978, Andersen, 2016) to adapt the existing resource position to the environmental dynamics. The following hypothesis can thus be advanced:

H1a: The higher the instability of the environmental dynamics during digitalization, the lower is the value created by the resource position in the market.

H1b: The greater the instability in the environmental dynamics caused by digitalization, the stronger is the adjustment of the resource position to the environmental dynamics

(2) Effects of the falling transaction costs of internal and external coordination during digitalization

In times of digitalization, the transaction costs of internal coordination fall (cf. Section 2.1) andvalue-adding activities can be rearranged and linked to form modular value adding systems (Koch/Windsperger, 2017, p. 22). Digitalization, therefore, reduces the complexity of the resource position (Ethiraj/Levinthal, 2004). With decreasing complexity of the resource position, its substitutability and imitability increase (see Section 2.2), because due to digitalization interrelationships between the deployment of resources and (partially) modularized goods and services become more transparent (Bennis, 2013) and are easier for external parties to understand (Pil/Cohen, 2006, p. 999) and copy (Kamasak, 2017, p. 256). Also, transaction costs of external coordination with suppliers and cooperation partners are falling (see section 2.2). Thereby knowledge can be transferred more effectively (Sheng et al., 2013, p. 465) and handled more easily (Cowan et al., 2000). This also applies to implicit knowledge (cf. Roberts, 2000, p. 435; Bouncken/Barwinski, 2020). As a result, it is almost impossible to preserve tacitness about the resource position (Ghadge et al., 2019) and its substitutability and imitability will become easier. This leads to further hypotheses:

H2a: The lower the transaction costs of (internal) coordination during digitalization, the lower is the complexity of the resource position.

H2b: The lower the transaction costs of (external) coordination during digitalization, the less tacit is the resource position.

(3) Effects of increasing participation in new value-adding networks (structural ecosystems) during digitalization

In new value adding networks (structural ecosystems) complementary resources lead to an above-average value increase (Kim/Finkelstein, 2009, p. 619). As a result of resource bundling, a superordinate value proposition is created (Feldmann, 2002, Nalebuff/Brandenburger, 1997), i.e., the value created by the resource position in the market (Section 2.2) increases. Those complementary resources for shared value creation are embedded within the structural ecosystem and restricted to fewer areas of application. Their value decreases outside the ecosystem. Therefore, the specificity of the resource position rises in shared value-adding networks (Smart et al. 2007). Also, the complexity of the resource position rises because of the large number of new connections between the partners in the ecosystem (cf. Dejgaard, 2000; Lee et al., 2015) which is difficult for outsiders to understand and copy (cf. Kamasak, 2017, p. 256). In digital platforms (e.g., social media platforms) it is also easier to transfer implicit knowledge between the network partners (cf. Roberts, 2000), because intense interaction facilitates knowledge transfer (Chung, 2015). However, it, therefore, passes out of the individual company (Karhu et al., 2018). Tacitness about the resource position is thereby reduced (Zander/Kogut, 1995). The following hypotheses can be argued:

H3a: The stronger the interaction with external partners via technical platforms in new value-adding networks (structural ecosystems) during digitalization, the more value is created by the resource position in the market.

H3b: The stronger the interaction with external partners via technical platforms in new value-adding networks (structural ecosystems) as a result of digitalization, the higher is the specificity of the resource position.

H3c: The stronger the interaction with external partners via technical platforms in new value-adding networks (structural ecosystems) during digitalization, the higher is the complexity of the resource position.

H3d: The stronger the interaction with external partners via technical platforms in new value-adding networks (structural ecosystems) during digitalization, the less tacit the resource position becomes.

3.2 Effects of Digitalization on the Requirements for Operational Capabilities on their Advantageousness

The requirements for operational capabilities contribute to creating advantages and are therefore advantageous (see section 2.2). In Section 3.1 we explained that the impacts of different effects of digitalization on the resource position's specificity, tacitness, and adjustment to the environmental dynamics are clearly positive (on specificity according to hypothesis 3b and on the adjustment to the environmental dynamics according to hypothesis 1b) or negative (on tacitness according to hypothesis 2b and 3d). You can use this to clearly influence the advantageousness of the operational capabilities and three further hypotheses can be argued:

H4: The increasing specificity of the resource position due to digitalization increases the advantageousness of the operational capabilities.

H5: The greater adjustment of the resource position to the environmental dynamics caused by digitalization increases the advantageousness of the operational capabilities.

H6: The decreased tacitness about the resource position because of digitalization reduces the advantageousness of the operational capabilities.

No clear statements can be made about the two other requirements for operational capabilities ex-ante. There are conflicting effects of digitalization concerning the higher instability of the market dynamics and the increasing interaction with partners on technical platforms in ecosystems on the value creation of the resource position in the market (see H1a and H3a). The same applies to falling transaction costs of internal coordination and increasing interaction with partners on technical platforms and in ecosystems on the complexity of the resource position (see H2a and H3c).

In view of these conflicting economic effects, no hypothesis on the overall impact on advantageousness of operational capabilities can be derived theoretically (cf. Adam/Urquhart, 2009). Analyzing the overall effect of digitalization, therefore, requires an exploratory empirical study (Gruber et al., 2010).

4. Empirical Study

4.1 Approach

To examine the relationships between the variables and the underlying hypotheses further, structural equation modeling was performed and a PLS (Partial Least Squares) approach using SmartPLS software to analyze the data gathered (cf. Hair et al., 2011). This approach is suitable for both formative and reflective measuring models (Bollen/Lennox, 1991). The existing analysis model is based on the one hand on reflective measurement models of exogenous variables on environmental dynamics, relating to internal and external transaction costs and to participation in value-adding networks (structural ecosystems) as well as the endogenous variables on the advantageousness of operational capabilities. On the other hand, formative measuring models are used for the intervening variables relating to value creation in the market, specificity, complexity and tacitness about the resource position and for the adjustment of the resource position to the environmental dynamics. The individual constructs were transferred to a structural equation model (see Fig. C-1).

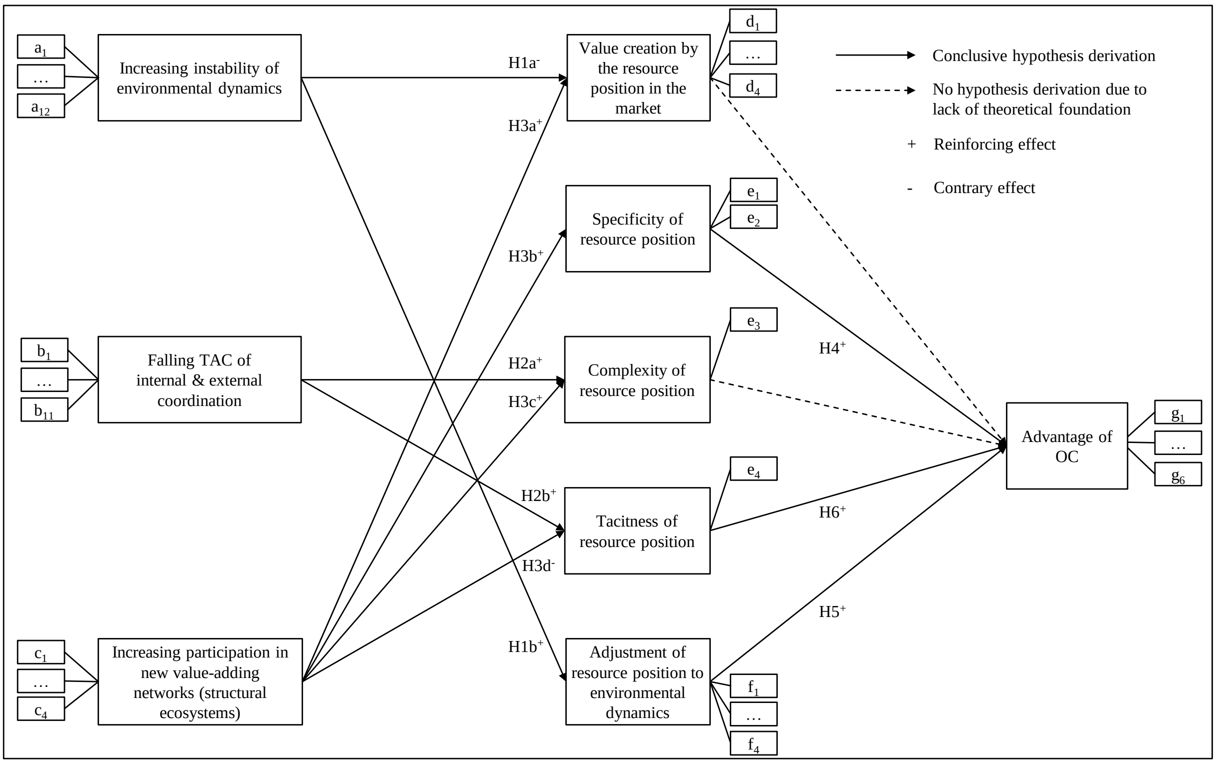

Fig. C-1: Analysis model (source: own compilation)

4.2 Operationalization of the Variables

The construct of the environmental dynamics is operationalized based on Davis et al. (2009). This operationalization encompasses the speed (a_{1-3}), unpredictability (a_{4-6}), complexity (a_{7-9}), ambiguity (a_{10-12}) of changes in processes, goods and services, and business models (cf. also Knobbe/Proff, 2020). The construct of the transaction costs of internal and external coordination caused by digitalization is operationalized via the coordination costs (b_{1-4}), search costs (b_{5-7}) and the process risk (b_{8-11}) based on Benslimane et al. (2007) and Hong et al. (2010).

A wider scope of action for participation in value-adding networks (structural ecosystems) was operationalized on the basis of Adner's understanding (2017). The construct is described using the following four items: enlargement of the scope of action for corporate adjustment with a superordinate value-adding network and for cooperation with a defined group of partners with shared value-adding objectives, and an increase in the scope of action for network interaction with several partners and through the creation of a shared improved customer solution (c_{1-4}). The construct of value creation of the resource position in the market is operationalized based on Nothnagel (2008) through the contribution of the resources to efficiency, cost, quality and customer satisfaction (d_{1-4}). The construct of limited substitutability and imitability is divided up into the sub-constructs of specificity, complexity and tacitness as in the understanding of Reed/de Filippi (1990). On the basis of Simonin (1999), the resource position's specificity is operationalized with investments in machinery and plant (e_1) and competent employees (e_2). For the resource position's complexity and tacitness, single-item operationalizations are used (larger number of interdependent persons and processes (e_3), reduced documentability of technology and process knowledge (e_4)). Single-item operationalization is a permissible alternative to multi-item measurements (cf. Drolet/Morrison, 2001 and Bergkvist/Rossiter, 2007) and has become established in strategic management research (Boyd et al., 2005). The construct of adjustment to the environmental dynamics is operationalized according to Hult/Ferrell et al. (1997), Proff (2005) and Škerlavaj et al. (2007) with a sufficiently fast reaction to environmental changes (f_1), knowledge absorption and processing (f_2), marked teamwork (f_3) and decentral management structures (f_4).

The advantageousness of the operational capabilities is operationalized in accordance with Teece (2017) by improvement in the employees' knowledge (g_1), the plant and equipment (g_2), the processes and routines (g_3) and the administrative coordination (g_4). The improvement in profitability and total turnover was also asked for in order to measure the EBIT impact (g_5) and (g_6). The significance of all items was surveyed in relation to digitalization and on the basis of a 7-point Likert scale from “Totally agree” to “Totally disagree”. (For example Item a_7: “Operational business in your company has become more complex in the course of digitalization”.) In addition, control questions (k_1 – k_4) were asked about the company’s industry, annual turnover and the number of employees.

4.3 Study Group

An online survey of capital-intensive German companies was conducted for the study. A total of 200 responses were received. All of them were useable and available for subsequent analysis. After an examination of the control questions, the sample was made up as follows: automotive (25.5%), chemicals (13.5%), electronics (7%), industrial products (34.5%), logistics (16%) and other (3.5%). 144 participants in the study were from senior management, 56 worked in middle management. All the companies had a turnover above €50 million, 52.5% of them actually over one billion. Only two companies had fewer than 250 employees. Due to its cross-industry character (Li/Greenwood, 2004) and the large amount of useable responses (Chin/Newsted, 1999) the sample size is representative.

5. Results and Discussion

5.1 Analysis of the Results

In the course of analyzing the construct with SmartPLS, the reflective and formative measuring models were checked for validity and reliability (cf. Tables C-1 and C-2). The quality criteria of the reflective measuring models are fulfilled according to Cronbach’s alpha ($\alpha > 0.7$; cf. Schmitt, 1996). Indicator reliability is given due to the loadings of all items greater than 0.5 and is statistically highly significant at $p < 0.001$ (cf. Hair et al., 2010). Because the average variance extracted (AVE) for each construct is more than 0.5 and the composite reliability > 0.6, the convergence criteria of the reflective measuring models are fulfilled (cf. Bagozzi/Yi, 1988; Fornell/Larcker, 1981).

Constructs	Items	Loading	CA	CR	AVE
Environmental dynamics	12	0.584 – 0.823	0.920	0.931	0.532
TAC (int./ext. coordination)	11	0.633 – 0.795	0.906	0.922	0.518
Participation in networks(ecosystems)	4	0.871 – 0.897	0.907	0.935	0.782
Advantage of OC	6	0.548 – 0.876	0.859	0.894	0.592
CA = Cronbach’s Alpha, CR = Composite reliability, AVE = Average variance extracted					

Tab. C-1: Cronbach’s alpha and convergence criteria (source: own compilation)

Because the correlations are less than the root of the average variance extracted (AVE) in the principal diagonals (see Tab. C-4 in the appendix; Fornell-Larcker-Criterion; Fornell/Larcker, 1981, p. 46) and each item loads significantly higher on its own construct than on all other constructs (see Tab. C-5 in the appendix; cross-loadings of reflective constructs; cf. Chin, 1998, p. 321), discriminant validity of the reflective measuring models is given.

In the inner measuring models, the discriminant validity is shown to have correlations of the formative constructs with the other constructs of less than 0.9 and validity is therefore given (see Tab. C-2).

Constructs	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
(1) Environmental dynamics	1.000								
(2) TAC (int./ext. coordination)	0.667	1.000							
(3) Participation (networks/ecosystems)	0.679	0.764	1.000						
(4) Perceived value of resource position	0.548	0.759	0.759	1.000					
(5) Specificity of resource position	0.526	0.606	0.670	0.706	1.000				
(6) Complexity of resource position	0.569	0.508	0.571	0.611	0.631	1.000			
(7) Tacitness of resource position	0.538	0.567	0.501	0.481	0.344	0.298	1.000		
(8) Alignment to env. dynamics	0.544	0.600	0.640	0.743	0.722	0.617	0.395	1.000	
(9) Advantage of OC	0.528	0.694	0.690	0.826	0.753	0.635	0.385	0.800	1.000

Tab. C-2: Correlation of the latent variables (source: own compilation)

A bootstrap analysis with 5,000 resamples was conducted to test the inner model. Construct validity of the inner structural equation model is given, because the stated variance R^2 for the endogenous constructs is higher than 0.26 (see Fig. C-2) and can therefore be considered strong (Cohen, 1988, p.82). According to a collinearity test for the inner model, there is no multicollinearity, because the variance inflation factor (VIF) is below 5 (see Tab. C-3; Diamantopoulos/Winklhofer, 2001, p. 272). Fig. C-2 shows the results of the model analysis including the path coefficients and significances of the relationships.

	Items	VIF (Items)
Value creation by the resource position in the market	6	1.794 – 2.239
Specificity of resource position	2	1.986 – 1.986
Complexity of resource position	1	1.000 – 1.000
Tacitness of resource position	1	1.000 – 1.000
Adjustment of resource position to env. dynamics	4	1.676 – 2.144

Tab. C-3: Variance inflations factor (VIF; source: own compilation)

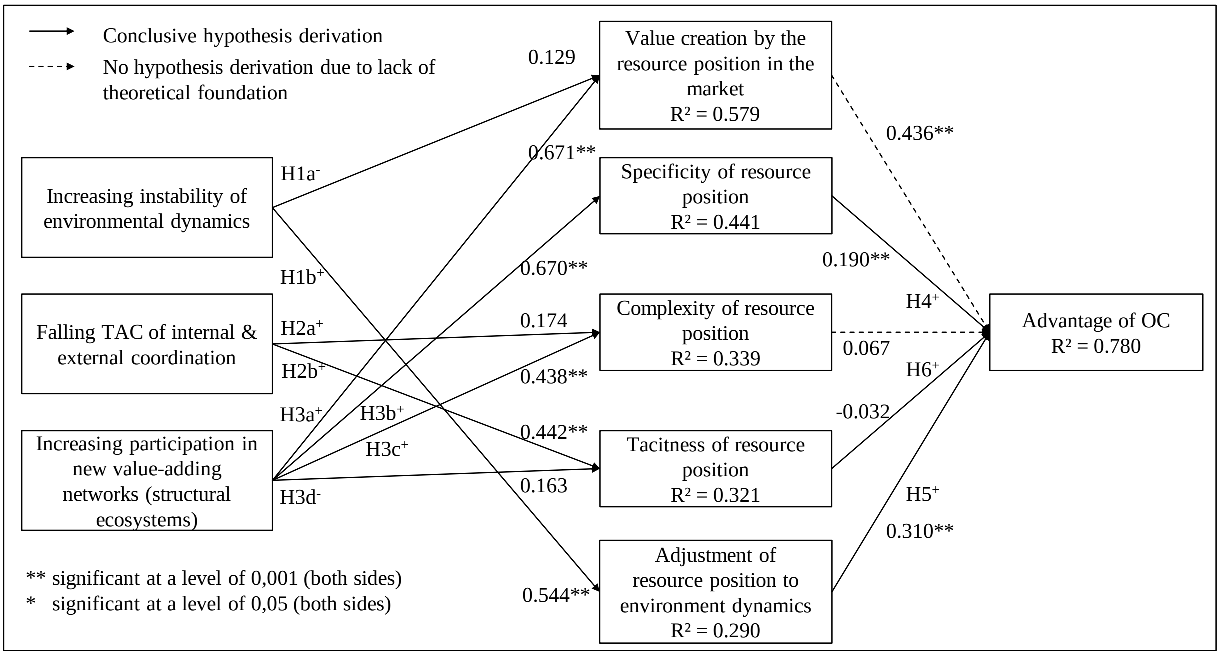

Fig. C-2: Paths and significances of the model (source: own compilation)

Hypothesis 1a expected falling value creation by the resource position in the market with rising instability of the environmental dynamics. It has to be rejected, because the results show a weak and insignificant influence, contrary to expectations (0.129, $t = 1.624$, $p > 0.05$). Hypothesis 1b assumes that the adjustment of the resource position to the environmental dynamics will be higher with increasing environmental dynamics. Because the path relationship between the two constructs is strong and highly significant (0.544, $t = 8.350$, $p < 0.001$), the hypothesis can be accepted. The falling transaction costs of internal and external coordination in the course of digitalization do not show any significant effects on the complexity of the resource position (0.174, $t = 1.373$, $p > 0.05$), hypothesis 2a is therefore rejected. However, they do lead to reduced tacitness about the resource position (0.442, $t = 3.901$, $p < 0.001$). Hypothesis 2b can therefore be accepted. Increasing collaboration in value-adding networks and ecosystems in the course of digitalization has a strong influence on higher value creation of the resources in the market (0.671, $t = 9.959$, $p < 0.001$), higher specificity of the resource position (0.670, $t = 12.283$, $p < 0.001$) and increasing complexity of the resource position (0.438, $t = 3.521$, $p < 0.001$). Hypotheses 3a, 3b, and 3c are therefore accepted. There is no support for hypothesis 3d because the path coefficient between the increasing collaboration in value-adding networks (structural ecosystems) shows only a small, insignificant positive influence on tacitness about resources (0.163, $t = 1.241$, $p > 0.05$).

Concerning the connection between the requirements for operational capabilities and the advantageousness of these capabilities the analysis results show that increased specificity of the resource position because of digitalization has a significant influence on operational capabilities

(0.190, t = 2.669, p < 0.05). Hypothesis 4 can therefore be accepted. The results also show that the increased adjustment of the resource position to the environmental dynamics caused by digitalization has a highly significant influence on the advantageousness of the operational capabilities (0.310, t = 3.946, p < 0.001). Hypothesis 5 can therefore be accepted.

The effects of digitalization on the resource position's tacitness are - in contrast to the theoretical expectations - not consistently negative (although there are highly significant negative effects of falling transaction costs (H2b), there is no impact from collaboration in ecosystems (H3d). Therefore, an overall effect has to be estimated here. Empirical analysis shows here there is a path coefficient of -0.032 (t = 0.718, p > 0.05) between tacitness about the resource position and the advantageousness of the operational capabilities. Even though tacitness about the resource position thus decreases overall, the effect is less than expected. Due to a lack of significant results, the expected negative influence of digitalization on the advantageousness of operational capabilities (hypothesis 6) therefore cannot be confirmed.

In accordance with Chapter 3.1 conflicting effects on the value creation of the resource position in the market arise from digitalization. Therefore, no hypothesis on the overall effect could be established ex-ante. Empirical analysis shows a highly significant, positive overall effect of the change in the resource position's value creation in the market due to digitalization on the advantageousness of the operational capabilities (0.436, with t = 6.099, p < 0.001).

The complexity of the resource position is also affected by digitalization in different ways in accordance with Section 3.1. However, the empirical analysis does not show a significant correlation (0.067, t = 1.170, p > 0.05) here between a digitalization-dependent increase in the resource position's complexity and the advantageousness of the operational capabilities.

The overall effect of digitalization on the advantageousness of the operational capabilities can be measured by a superblock (Tenenhaus/Vinzi, 2005, p. 147) which encompasses the three latent variables (increasing environmental dynamics, falling transaction costs of internal and external cooperation, increasing scope for participation in value-adding networks, that is, structural ecosystems). This superblock variable is measured reflectively here by all indicators of the three latent variables. The total effect of digitalization on the advantageousness of the operational capabilities is highly significantly positive here (0.691, t = 17.754, p < 0.001).

5.2 Discussion of the Results

The research was able to show conclusively that, as a result of digitalization, there is a significantly positive effect from the easier participation in value-adding networks (structural ecosystems) caused by digitalization on the advantageousness of operational capabilities. This is a result, on the one hand, of higher value creation and on the other hand, of the specificity of the resource position in the market (because capabilities are less substitutable and imitable). There is also a significantly positive impact on the advantageousness because of the higher adjustment of the resource position due to increasing environmental dynamics as a result of digitalization. The participation in value-adding networks (structural ecosystems) also causes increasing complexity and the falling transaction costs lead to reduced tacitness about the resource position, but these findings have no negative effects on the advantageousness of the operational capabilities. Because of that, a positive overall effect of digitalization on the advantageousness of the operational capabilities results from these partial effects.

Our survey shows that the potential conflict between, on the one hand, falling transaction costs and easier exchange via platforms, and, on the other hand, the requirements for advantageous resources for the companies surveyed does not exist. The resulting management implications are presented in the next section.

6. Implications, Limitations and Future Research

The present study opens the black box of building operational capabilities and makes the influences of digitalization on individual requirements for the development of these capabilities transparent. It, therefore, makes a theoretical contribution to understanding the development of operational capabilities during discontinuous change, which goes beyond previous research projects.

The results show that companies, which adjust their resource position strongly to digitalization, can quite definitely build more advantageous operational capabilities. Because the decreasing tacitness due to falling transaction costs and the increasing complexity of the resource position due to participation in value-adding networks (structural ecosystems) have very little influence on the advantageousness of the operational capabilities, the requirement of limited substitutability and imitability of the resources loses importance in times of digitalization. Instead, companies can collaborate more in value-adding networks (structural ecosystems, e.g., via digital platforms) and contribute resources to these. Then they will build operational capabilities) together with partners to create a greater value for the customer. Whereas these capabilities had to be kept as tacit as possible in earlier times, more openness in networks is now needed for value co-creation in networks. This is a fundamental transformation for many companies. At the same time, however, it is observable that large technology companies are protecting their original algorithms (distinctive capabilities) strongly in shared platforms and not passing all of them on (cf. the discussion on co-opetition, e.g., Nalebuff/Brandenburger, 1997, Cozzolino/Rothaermel, 2018), which is why the question of value distribution among the ecosystem partners (Jacobides et al., 2018) still has to be considered (Nambisan, 2018).

Further limitations in the present study lie both in the conflicting effects of the impact of digitalization and in the composition of the sample. Additional theoretical studies are needed here to explain the conflicting effects. Furthermore, the size of the sample, with 200 companies surveyed, cannot represent a full study of the influence of the digitalization which is in operation across the globe. A larger sample including international participants is needed, first to improve the generalizability of the results, and second to highlight country-specific differences in results. Only capital-intensive companies were surveyed. A comparison with companies from the software and telecommunications sector may enable a cross-industry comparison. Also, a study for comparing B2B and B2C companies can explore differences in the impact of digitalization on the advantageousness of the operational capabilities, because there are deviant approaches concerning digital transformation (Iankova et al., 2019, López-López/Giusti, 2020).

Appendix

	(1)	(2)	(3)	(4)
(1) Participation (networks/ecosystems)	**0.885**			
(2) TAC (int./ext. coordination)	0.761	**0.718**		
(3) Environmental dynamics	0.673	0.659	**0.729**	
(4) Advantage of OC	0.686	0.693	0.521	**0.771**

Tab. C-4: Discriminant validity assessment (diagonal values are square root of AVE, source: own compilation)

Constructs		(1)	(2)	(3)	(4)
(1) Environmental dynamics	a_1	**0.651**	0.536	0.551	0.466
	a_2	**0.793**	0.544	0.594	0.463
	a_3	**0.744**	0.505	0.504	0.367
	a_4	**0.619**	0.358	0.274	0.211
	a_5	**0.584**	0.320	0.279	0.201
	a_6	**0.653**	0.339	0.311	0.275
	a_7	**0.732**	0.455	0.489	0.401
	a_8	**0.802**	0.505	0.562	0.396
	a_9	**0.823**	0.493	0.600	0.458
	a_{10}	**0.774**	0.511	0.482	0.413
	a_{11}	**0.772**	0.571	0.549	0.384
	a_{12}	**0.757**	0.574	0.496	0.392
(2) Falling TAC (int./ext.)	b_1	0.402	**0.633**	0.496	0.539
	b_2	0.399	**0.661**	0.562	0.560
	b_3	0.442	**0.729**	0.582	0.607
	b_4	0.557	**0.780**	0.644	0.635
	b_5	0.509	**0.725**	0.527	0.440
	b_6	0.481	**0.717**	0.508	0.422
	b_7	0.481	**0.659**	0.459	0.414
	b_8	0.455	**0.723**	0.465	0.424
	b_9	0.393	**0.725**	0.518	0.491
	b_{10}	0.531	**0.751**	0.608	0.483
	b_{11}	0.581	**0.795**	0.642	0.491
(3) Increasing partic. in networks	c_1	0.621	0.680	**0.888**	0.633
	c_2	0.580	0.675	**0.871**	0.560
	c_3	0.605	0.657	**0.880**	0.596
	c_4	0.594	0.688	**0.897**	0.647
(4) Advantage of OC	g_1	0.352	0.542	0.526	**0.817**
	g_2	0.411	0.586	0.569	**0.856**
	g_3	0.491	0.611	0.603	**0.876**
	g_4	0.466	0.596	0.569	**0.870**
	g_5	0.377	0.450	0.472	**0.576**
	g_6	0.367	0.402	0.475	**0.548**

Tab. C-5: Cross-loadings of reflective constructs (source: own compilation)

References

Adam, M.S. and Urquhart, C., “No man is an island: social and human capital in IT capacity building in the Maledives”, Information & Organization, Volume 19, Number 1, Pages 1-21, 2009.

Adner, R., “Ecosystems as Structure”, Journal of Management, Volume 43, Pages 39-58, 2017.

Andersen, E., “Learning to learn: Mental tools to help you master new skills”, Harvard Business Review, Volume March, Pages 98-101, 2016.

Argyris, C. and Schön, D. A., Organizational learning. A theory of action perspective, Reading/Mass: Addison-Wesley Pub. Co, 1978.

Bagozzi, R. P. and Yi, Y., “On the Evaluation of Structural Equation Models”, Journal of Academy of Marketing Science, Volume 16, Number 1, Pages 74-94, 1988.

Banalieva, E. R. and Dhanaraj, C., “Internalization theory for the digital economy”, International Journal of Business Studies, Volume 50, Pages 1372-1387, 2019.

Barney, J., “Firm Resources and Sustained Competitive Advantage”, Journal of Management, Volume 17, Number 1, Pages 99-120, 1991.

Bennis, W., “Leadership in a digital world: embracing transparency and adaptive capacity”, Management Information Systems Quarterly, Volume 37, Number 2, Pages 635–636, 2013.

Benslimane, Y., Plaisent, M. and Bernard, P., “Investigating Search Costs and Coordination Costs in Electronic Markets: A Transaction Costs Economics Perspective”, Electronic Markets, Volume 15, Number 3, Pages 213-224, 2007.

Bergkvist, L. and Rossiter, J. R., “The Predictive Validity of Multiple-Item versus Single-Item Measures of the Same Constructs”, Journal of Marketing Research, Volume 44, Number 2, Pages 175–184, 2007.

Bollen, K. and Lennox, R., “Conventional wisdom on measurement: A structural equation perspective”, Psychological Bulletin, Volume 110, Number 2, Pages 305–314, 1991.

Bouncken, R. and Barwinski, R., “Shared digital identity and rich knowledge ties in global 3D printing – A drizzle in the clouds?”, Global Strategy Journal, Volume 2020, Pages 1-28, 2020.

Boyd, B. K., Gove, S. and Hitt, M. A., “Construct measurement in strategic management research: illusion or reality?”, Strategic Management Journal, Volume 26, Number 3, Pages 239–257, 2005.

Ceccagnoli, M., Forman, C., Huang, P. and Wu, D., “Cocreation of Value in a Platform Ecosystem! The Case of Enterprise Software”, Management Information Systems Quarterly, Volume 36, Number 1, Pages 263-290, 2012.

Cha, K. J., Hwang, T. and Gregor, S., “An integrative model of IT-enabled organizational transformation: A multiple case study”, Management Decision, Volume 53, Number 8, Pages 1755-1770, 2015.

Chin, W. W., “The partial least square approach for structural equation modelling,” G. A. Marcoulides (Ed.), Methodology for business and management. Modern methods for business research, Lawrence Erlbaum Associates Publishers: Pages 295-336, 1998.

Chin, W. W. and Newsted, P. R., "Tructural equation modeling analysis with small samples using partial least squares", R. H. Hoyle (Ed.), Statistical strategies for small sample research (pp. 307– 341). Thousand Oaks: CA: Sage Publications, Pages 307-341, 1999.

Chung, D. S., "Social Capital, Knowledge Sharing and Financial Performance", International Journal of Business Strategy, Volume 15, Number 2, Pages 23-28, 2015.

Cohen, J., Statistical power analysis for the behavioral sciences, (2nd ed.), Hillsdale, N.J.: L. Erlbaum Associates, 1988.

Cowan, R., David, P. A. and Foray, D., "The explicit economies of knowledge codification and tacitness. In: Industrial and Corporate Change", Volume 9, Number 2, Pages 211-253, 2000.

Cozzolino, A. and Rothaermel, F., "Discontinuities, competition, and cooperation: Coopetitive dynamics between incumbents and entrants", Strategic Management Journal, Volume 39, Pages 3053-3085, 2018.

Cyert, R. and March, J., A., Behavioral Theory of the Firm. Englewood Cliffs, NJ: Prentice-Hall, 1963.

Davis, J. P., Eisenhardt, K. M. and Bingham, C. B., "Optimal structure, market dynamism, and the strategy of simple rules", Administrative Science Quarterly, Volume 54, Number 3, Pages 413-452, 2009.

Dejgaard, S., "Looking into Virtual Organizations – Interaction and Coordination Issues", Malhotra, Y. (Ed.), Knowledge management and business model innovation, Idea Group Publishing, Pages 77-94, 2001.

Diamantopoulos, A. and Winklhofer, H. M., "Index Construction with Formative Indicators: An Alternative for Scale Development", Journal of Marketing Research, Volume 38, Number 2, Pages 269-277, 2001.

Dierickx, I. and Cool, K., "Asset stock accumulation and sustainability of competitive advantage", Management Science, Volume 35, Number 12, Pages 1504-1511, 1989.

Drolet, A. L. and Morrison, D. G., "Do We Really Need Multiple-Item Measures in Service Research?", Journal of Service Research, Volume 3, Number 3, Pages 196-204, 2001.

Donada, C. and Attias, D., "Food for thought: Which organisation and ecosystem governance to boost radical innovation in the electromobility 2.0 industry?", International Journal of Automotive Technology and Management, Volume 15, Number 2, Pages 105-125, 2015.

Ethiraj, S. K. and Levinthal, D. A., "Modularity and Innovation in Complex Systems", Management Science, Volume 50, Number 2, Pages 159-173, 2004.

Feldmann, V., "Competitive Strategy for Media Companies in the Mobile Internet", Schmalenbach Business Review, Volume 54, Number 4, Pages 351–371, 2002.

Fornell, C. and Larcker, D. F., "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error", Journal of Marketing Research, Volume 18, Pages 39-50, 1981.

Gans, J. and Ryall, M. D., "Value capture theory: A strategic management review", Strategic Management Journal, Volume 38, Pages 17-41, 2017.

Garcia-Martinez, B., Molina-Diaz, J. G. and Gonzales-Acolt, R., "Bibliometrics of Digital Business Ecosystem", International Journal of Business Strategy, Volume 18, Number 2, Pages 53-58, 2018.

Ghadge, A., Weiß, M., Caldwell, N. D. and Wilding, R., “Managing cyber risk in supply chains: a review and research agenda,” Supply Chain Management: An International Journal, Volume 25, Number 2, Pages 223-240, 2019.

Gruber, M., Heinemann, F., Brettel, M. and Hungeling, S., “Configurations of resources and capabilities and their performance implications: an exploratory study on technology ventures”, Strategic Management Journal, Volume 31, Number 12, Pages 1337–1356, 2010.

Hagiu, A. and Wright, J., “Multi-sided platforms”, International Journal of Industrial Organization, Volume 43, Number C, Pages 162-174, 2015.

Hair, J. F., Black, W. C., Babin, B. J. and Anderson, R. E., Multivariate Data Analysis, Seventh Edition, Prentice Hall, Upper Saddle River, New Jersey, 2010.

Hair, J. F., Ringle, C. M. and Sarstedt, M., “PLS-SEM: Indeed a Silver Bullet”, Journal of Marketing Theory and Practice, Volume 19, Number 2, Pages 139–152, 2011.

Hannah, D. P. and Eisenhardt, K. M., “How firms navigate cooperation and competition in nascent ecosystems”, Strategic Management Journal, Volume 39, Pages 3163-3192, 2018.

Helfat, C. E. and Peteraf, M. A., “The dynamic resource-based view: capability lifecycles”, Strategic Management Journal, Volume 24, Number 10, Pages 997-1010, 2003.

Helfat, C. E. and Winter, S. (2011), “Untangling Dynamic and Operational Capabilities: Strategy for the (N)Ever-Changing World”, Strategic Management Journal, Volume 32, Number 11, Pages 1243-1250, 2011.

Hong, E., Son, B.-G. and Menachof, D., “Exploring the link between IT systems and the outsourcing of logistics activities: a transaction cost perspective”, International Journal of Logistics Research and Applications, Volume 13, Number 1, Pages 41-57, 2010.

Hoppmann, J., Naegele, F. and Girod, B., “Boards as a Source of Intertia: Examining the Internal Challenges and Dynamics of Boards of Directors in Times of Environmental Discontinuities”, Academy of Management Journal, Volume 62, Number 2, 2016.

Hult, G. T. and Ferrell, O.C., “Global organizational learning capacity in purchasing: Construct and measurement”, Journal of Business Research, Volume 40, Number 2, Pages 91-111, 1997.

Iankova, S., Davies, I., Archer-Brown, C., Marder, B. and Yau, A., “A comparison of social media marketing between B2B, B2C and mixed business models”, Industrial Marketing Management, Volume 81, Pages 169-179, 2019.

Jacobides, M. G., Cennamo, C. and Gawer, A., “Towards a theory of ecosystems”, Strategic Management Journal, Volume 39, Pages 2255-2276, 2018

Kamalaldin, A., Linde, L., Sjödin, D. and Parida, V., “Transforming provider-customer relationships in digital servitization: A relational view on digitalization”, Industrial Marketing Management, Volume 89, Pages 306-325, 2020.

Kamasak, R., “The contribution of tangible and intangible resources, and capabilities to a firm’s profitability and market performance”, European Journal of Management and Business Economics, Volume 26, Number 2, Pages 252-275, 2017.

Kane, G. C., Buckley, N., Kiron, D., Phillips, A. N., and Palmer, D., Aligning the Organization for Its Digital Future. MIT Sloan management review and Deloitte University Press, July 26, 2016.

Karhu, K., Gustafsson, R., and Lyytinen, K., “Exploiting and Defending Open Digital Platforms with Boundary Resources: Android’s Five Platform Forks”, Information Systems Research, Volume 29, Number 2, Pages 479-497, 2018.

Karna, A., Richter, A. and Riesenkampff, E., “Revisiting the role of the environment in the capabilities – financial performance relationship: A meta-analysis”, Strategic Management Journal, Volume 37, Number 6, Pages 1154-1173, 2015.

Klein, B. H., Dynamic economies, Cambridge/Maas, 1977.

Kim, J.-Y. and Finkelstein, S., “The effects of strategic and market complementarity on acquisition performance: evidence from the U.S. commercial banking industry, 1989-2001”, Strategic Management Journal, Volume 30, Pages 617-646, 2009.

Knobbe, F. and Proff, H., “Digitalization and dynamic capabilities in the automotive industry - Measuring discontinuous change abilities of automotive suppliers”, International Journal of Automotive & Technology Management, Volume 20, Number 4, 2020, 436-456.

Koch, T. and Windsperger, J., “Seeing through the network: Competitive advantage in the digital economy”, Journal of Organization Design, Volume 6, Number 6, Pages 1-30, 2017.

Lee, S., Kim, W., Lee, H. and Jeon, J., “Identifying the structure of knowledge networks in the US mobile ecosystems: patent citation analysis”, Technology Analysis & Strategic Management, Volume 28, Number 4, Pages 411-434, 2015.

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N. and Ahlemann, F., “Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community”, Business & Information Systems Engineering, Volume 59, Number 4, Pages 301–308, 2017.

Lenka, S., Parida, V., Rönnberg Sjödin, D. and Wincent, J., “Digitalization and advanced service innovation How digitalization capabilities enable companies to co-create value with customers”, Management of Innovation and Technology, Volume 3, Number 3, Pages 2–4, 2016.

Li, L., Su, F., Zhang, W. and Mao, J.-Y., “Digital transformation by SME entrepreneurs: A capability perspective”, Information Systems Journal, Volume 28, Number 6, Pages 1129–1157, 2018.

Li, S. X. and Greenwood, R., “The effect of within-industry diversification on firm performance: synergy creation, multi-market contract and market structuration”, Strategic Management Journal, Number 25, Pages 1131-1153, 2004.

Lim, I. K., Thi, L. S. and Kadir, K. A., “Effect of knowledge management, management innovation and dynamic capabilities in sustaining competitive advantage in dynamic business environments”, International Journal of Accounting, Finance and Business, Volume 3, Number 15, Pages 1-12, 2018.

López-López, D. and Giusti, G., “Comparing Digital Strategies and Social Media Usage in B2B and B2C Industries in Spain”, Journal of Business-to-Business Marketing, Volume 27, Number 2, Pages 175-186, 2020.

Mueller, J., Hutter, K., Fueller, J. and Matzler, K., “Virtual worlds as knowledge management platform – a practice-perspective”, Information Systems Journal, Volume 21, Pages 479-501, 2011.

Nadler, D. A. and Tushman, M. L., “Organizational Frame Bending: Principles for Managing Reorientation”, Academy of Management Perspectives, Volume 3, Number 3, Pages 194-204, 1989.

Nalebuff, B. J. and Brandenburger, A. M., “Co-Opetition: Competitive and Cooperative Business Strategies for the Digital Economy”, Strategy & Leadership, Volume 25, Number 6, Pages 28–35, 1997.

Nambisan, S., “Architecture vs. ecosystem perspectives: Reflections on digital innovation”, Information and Organization, Volume 28, Pages 104-106, 2018.

Nasiri, M., Ukko, J., Saunila, M., Rantala, T. and Rantanen, H., “Digital-related capabilities and financial performance: the mediating effect of performance measurement systems”, Technology Analysis & Strategic Management, Volume 2020, Pages 1-14, 2020.

Nelson, R. R. and Winter, S. G., An Evolutionary Theory of Economic Change, Belknap Press/Harvard University Press: Cambridge, 1982.

Nothnagel, K., Empirical Research within the Resource-Based Theory. A Meta-Analysis of the Central Propositions, Wiesbaden, Gabler/GWV Fachverlage GmbH, 2008.

Peppard, J. and Ward, J., The strategic management of information systems: Building a digital strategy, New York, Wiley & Sons, 2016.

Peteraf, M. A., The cornerstone of competitive advantage: A resource-based view”, Strategic Management Journal, Volume 14, Number 3, Pages 179-191, 1993.

Pil, F. K. and Cohen, S. K., “Modularity: Implications for Imitation, Innovation, and Sustained Advantage”, Academy of Management Review, Volume 31, Number 4, Pages 995–1011, 2006.

Porter, M., Competitive Advantage – Creating and Sustaining Superior Performance, Free Press, 1985.

Proff, H., “A “model of resources refinement“ for deriving competence-based competitive advantages and strategies”, Sanchez, R., Heene, A. (Eds.), Resources, stakeholders, and rene-wal, München, Pages 55-80, 2005.

Reed, R. and DeFilippi, R., “Causal ambiguity barriers to imitation, and sustainable competitive advantage”, Academy of Management Review, Volume 15, Number 1, Pages 88-102, 1990.

Roberts, J., “Form Know-how to Show-how? Questioning the Role of Information and Communication Technologies in Knowledge Transfer”, Technology Analysis & Strategic Management, Volume 12, Number 4, Pages 429-443, 2000.

Sanchez, R. and Heene, A., “Managing articulated knowledge in competence-based competition”, Sanchez, R./Heene, A. (Eds.), Strategic Learning and Knowledge Management, Chichester, Wiley, Pages 163-187, 1997.

Schmitt, N., “Uses and Abuses of Coefficient Alpha”, Psychological Assessment, Volume 8, Number 4, Pages 350-353, 1996.

Sheng, M. L., Chang, S. Y., Teo, T. and Lin, Y. F., “Knowledge barriers, knowledge transfer, and innovation competitive advantage in healthcare settings”, Management Decision, Volume 51, Number 3, Pages 461-478, 2013.

Simonin, B. L., “Ambiguity and the process of knowledge transfer in strategic alliances”, Strategic Management Journal, Volume 20, Number 7, Pages 595-623, 1999.

Škerlavaj, M., Štemberger, M. I., Škrinjar, R. and Dimovski, V., "Organizational learning culture – the missing link between business process change and organizational performance", International Journal of Production Economics, Volume 106, Number 2, Pages 346-367, 2007.

Smart, P., Bessant, J. and Gupta, A., "Towards technological rules for designing innovation networks: A dynamic capabilities view", International Journal of Operations & Production Management, Volume 27, Number 10, Pages 1069-1092, 2007.

Sturgeon, T. J., "Upgrading strategies for digital economy", Global Strategy Journal, Pages 1-24, 2019.

Spulber, D. F., "The Economics of Markets and Platforms", Journal of Economics & Management Strategy, Volume 28, Pages 159-172, 2018.

Teece, D. J., "Business models and dynamic capabilities", Long Range Planning, Volume 51, Number 1, Pages 40-49, 2017.

Teece, D. J., "The Foundations of Enterprise Performance: Dynamic and Ordinary Capabilities in an (Economic) Theory of Firms", Academy of Management Perspectives, Volume 28, Number 4, Pages 328–352, 2014.

Tenenhaus, M. and Vinzi, V. E., "PLS regression, PLS path modeling and generalized procrustean analysis: A combined approach for multiblock analysis", Journal of Chemometrics, Volume 19, Pages 145 – 153, 2005.

Theeke, M. and Lee, H., "Multimarket Contact and Rivalry over Knowledge-based Resources", Strategic Management Journal, Volume 38, Number 12, Pages 2508-2531, 2017.

Tushman, M. L. and Anderson, P., "Technological Discontinuities and Organizational Environments", Administrative Science Quarterly, Volume 31, Number 3, Pages 439-465, 1986.

Vargo, S. L./Lusch, R. F., "Service-dominant logic: continuing the evolution", Journal of the Academy of Marketing Science, Volume 36, Pages 1-10, 2008.

Williamson, O. E., The Economic Institutions of Capitalism, New York, NY, The Free Press, 1985.

Zander, U. and Kogut, B., "Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test", Organization Science, Volume 6, Number 1, Pages 76–92, 1995.

Zhiqiang, W., Zhang, M., Sun, H. and Zhu, G., "Effects of standardization and innovation on mass customization: An empirical investigation", Technovation, Volume 48/49, Pages 79-86, 2016.

Chapter D: How to Transfer Operational Capabilities in Multinational Companies without Disclosure: Optimizing Decentralization and Information Richness in Times of Digitalization

Published in International Journal of Business Science and Applied Management,
Vol. 17 (3), pp. 49-65.

Stefan Sommer
University of Duisburg-Essen (Germany)
stefan.sommer@uni-due.de
Lotharstraße 1, 47057 Duisburg, Germany

Executive Summary

Multinational companies simultaneously try to facilitate the internal transfers of operational capabilities without disclosing them to external stakeholders. To mitigate this tension, the decentralization of the decision-making and information richness of communication mechanisms are balancing parameters that can be regulated appropriately. Since digitalization has changed the coordination and interaction in intra-firm transfers, both balancing parameters need to be optimized. The present study examines how to adjust decentralization and information richness in times of digitalization by drawing on an exploratory single-case study approach in a German industry company. This research identified six sub-parameters set differently within the company's digital collaboration platform and video conference technology network.

Keywords: operational capabilities; capability transfer; capability protection; decentralization; information richness; digitalization; digital collaboration platform; video conference technology

1. Introduction

Multinational companies (MNCs) generate competitive advantages (Argote & Fahrenkopf, 2016) if there are many intra-firm flows of capabilities (e.g., De Castro & Aquino, 2021; Gaur, Ma & Ge, 2019; Prompreing & Hu, 2021), or, more precisely, operational capabilities (Helfat & Winter, 2011; and similar Teece, 2014). These are firm-specific sets of skills, processes, and routines (Cepeda & Vera, 2007) based on valuable, rare, inimitable, and non-substitutable (VRIN) resources (Barney, 1991). However, these capability transfers within MNCs are facing a "paradox" (Coff, Coff & Eastvold, 2006): on the one hand, the companies try to facilitate the transfers of operational capabilities within their organization (e.g., Burmeister, Lazarova, & Deller, 2016), but on the other hand, they are careful to avoid disclosure to external parties

(Contractor, 2019; Ritala & Stefan, 2021), e.g., when underlying skills, routines and resources become transparent to rivals (Hurmelinna-Laukkanen, 2011; Ralston & Blackhurst, 2020).

To mitigate this tension, (I) the level of decentralization of decision-making (Sumelius & Sarala, 2008) and (II) the information richness of communication mechanisms (Daft & Lengel, 1986) are considered to be balancing parameters, whereby (I) describes the autonomy of the transfer participants in their actions (Molina, Lloréns-Montes & Ruiz-Moreno, 2007) and (II) refers to the ability of the media channel to transmit information and effectively change the understanding of the receivers (Shaw, Chen, Harris & Huang, 2009).

As digitalization reduces traditional physical boundaries and interdependencies between organizational units and standardizes communication interfaces (Cano-Kollmann, Cantwell, Hannigan, Mudambi & Song., 2016; Culot, Orzes, Sartor & Nassimbeni, 2020), it enables more scope for interaction and coordination in the transfer of operational capabilities (Eisenman & Paruchuri, 2019; Hagiu & Wright, 2015). In doing so, digitalization also intensifies the paradox between simultaneously facilitating the transfer of operational capabilities and their protection from disclosure (Thalmann, Manhart, Ceravolo & Azzini, 2014), thus shifting the focus to the optimization of decentralization of decision-making and the information richness of communication mechanisms.

Some scholars have attempted to examine the advantages and disadvantages that come with leakages of capabilities to externals (Inkpen, Minbaeva and Tsang, 2018; Wadhwa, Freitas & Sarkar, 2017). Other studies investigated how the internal use of digital tools enhances or threatens the codifiability of knowledge and capabilities (Coff et al., 2006; Berraies, 2019; Chatterjee, Chaudhuri, Vrontis & Piccolo, 2021), or they focused on the paradox from the perspective of inter-organizational transfers (Contractor, 2019; Ritala & Stefan, 2021), and were anchored, for example, in open innovations research (e.g., Lauritzen & Karafyllia, 2014). However, these studies do not open the black box of the balance between facilitation and protection of intra-firm capability transfers, nor do they guide how digital transfer mechanisms need to be optimized. Therefore, current literature remains on a higher level of consideration in the context of the trade-off, which neglects the influencing factors of decentralization of decision-making and information richness in times of digitalization. This raises the following research question, both theoretically and practically:

RQ: How do MNCs optimize (I) decentralization of decision-making and (II) the information richness of communication mechanisms to simultaneously facilitate and protect transfers of operational capabilities in times of digitalization?

For this purpose, a German-headquartered multinational industrial product company, characterized by high rates of capability transfer flows between organizational units, was analyzed in a single-case study (Zhao & Anand, 2009).

The article is organized as follows. Section 2 presents a literature review of the transfer of operational capabilities, decentralization of decision-making, and the information richness of communication mechanisms. In addition, the influences of digitalization on intra-firm transfers of capabilities are discussed. Then, Section 3 explains the research framework applied to investigate the research question. Section 4 examines the research methodology used in this study. This is followed by a presentation of the findings in Section 5, and the subsequent discussion in Section 6. This article ends with a conclusion (Section 7) including theoretical and practical contributions as well as the limitations of the study.

2. Literature Review

2.1 Transfer of Operational Capabilities

In the literature, operational capabilities are seen as a subset of frequently used organizational capabilities and thus share a large overlap in attributes (Argyres, 2021; Sheehan & Foss, 2017). Operational capabilities, in consequence, represent "information-based tangible or intangible processes that are firm-specific and are developed over time through complex interactions among the firm's resources" (Amit & Schoemaker, 1993, p. 35). Ideally, operational capabilities can generate competitive advantages when they are based on valuable, rare, inimitable, and non-substitutable (VRIN) resources (Barney, 1991) such as knowledge (Papa, Dezi, Gregori, Mueller & Miglietta, 2018; Proff 2005).

Operational capabilities can be transferred between organizational units such as the headquarters and subsidiaries (Jankowska, Bartosik-Purgat, & Olejnik, 2020; Law & Kamoche, 2017) or peer subsidiaries of an MNC and have the "ability to globally leverage dispersed subsidiary specific advantages and to generate new knowledge through a global synthesis of dispersed knowledge" (Keupp, Palmié & Gassmann, 2011, p.214). The management is interested in facilitating these transfers, because, on the one hand, the operational capabilities are bound to complex routines and processes (Bloodgood, 2019; Inkpen, 2008), which means a separation and documentation ("codification"; Simonin, 1999; Zander & Kogut, 1995) is difficult (Windsperger & Gorovaia, 2011), or the organizational structures are too centralized concerning the subsidiary's management transfer decisions (Nesheim & Gressgard, 2014). On the other hand, MNCs also try to avoid operational capabilities becoming transparent to external parties in the case of spreading the transfer to a large number of receivers (Ritala & Stefan, 2021). Hence, there is a tension between facilitating the transfer of operational capabilities within the company (e.g., Burmeister et al., 2016) and protecting them from disclosure to external stakeholders (Contractor, 2019), which is described as a "paradox" (Coff et al., 2006), and cannot be mitigated in favour of a clear decision for one of the two sides.

However, it can be seen from literature that there are parameters, such as decentralization of transfer decisions and the information richness of communication mechanisms, which can be used to reduce the tensions of this trade-off (Molina et al., 2007; Shaw et al., 2009). These two parameters are presented below.

2.2 Decentralization and Information Richness

The level of (I) *decentralization of transfer decisions* and (II) *information richness of communication mechanisms* are parameters that influence (facilitate or hinder) the transfer of operational capabilities (Gaur et al., 2019; Molina & Llorens-Montes, 2006; Nisar, Prabhakar & Strakova, 2019):

Decision-making decentralization varies between full decentralization and full hierarchy, whereby decentralization refers to the high level of freedom that an organizational member has in carrying out his or her activities (Grant, 1997; Molina et al., 2007). Decentralization, therefore, also influences commitment and cooperation in the transfer of operational capabilities (Nahapiet & Ghosal, 1998). According to Teece (2000), non-bureaucratic, decentralized, autocratic, and task-owner-oriented transfer conditions are particularly necessary to facilitate the transfer of capabilities in MNCs (Molina & Llorens-Montes, 2006). That is, it is difficult to transfer operational capabilities that are more likely to flow from one organizational unit to another. In addition, too much decentralization can lead to a lack of clear rules on intellectual property and security (Luo, 2022), and the transfer processes become uncontrolled and dissipated in the organization (Ritala, Husted, Olander & Michailnova, 2018). Individual capability owners might also resist a transfer if their decision-making freedom is too high, for example, because they fear a loss of uniqueness within the organization (Cabrera, Collins & Salgado, 2006). The managerial challenge is to balance the two sides: a high level of decentralization of decision-making to empower the independent creation and dissemination of operational capabilities within the organization and a low level of decentralization to ensure the transfer of capabilities in an orderly and safe manner (Andersson, 2003).

According to the information richness theory (Daft & Lengel, 1986), the effective transfer of operational capabilities also requires a fit between the codifiability, that is, the level of documentability of the operational capabilities, and the "richness" of the communication media or mechanisms (Windsperger & Gorovaia, 2010). Appropriate information richness is shown in four attributes (Ishii, Lyons & Carr, 2019; Windsperger & Gorovaia, 2010): immediate feedback, availability of multiple cues (voice, body, gestures, and words), language variety, and personal focus (transfer of emotions and feelings). Mechanisms that fulfil these attributes facilitate the sharing of unconcealed tacit knowledge as the basis of operational capabilities (Szulanski, Ringov & Jensen, 2016) because they can transfer the context of information, resolve ambiguity, and support understandability (Peltokorpi, 2014). While text-based communication mechanisms, such as e-mails, have rather low information richness, feedback can be provided, and body language is shown particularly quickly in face-to-face conversations (Abbariki, Snell & Easterby-Smith, 2017). Here, the information richness can be described as very high (Dunaetz, Lisk & Shin, 2015). However, high information richness in communication mechanisms bears the risk of unraveling the VRIN characteristics of capabilities more easily (see Section 2.1).

However, the two parameters of (I) decision-making decentralization and (II) information richness of communication mechanisms are not to be regarded as invariable. Rather, they need to be adapted to organizational changes (Chatterjee et al., 2021; Contractor, 2019). One of these changes is triggered by digitalization, which will be explained in the next section.

2.3 Digitalization

Digitalization causes changes in organizations through the increasing use of digital technologies (Krasonikolakis, Tsarbopoulos & Eng, 2020; Sandkuhl, Shilov & Smirnov, 2020), which leads to far-reaching socio-technical phenomena and processes of use and adaption (cf. Gray & Rumpe, 2015; Legner et al., 2017). This wide application of new technologies has also influenced the transfer of operational capabilities within MNCs, as strictly sequential and interdependent communication and decision-making channels, for example, within the relationship between a subsidiary and the parent company, have been dissolved by the introduction of standardized communication tools (Peñarroja, Sánchez, Gamero, Orengo & Zornoza, 2019). Consequently, activities can be uncoupled, and decision-making units can make partial decisions independently (Weyer, Schmitt, Ohmer & Gorecky, 2015). Therefore, organizational units can be linked to modular systems (cf. Herbst, 2021; Koch & Windsperger, 2017) and thus form temporary, network-like structures, such as connected production systems

(Lu, Liu, Wang, Huang & Xu, 2020). This also applies to the transfer of operational capabilities within digital networks which are implemented with the help of software tools, and thus can be made faster and more far-reaching (Paruchuri & Awate, 2016). Common communication mechanisms include blogs and wikis (Matos & Lourenço, 2013) or video conference technologies (Schneckenberg, Truong & Mazloomi, 2015). In the course of digitalization, platforms are also emerging, such as enterprise collaboration platforms in which interactions for extensive two-way dialogue among employees are created, including private and social topics and issues (Lehmkuhl & Jung, 2013). Thus, network attendees create social ties (Valenzuela, Correa & de Zuniga, 2018) in multilateral relationships between organizational units (Murray & Peyrefitte, 2007) and consequently build intra-firm networks of employees (Razzaque, Eldabi & Jalal Karim, 2013). The implementation of these digital networks creates more scope for interaction and coordination in the transfer of operational capabilities, which on the one hand allows faster and more frequent transfers with a high number of network participants and on the other hand also increases the danger of capabilities becoming transparent to external companies (Hurmelinna-Laukkanen, 2011), which amplifies the risk of the disclosure of operational capabilities (Krylova, Vera & Crossan, 2016).

Thus, further research is needed on how to mitigate this trade-off which gets intensified by advancing digitalization. An approach to this is presented in the next section.

3. Research Framework

In this study, a research framework (see Fig. D-1) was applied to investigate the trade-off between the facilitation of the transfer of operational capabilities and their protection from disclosure in times of digitalization. This research framework was developed based on the theoretical foundations in Section 2. At this point, it could be shown that the tensions cannot be mitigated by a decision in favor of one of the conflicting goals. Instead, one proposition is to make the trade-off “more favorable” (Teece, 2019) by reducing (Mudambi, 2011) or more strongly narrowing down the conflict to the level of balancing parameters (Elahi & Yu, 2007; Winter, 1987), which need to be optimized. In the literature, the two parameters of (I) decentralization of decision-making and (II) the information richness of communication mechanisms are often discussed as having an impact on the transfer and protection of operational capabilities (see Section 2.2). That is, they can be seen as “third variables” (Ledgerwood & Shrout, 2011) and sub-parameters. However, the balancing of (I) and (II) can range from high to low and always needs to be adapted in consideration of organizational changes. As shown in Section 2.3, digitalization can be seen as a cause of organizational change, which has shifted the transfer of operational capabilities. This means especially the transformation from traditional bilateral communication (e.g., headquarters and subsidiaries) to multilateral communication based on software tools, such as collaboration platforms that enable the coordination and interaction by means of multiple connections and transfer channels (see Section 2.3).

Therefore, based on the review of the literature in the respective sections the present research framework focuses on the optimization of the two sub-parameters (I) decentralization of decision-making and (II) information richness of communication mechanisms under digitalization. This research framework, therefore, builds the starting point for the in-depth case study approach and thus can shed light on the optimization of (I) and (II) from a qualitative perspective. The underlying methodology is explained in the next Section.

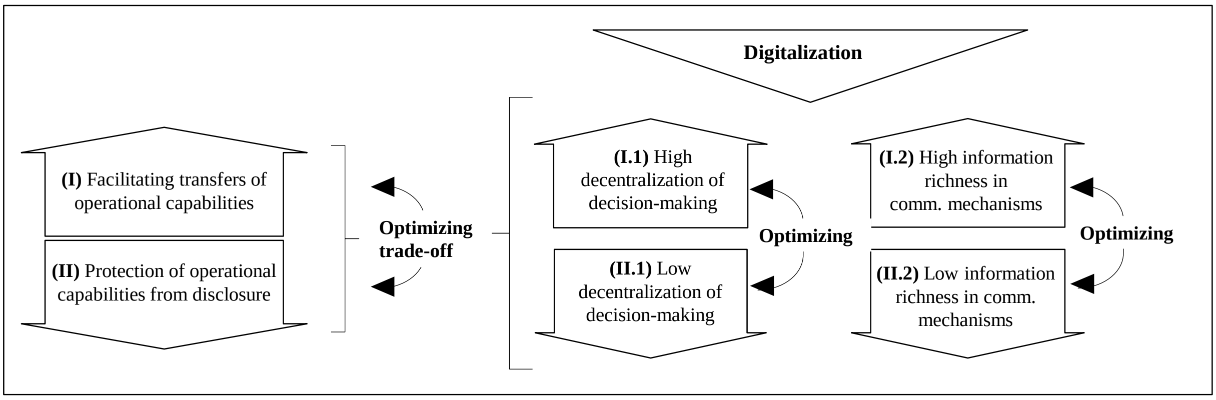

Fig. D-1: Research framework (Source: own compilation)

4. Methodology

4.1 Case Study Approach

Qualitative research was used that provides in-depth insights into the transfer of operational capabilities (Mees-Buss, Welch & Westney, 2019; Simons, 2013) by answering "how" and "why" questions (Yin, 2004). The case in the present research is a worldwide industrial company headquartered in Germany, generating more than 5 billion euros in sales with more than 20,000 employees (state of 2022) from over 100 locations. It has diversified its product portfolios for industrial products. Digital intra-firm networks for the transfer of operational capabilities have already been implemented.

4.2 Data Collection

The present study's data are based on 12 interviews with middle- and top-management employees who are highly involved in knowledge and capability-transferring activities. The interviews were conducted following a semi-structured approach with open questions (Wagstaff, Salvaj & Villanueva, 2020) concerning decentralization of transfer decisions (for example, "How can participants decide to take part in capability transfers" and "Who is responsible for the administration of these transfers?") and the information richness of communication mechanisms (e.g., "What kind of software do you use in the transfer of capabilities?" and "Which type of data were transferred?"). Video calls were used for each interview (Gray, Wong-Wylie, Rempel & Cook, 2020) with respondents from international company locations, and the interviews were recorded (see Tab. D-1).

Respondent	**Position at Company**	**Located**	**Duration**
A	Head of Corporate Business Excellence	Headquarters	84 min
B	Corporate Excellence Network Manager	Headquarters	60 min
C	Corporate IT Manager	Headquarters	58 min
D	Head of Corporate IT	Headquarters	58 min
E	Corporate Strategy Manager	Headquarters	50 min
F	Senior Manager Production Excellence	Subsidiary	63 min
G	Vice President	Subsidiary	53 min
H	Plant Manager	Subsidiary	53 min
I	Plant Manager	Subsidiary	54 min
J	CTO, COO Business Unit	Subsidiary	58 min
K	Technology Manager	Staff Unit	76 min
L	Technology Manager	Staff Unit	65 min

Tab. D-1: Conducted interviews (source: own compilation)

After 12 interviews with a deep focus on the research question, the point of saturation was reached, that is, no new information could be gained after this point (Glaser & Strauss, 1967). The recorded interviews were transcribed for data analysis (Meyer, 2001), resulting in 124 pages of transcription. For triangulation, additional digital artifacts were collected (Eisenhardt, 1989) in the form of software manuals (991 pages) and documents (626 pages), both demonstrating the functionality and features of the networks. The research team was also allowed to attend live meetings on intra-firm capability transfers. A researcher with expertise in knowledge and capability transfer conducted pretests of the interviews with two employees from the organization (Ellram, 1996) before the actual interviews were conducted.

4.3 Data Analysis

The analysis was applied to all the available data (interview transcripts, documents, and software manuals; see Section 4.1) following the principles of inductive qualitative research (Gioia, Corley & Hamilton, 2013). Open coding was applied (Holton, 2007) and supported with software (MAXQDA; see Kuckartz & Rädiker, 2019) using the constant comparison method (Corbin & Strauss, 1990). By cycling between the coded data and theoretical constructs and vice versa, central statements and first-order concepts were generated from the data and finally grouped into sub-parameters ("second-order concepts"; Langley, 1999; Strauss, 1987, see Fig. D-2). The results indicate how to set these sub-parameters to optimize (I) the decentrality of decisions and (II) the information richness of communication mechanisms (see Section 3). For proof of reliability, research colleagues who performed the coding independently arrived at the same conclusion (Yan & Gray, 1994).

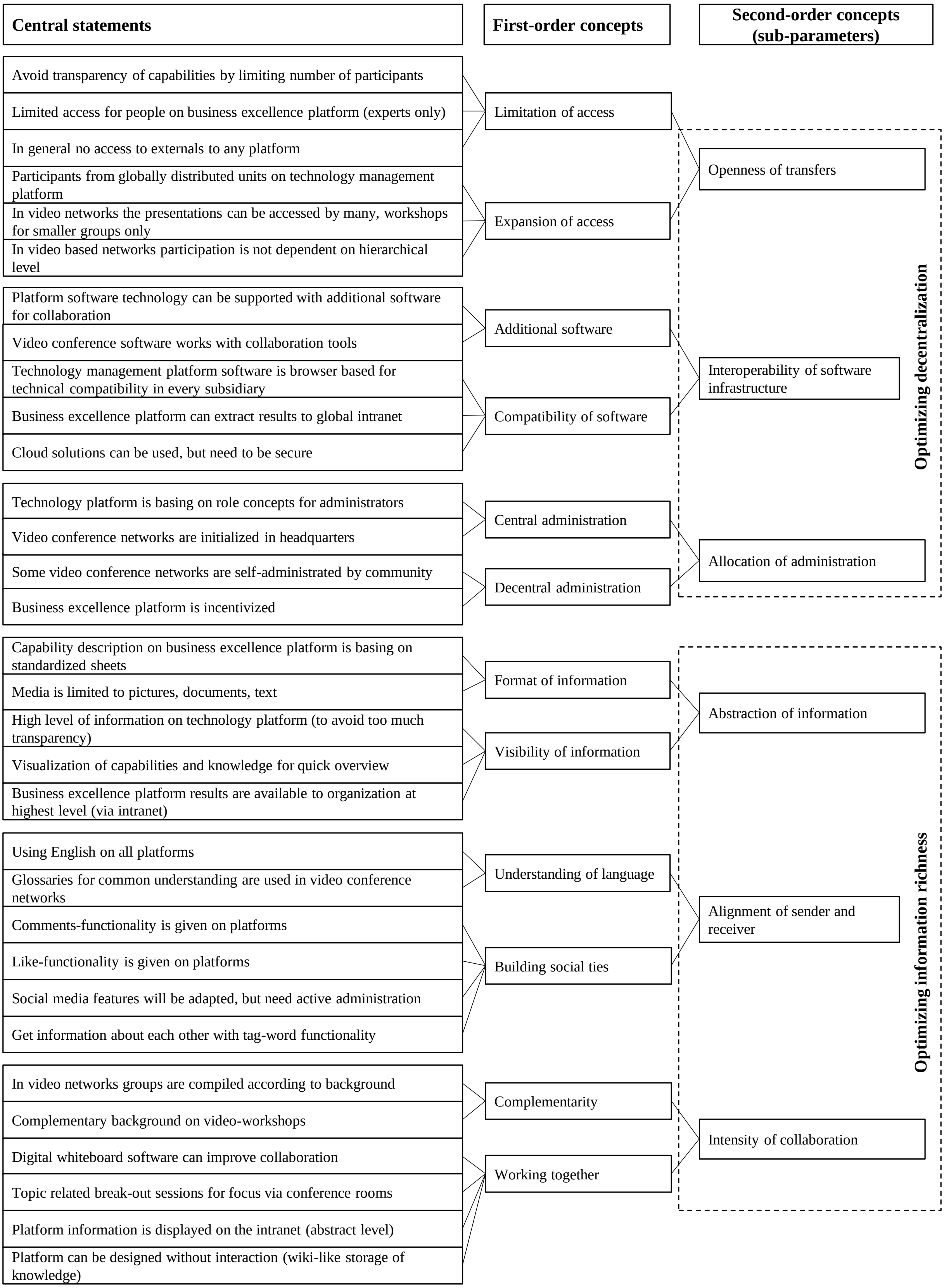

Fig. D-2: Central statements, first-order concepts, and aggregated sub-parameters for the optimization of decentralization and information richness (source: own compilation)

5. Findings

On the one hand, digital collaboration platforms are set up within the case study company in which participants contribute their best practices or technologies and transfer information to the community. These platforms are based on enterprise social media technology, where users can open, edit, and comment on best practices and participate in virtual groups (Gressgard, 2012; Sun, Fang & Zhang, 2021). On the other hand, networks based on video conferencing technology are built in which participants deliver presentations or participate in interactive workshops. Both network types differ in terms of (I) the decentralization of the MNC's decisions on transfers and (II) the information richness of the communication mechanisms, which can be seen in the three sub-parameters for both (I) and (II).

5.1 Optimizing the Decentralization of Decision-Making

Sub-Parameter A: Openness of transfer

From the data, it can be seen that the company has defined accessibility to its transfer networks for the subsidiaries', and headquarters' employees to varying degrees. In the case of collaboration platforms, this parameter is set more restrictively such that only a fixed group of participants is admitted. Registration was not possible for all employees. For example, the worldwide business excellence platform for best practice transfers has limited access to business excellence experts. The company wants to keep the number of transfer participants manageable, thereby avoiding the circulation of capabilities in an uncontrolled manner.

Capability transfer networks based on video network technology extend beyond the usual one-to-one conversations in normal calls and act more like "communities of practice" (Roberts, 2006). Meetings normally take place with 10 to 15 participants and therefore have smaller characteristics. The openness of transfer is high and is based on a voluntary exchange of capabilities so that participants benefit from free (i.e., intrinsically motivated) interaction and the formation of social relationships (Lave & Wenger, 1991). That is, network members from different subsidiaries are free to transfer their capabilities, as respondent B stated.

"[…] and by the foundation of these networks people from different company locations can meet on [video conference software], and can talk to each other, and can share capabilities very well."

Participants' access is granted without restrictions concerning their hierarchical level or affiliation to a corporate division, and the interaction can occur in webinars and lectures, mainly in smaller groups, so that conversations are easy to manage.

Sub-Parameter B: Interoperability of Software Infrastructure

The company uses a standardized collaboration platform and video-conferencing technologies in which the central headquarters or leading subunits have decided to implement and meet the requirements specified by the top management. Both network types have the possibility of expansion. In collaboration platforms, software usage is browser- and cloud-based, because standard interfaces (see Section 2.2) can enable compatibility with a broad range of global IT systems, as can be seen from respondent L:

"The software is cloud-based software, which we deliberately chose. Because we need to have a cross-group tool, and because our group has different IT architectures, which then cannot always connect to one solution. Therefore, a cloud-based solution that is accessible through the browser."

However, independent use of additional software is not possible. Instead, only software extensions that work together with existing infrastructure (add-in tools) can be used. By doing so, the software variety is expanded to a predetermined pool of products, applications, and additional tools that have been proven to be secure. This ensures that the transferred capabilities remain within controllable environments and that the transfer processes are stable.

In transfer networks based on video call technology, standardized software can be expanded for functionality up to a certain level, for example, if more collaboration is needed. Additional software was used in parallel. Therefore, communities can individually decide whether an additional browser-based collaboration tool should be added, such as *Mural* (Mural Enterprise, 2021), which supports the joint creation and editing of content and information. This affords users more freedom than would be possible with proprietary solutions, leading to improvements in meeting their expectations and increasing their satisfaction (Wang & Li, 2012).

Sub-Parameter C: Allocation of Transfer Administration

Networks that transfer capabilities based on collaboration platform technology or video technology are implemented within the company from the headquarters or by leading subsidiaries, but administration differs according to the size and underlying technology of these networks. Big transfer networks based on platforms (e.g., best practice sharing in a narrowly defined subject area) are administered by a central subsidiary, which uses a reward system based on performance points to track and incentivize transfer activities, as respondent F explained:

"Sharing knowledge of best practice and lessons learned is part of our excellence system, and that is assessed in assessments, and if the factories don't do that […] then he [transfer contributing subsidiary] gets fewer points."

Incentivization often occurs when there are too few network participants to generate a steady flow of contributions or when they have little motivation to share the information on their own (Friedrich, Becker, Kramer, Wirth & Schneider, 2020). Especially at the beginning of the formation of such platforms, incentivization is a solution to generate both secure and traceable transfer activities, as well as adequate engagement from the participants. Centralized administration with incentivization for transfer activities mediates these networks, creating an artificial impetus for transfers. On some platforms that have reached a certain size, the central units cannot handle the administration alone because the traceability of activities across the growing network requires too much capacity. Therefore, globally accessible platforms are based on role concepts, meaning that certain community members become administrators acting as moderators, who can still maintain connections to top-level administrators.

In contrast, video-technology-based transfer networks are implemented from the headquarters to staff offices but can move from centrally administrated to self-administered governance (i.e., managed independently by the community). Respondent A stated:

"We see that the members of the network access the colleagues in the excellence network as a source of solutions for their daily business as if it were a matter of course. […] This means that beyond the formal events, independently developing networks emerge here."

In this case, people from different subsidiaries of the network are part of the transfer network and are also responsible for coordinating transfer processes and content.

5.2 Optimizing Information Richness in Communication Mechanisms

Sub-Parameter D: Abstraction of Information

The case study company's collaboration-platform-based transfers contain information with reduced details only. Even though more detailed information can be transferred, the storage of capabilities is based on superficial and standardized input options with a higher degree of abstraction so that sensitive data and information do not become too transparent in the organization. This kind of "anonymization" (Alamäki, Aunimo, Ketamo & Parvinen, 2019) of content decreases the information richness and is chosen in such a way that the stored capabilities still provide a basic understanding of the underlying principles and functionalities;

more detailed information is deliberately transferred only if there is interest in a bilateral exchange, which is handled via other channels. Respondent L confirmed this as follows:

“However, technical documents or drawings are never exchanged on the platform. This is not done via the cloud, but is exchanged bilaterally between the experts using internal communication channels.”

In comparison, networks based on video conference software enable the transfer of operational capabilities with greater language variety and a higher number of cues and channels (Daft & Lengel, 1986), which is typical in video face-to-face interactions. Thus, even capabilities in a highly complex context can be explained by these mechanisms. Because the group of participants in workshops, in particular, is small compared to the potential number of people in platform-based solutions, the risk of uncontrolled transfer of capabilities remains low.

Sub-Parameter E: Alignment of Sender and Receiver

On the company’s collaboration platforms, participants can add keywords, ratings, comments, and linkages to information on capabilities, and the sender and receiver will automatically get in touch after a search inquiry. In particular, because the organization is increasingly based on the globally distributed expertise and knowledge of individuals (see also Caldwell, Palmer & Cuevas, 2008), the company’s platforms can connect members if they have shared interests or complementary capabilities. According to Sheer (2011), even though these exchange channels offer limited opportunities for transmitting social information compared with face-to-face communication, their multiple features (e.g., commenting, rating, and sharing) make it easier to build relationships and build up social-emotional cues (Daft & Lengel, 1986). In the future, the company intends increasingly to rely on algorithms with artificial intelligence analyzing each documentation of capabilities to make accurate recommendations as to which capabilities need to be transferred to which persons. According to Respondent D,

“[This technology can] evaluate the information that I have and target it in the group or on an employee’s intranet page who then says he is interested in the following points, and then he gets a tech cloud, and there is the intelligence behind it. These are new ways to display relevant information. [...] New topics are suggested to me.”

In comparison to collaboration platforms, the company’s video-based networks offer the possibility of face-to-face interaction, which can enable rapid feedback related to information richness (Daft & Lengel, 1986). In these networks, wikis and glossaries as well as user profiles are created to improve participants’ understanding of the topics issued in the network, where prior knowledge is required. As a result, not only are the participants always involved and they co-determine the content of the transfer networks, but also the alignment of participants to network goals is stronger than on digital platforms.

Sub-Parameter F: Intensity of Collaboration

The transfer of capabilities via the digital collaboration platform focuses on the unilateral sharing of information and is based only on delayed feedback because there is a time lag between members' contributions, which prevents instant answers and communication (Dennis & Kinney, 1998). Consequently, platform transfers are mainly utilized to document best practices and publish them within a circle of participants. Collaboration occurs at a low level through comments, supplementary entries, or shared documents edited by the community. On the one hand, this hinders the deeper co-creation of capabilities, but on the other hand, it can keep the collaboration documentable and thus prevent uncontrolled and overhasty dissemination of content.

For more intensive collaboration with multilateral interaction, video-technology-based networks enable the transfer of operational capabilities with greater language variety and a higher number of cues and channels (see Daft & Lengel, 1986). This allows people with different background knowledge to interact better with each other and exchange the character of a workshop in which content is developed jointly. Respondent C said:

"Because we do everything at [video-call software] and […] said we would take people from our network top-down to the technical basis so that we can work in a workshop format."

In the course of this communication, participants can not only document their already known capabilities but also, by bringing in complementary knowledge, co-create completely new capabilities ("value co-creation"; Vargo & Lusch, 2008) outside their daily work. In this context, additional collaboration software is used in the case company, which people can use in different groups (e.g., on a blackboard or a mind map) and present the results together, giving immediate feedback.

6. Implications

The findings from the present study show six parameters behind (I) decentralization of decision-making and (II) the information richness of communication mechanisms, which optimize the facilitation of intra-firm transfers of operational capabilities and their protection from disclosure to externals in times of digitalization (see Fig. D-3).

	Sub-Parameters	Digital collaboration platform	Video-technology network
Optimizing decentralization	**Openness of transfer** (A)	Restricted access to platforms, background related (i.e., experts only)	Open access, voluntary participation, interdisciplinary composition
	Interoperability of software infrastructure (B)	Cloud-based standardized platform software, supplementary add-in tools	Standardized video-conference software, supplementary stand-alone software
	Allocation of administration (C)	Initialized (incentivated) by central units, administration by de-central moderators and automated algorithms (for big networks)	Initialized in headquarters, self-administration by community
Optimizing information richness	**Abstraction of information** (D)	High level of abstraction (summarized information, text- and graphics-based interaction)	Low level of abstraction (detailed information, virtual face-to-face interaction)
	Alignment of sender and receiver (E)	Tag-words, linkages, ratings, comments and search functionality	Common understanding via glossaries, wikis, user profiles
	Intensity of collaboration (F)	Delayed feedback on platforms, limited co-creation of capabilities	Immediate co-creation of capabilities, enabling of workshop mode

Fig. D-3: Adjustments of sub-parameters for optimizing decentralization and information richness of capability transfers (source: own compilation)

Accordingly, decentralization in decision-making regarding the transfer of operational capabilities can be optimized by adjusting A) the accessibility of the transfer activities ("openness of transfer"), B) the level of autonomy to expand the software functionality or compatibility that is used in communication ("interoperability of software infrastructure") and C) the responsibility for the administration of the transfers ("allocation of administration"). The information richness of communication mechanisms in transfers of operational capabilities can be optimized by adjusting D) the depth of details of the transferred information ("abstraction of information"), E) the characteristics of the alignment between the sender and receiver of the capabilities ("alignment of sender and receiver"), and F) the intensity of collaboration, for example, when co-creating capabilities together.

The results provide initial indications of how the sub-parameters will be designed within the two basic technologies of collaboration platforms and video-conferencing for the transfer of operational capabilities. Companies can adjust (I) the decentralization of their decisions in the transfer of operational capabilities via collaboration platforms through limited access management for participants (A), a controlled extension of the software infrastructure without foreign additional tools (B), and a shift of administration to moderators in the case of larger numbers of participants on collaboration platforms (C). (II) Information richness in platform-based transfers can be optimized with abstract information sharing only (D), enabling the alignment of participants by (increasingly automated) matching their common interests and improving personalization (E). Moreover, companies might accept delayed collaboration functionality (F), which minimizes the risk of the rapid spread of sensitive content that occurs when communication is left completely dynamic and in real-time. For this reason, collaboration platform technology in the MNC is mainly used for the transfer of best practices to larger groups of participants (e.g., in the sharing of best practices in business excellence).

Furthermore, MNCs can optimize their (I) decentralization of decision-making in the transfer of operational capabilities via video conference software by providing open access for participants (A), allowing additional software for enhanced functionalities that can improve collaboration (B), and outsourcing the administration of transfers to the community (C). (II) Information richness of communication mechanisms is facilitated by allowing detailed information sharing (D), improving mutual understanding in smaller groups (e.g., by writing glossaries) (E), and enabling bilateral and live collaborations for strong co-creation of capabilities (F). That is, video conference technology-based networks facilitate the transfer of particularly complex operational capabilities and can create new capabilities in smaller groups of participants such that sensitive information is contained within a well-defined circle of involved participants.

7. Conclusion

7.1. Theoretical Contributions

This article has investigated the paradox between facilitating the intra-firm transfers and the protection of operational capabilities from becoming lost to externals in times of digitalization. So far, in the literature, this trade-off has been treated as a black box and has not been examined in detail by considering balancing factors for digital communication mechanisms (see Section 1). By narrowing down the trade-off with the introduction of “third variables” as balancing parameters (Elahi & Yu, 2007; Ledgerwood & Shrout, 2011), which includes optimizing the (I) decentralization of the MNC’s decisions and (II) the information richness of communication mechanisms, this study could provide a theory-based approach to mitigate the paradox. In general, the findings have contributed to a better understanding of the theoretical constructs of decentralization and information richness under digital impact. In particular, six sub-parameters for the optimization of the balancing parameters were identified. Thus, the present case-study results extend the previously generically described understanding of decentralization of decision-making (e.g., Grant, 1997) and information richness (Daft & Lengel, 1986) and apply it to the design of digital capability transfer networks, in which the balance between transfer and protection of operational capabilities are optimized. The identification of sub-parameters for (I) and (II) can thus also provide a fundamental basis for operationalizations in quantitative empirical research in the field of digital intra-firm knowledge or capability transfers.

7.2. Practical Contributions

The findings from the single-case study revealed six sub-parameters of (I) decentralization of decision-making and (II) the information richness of communication mechanisms, which can help the management of MNCs, to adjust their digital capability transfer networks. In particular, practical indications were provided, on how to design digital collaboration platforms and video conference networks that can improve the transfers, but without losing capabilities to externals (mitigation of the "paradox"; Coff et al., 2006). The findings show that to transfer operational capabilities in networks with many participants, but without uncontrolled content distribution, collaboration platform-based networks with a balancing parameter setting of lower decentralization and information richness would be appropriate. In contrast, for collaborative exchanges among participants and intensified interactions in smaller groups, video-based networks with parameters that lead to high autonomy and information richness could be the most suitable choice for MNCs. For both platform-based networks and video-based networks, the present research could provide concrete recommendations for implementation (see Section 6). Thus, the findings will not only contribute to the identification of design parameters for balancing the trade-off but can also be a preparation for the establishment of virtual organizations (Choi & Cho, 2019) in the medium term or the transfer of knowledge and capabilities in increasingly discussed metaverse organizations (Choi, 2022) in the future.

7.3. Limitations

Despite the contributions of this study, several limitations should be considered in future research. Due to the non-representative nature of the sample, the data collection process might be subjective and cause research bias (e.g., when identifying interview partners and conducting the interviews). Hence, the findings should be considered with care (as initial indications that require further quantitative research), since they do not provide general validity. In addition, other sectors or industries may have different digitalization impacts and capability transfers than those in the present study. Future research could therefore also apply a quantitative research approach to include a larger number of participants and allow conclusions to be drawn about the generalization of the results.

References

Abbariki, M., Snell, R.S. & Easterby-Smith, M. (2017). Sharing or ignoring tacit knowledge? A comparison of collective learning routines at two sites. Journal of General Management, 42(4), 57-67.

Alamäki, A., Aunimo, L., Ketamo, H. & Parvinen, L. (2019). Interactive Machine Learning: Managing Information Richness in Highly Anonymized Conversation Data. In Proceedings of the 20th Working Conference on Virtual Enterprises (PRO-VE), Turin, Italy, September 23-25, pp.173-184. Springer.

Amit, R. & Schoemaker, P.J.H. (1993). Strategic assets and organizational rent. Strategic Management Journal, 14(1), 33-46.

Andersson, U. (2003). Managing the transfer of capabilities within multinational corporations: the dual role of the subsidiary. Scandinavian Journal of Management, 19(4), 425-442.

Argote, L. & Fahrenkopf, E. (2016). Knowledge transfer in organizations: The roles of members, tasks, tools, and networks. Organizational Behavior and Human Decision Processes, 136, 146–159.

Argyres, N. (2021). Virtual Special Issue: The Organizational Economics of Organizational Capability Development. Organization Science, 32(2), 522-525.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99-120.

Berraies, S. (2019). The effect of enterprise social networks use on exploitative and exploratory innovations: Mediating effect of sub-dimensions of intellectual capital. Journal of Intellectual Capital, 20(3), 426-452

Bloodgood, J.M. (2019). Knowledge acquisition and firm competitiveness: the role of complements and knowledge source. Journal of Knowledge Management, 23(1), 46-66.

Burmeister, A., Lazarova, M.B. & Deller, J. (2016). The influence of motivation, opportunity, ability, and tacitness on Repatriate Knowledge Transfer. Academy of Management Proceedings, 2016(1).

Cable, D.M. & Yu, K.Y.T. (2006). Managing job seekers' organizational image beliefs: The role of media richness and media credibility. Journal of Applied Psychology, 91(4), 828-840.

Cabrera. A., Collins, W.C. & Salgado, J.F. (2007). Determinants of individual engagement in knowledge sharing. The International Journal of Human Resource Management, 17(2), 245-264.

Caldwell, B.S., Palmer, R.C. & Cuevas, H.M. (2008). Information Alignment and Task Coordination in Organizations: An 'Information Clutch' Metaphor. Information Systems Management, 25(1), 33-44.

Cano-Kollmann, M., Cantwell, J., Hannigan, T.J., Mudambi, R. and Song, J. (2016) Knowledge connectivity: An agenda for innovation research in international business. Journal of International Studies, 47, 255-262.

Cepeda, G. & Vera, D. (2007). Dynamic capabilities and operational capabilities: A knowledge management perspective. Journal of Business Research, 60(5), 426-437.

Chatterjee, S., Chaudhuri, R., Vrontis, D., & Piccolo, R. (2021). Enterprise social network for knowledge sharing in MNCs: examining the role of knowledge contributors and knowledge seekers for cross-country collaboration. Journal of International Management, 27(1), 100827.

Choi, H.Y. (2022). Working in the Metaverse: Does Telework in a Metaverse Office Have the Potential to Reduce Population Pressure in Megacities? Evidence from Young Adults in Seoul, South Korea. Sustainability, 14(6), 3629.

Choi, O. K., & Cho, E. (2019). The mechanism of trust affecting collaboration in virtual teams and the moderating roles of the culture of autonomy and task complexity. Computers in Human Behavior, 91, 305-315.

Coff, R.W., Coff, D.C. & Eastvold, R. (2006). The Knowledge-Leveraging Paradox: How to Achieve Scale without Making Knowledge Imitable. Academy of Management Review, 31(2), 452-465.

Contractor, F.J. (2019). Can a firm find the balance between openness and secrecy? Towards a theory of an optimum level of disclosure, Journal of International Business Studies 50, 261-274.

Corbin, J.M. & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. Qualitative Sociology, 13(1), 3-21.

Culot, G., Orzes, G., Sartor, M. & Nassimbeni, G. (2020). The future of manufacturing: A Delphi-based scenario analysis on industry 4.0. Technological Forecasting & Social Change, 157.

Daft, R.L. & Lengel, R.H. (1986). Organizational information requirements, media richness and structural design. Management Science, 32(5), 513-644.

Dennis, A.R. & Kinney, S.T. (1998). Testing Media Richness Theory in the New Media: The Effects of Cues, Feedback, and Task Equivocality. Information Systems Research, 9(3), 256-274.

De Castro, J.M. & Aquino, H. (2021). The role of institutional pressure in knowledge internalization: a longitudinal case. International Journal of Management Practice, 14(5), 561-579.

Dunaetz, D.R., Lisk, T.C. & Shin, M.M. (2015). Personality, gender, and age as predictors of media richness preference. Advances in Multimedia, 7, 7.

Eisenhardt, K.M. (1989). Building Theories from Case Study Research. The Academy of Management Review, 14(4), 532-550.

Eisenman, M. & Paruchuri, S. (2019). Inventor knowledge recombination behaviors in a pharmaceutical merger: The role of intra-firm networks. Long Range Planning, 52(2), 189-201.

Elahi, G. & Yu, E. (2007). A Goal Oriented Approach for Modeling and Analyzing Security Trade-Offs. In: Parent, C. (Eds.) Conceptual Modeling - ER 2007, Lecture Notes in Computer Science (p. 4801). Berlin: Springer.

Ellram, L.M. (1996). The use of the case study method in logistics research. Journal of Business Logistics, 17(2), 93-138.

Friedrich, J., Becker, M., Kramer, F., Wirth, M. & Schneider, M. (2020). Incentive design and gamification for knowledge management. Journal of Business Research, 106, 341-352.

Gaur, A.S., Ma, H. & Ge, B. (2019). MNC strategy, knowledge transfer context, and knowledge flow in MNEs. Journal of Knowledge Management, 23(9), 1885-1900.

Gioia, D.A., Corley, K.G. & Hamilton, A.L. (2013). Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology. Organizational Research Methods, 16(1), pp. 15-31.

Glaser, B.G. & Strauss, A.L. (1967). The discovery of grounded theory: Strategies for qualitative research. Chicago: Aldine Publishers.

Grant, R.M. (1997). The knowledge-based view of the firm: implications for management practice'. Long Range Planning, 30, 450–454.

Gray, J. & Rumpe, B. (2015). Models for digitalization. Software & Systems Modeling, 14, 1319-1320.

Gray, L.M., Wong-Wylie, G., Rempel, G. & Cook, K. (2020). Expanding Qualitative Research Interviewing Strategies: Zoom Video Communications. The Qualitative Report, 25(5), 1292-1301.

Gressgard, L.J. (2012). Computer-mediated group communication and ideation performance. International Journal of Business Science and Applied Management, 7(2), 29-39.

Hagiu, A. & Wright, J. (2015). Multi-sided platforms. International Journal of Industrial Organization, 43(C), 162-174.

Herbst, T.D. (2021). Component suppliers in the commodity battle: Can digital technology in multi-tier supply chains help to transform liabilities into opportunities? International Journal of Business Science and Applied Management, 16(2), 22-45.

Helfat, C.E. & Winter, S. (2011). Untangling Dynamic and Operational Capabilities: Strategy for the (N)Ever-Changing World. Strategic Management Journal, 32(11), 1243-1250.

Holton, J.A. (2007). The coding process and its challenges. In Bryant, A. & Charmaz, K. (Eds.), The Sage handbook of grounded theory (pp. 265-289). London: Sage.

Hurmelinna-Laukkanen, P. (2011). Enabling collaborative innovation – knowledge protection for knowledge sharing. European Journal of Innovation Management, 14(3), 303-321.

Inkpen, A.C. (2008). Managing knowledge transfer in international alliances. Thunderbird International Business Review, 50, 77-90.

Inkpen, A., Minbaeva, D., Tsang, E.W.K. (2018). Unintentional, unavoidable, and beneficial knowledge leagage from the multinational enterprise. Journal of International Business Studies, 50, 250-260.

Ishii, K., Lyons, M.M. & Carr, S.A. (2019). Revisiting media richness theory for today and future. Human Behavior and Emerging Technologies, 1(2), 124-131.

Jankowska, B., Bartosik-Purgat, M. & Olejnik, I. (2020). The reverse transfer of knowledge in MNEs: the perspective of foreign subsidiaries in a post-transition country. Journal of Intellectual Capital (ahead of print).

Keupp, M.M., Palmié, M. & Gassmann, O. (2011). Achieving subsidiary integration in international innovation by managerial 'tool'. Management International Review, 51(2), 213–239.

Koch, T. & Windsperger, J. (2017). Seeing through the network: Competitive advantage in the digital economy. Journal of Organization Design, 6(6).

Krasonikolakis, I., Tsarbopoulos, M. & Eng, T.Y. (2020). Are incumbent banks bygones in the face of digital transformation? Journal of General Management, 46(1), 60-69.

Krylova, K.O., Vera, D. & Crossan, M. (2016). Knowledge transfer in knowledge intensive organizations: the crucial role of improvisation in transferring and protecting knowledge. Journal of Knowledge Management, 20(5), 1045-1064.

Kuckartz, U. & Rädiker, S. (2019). Analyzing qualitative data with MAXQDA. Text, audio, and video. Cham: Springer Nature.

Langley, A. (1999). Strategies for theorizing from process data. Academy of Management Review, 24, 691–710.

Lauritzen, G.D. & Karafyllia, M. (2018). Perspective: Leveraging Open Innovation through Paradox. Journal of Product Innovation Management, 36(1), 107-121.

Lave, J. & Wenger, E. (1991). Situated Learning: Legitimate Peripheral Participation. Cambridge: Cambridge University Press.

Law, K.K. & Kamoche, K. (2015). Re-conceptualising Knowledge Transfer Approach: A two-dimensional framework. Journal of General Management, 41(2), 59-77.

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N. & Ahlemann, F. (2017). Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community. Business & Information Systems Engineering, 59(4), 301–308.

Lehmkuhl, T. & Jung, R. (2013). Towards Social CRM - Scoping the concept and guiding research. 26th Bled eConference 'eInnovations: challenges and impacts for individuals, organizations and society'.

Ledgerwood, A. & Shrout, P.E. (2011). The trade-off between accuracy and precision in latent variable models of mediation processes. Journal of Personality and Social Psychology, 101(6), 1174-1188.

Lu, Y., Liu, C., Wang, K.I.K., Huang, H. & Xu, X. (2020). Digital Twin-driven smart manufacturing: Connotation, reference model, applications and research issues. Robotics and Computer-Integrated Manufacturing, 61, 1-14.

Luo, Y. (2022). A general framework of digitization risks in international business. Journal of International Business Studies, 53, 344-361.

Matos, J.L.A. & Lourenço, R.P. (2013). Use and acceptance of social software in corporate environments. Management Research, 11(3), 305-329.

Mees-Buss, J., Welch, C. & Westney, D.E. (2019). What happened to the transnational? The emergence of the neo-global corporation. Journal of International Business Studies, 50, 1513-1543.

Meyer, C.B. (2001). A Case in Case Study Methodology. Field Methods, 13(4), 329-352.

Molina, L.M., Lloréns-Montes, J. & Ruiz-Moreno, A. (2007). Relationship between quality management practices and knowledge transfer. Journal of Operations Management 25(3), 682-701.

Molina, L.M. & Llorens-Montes, F.J. (2006). Autonomy and teamwork effect on knowledge transfer: knowledge transferability as a moderator variable. International Journal of Technology Transfer and Commercialisation, 5(3), 263-280.

Mudambi, R. (2011). Hierarchy, coordination, and innovation in the multinational enterprise. Global Strategy Journal, 1(3/4), 317-323.

Mural Enterprise (2021). Visual Collaboration at the enterprise level. Retrieved May 10, 2022, from https://www.mural.co/enterprise

Murray, S.R. & Peyrefitte, J. (2007). Knowledge Type and Communication Media Choice in the Knowledge Transfer Process. Journal of Managerial Issues, 19(1), 111-133.

Nahapiet, J. & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. Academy of Management Review, 23(2), 242-266.

Nesheim, T. & Gressgard, L.J. (2014). Knowledge sharing in a complex organization: Antecedents and safety effects. Safety Design, 62, 28-36.

Nisar, T.M., Prabhakar, G. & Strakova, L. (2019). Social media information benefits, knowledge management and smart organizations. Journal of Business Research, 94(C), 264-272.

Paruchuri, S. & Awate, S. (2017). Organizational knowledge networks and local search: The role of intra-organizational inventor networks. Strategic Management Journal, 38(3), 657-675.

Papa, A., Dezi, L., Gregori, G.L., Mueller, J. & Miglietta, N (2018). Improving innovation performance through knowledge acquisition: the moderating role of employee retention and human resource management practices. Journal of Knowledge Management 24(3), 589-605.

Peltokorpi, V. (2014). Corporate Language Proficiency and Reverse Knowledge Transfer in Multinational Corporations: Interactive Effects of Communication Media Richness and Commitment to Headquarters. Journal of International Management, 21(1), 49-62.

Peñarroja, V., Sánchez, J., Gamero, N., Orengo, V., & Zornoza, A.M. (2019). The influence of organisational facilitating conditions and technology acceptance factors on the effectiveness of virtual communities of practice. Behaviour & Information Technology, 38(8), 845-857.

Proff, H. (2005). A “model of resources refinement“ for deriving competence-based competitive advantages and strategies. In: Sanchez, R. & Heene, A. (Eds.) Resources, stakeholders, and renewal (pp. 55-80). Amsterdam: Pergamon Press.

Prompreing, K., Hu, C. (2021). The Role of Knowledge-Sharing Behaviour in the Relationship Between the Knowledge Creation Process and Employee Goal Orientation. International Journal of Business Science and Applied Management, 16(2), 47-63.

Ralston, P. & Blackhurst, J. (2020). Industry 4.0 and resilience in the supply chain: a driver of capability enhancement or capability loss? International Journal of Production Research, 58(16), 5006-5019.

Razzaque, A., Eldabi, T. & Jalal-Karim, A. (2013). Physician virtual community and medical decision making: Mediating role of knowledge sharing. Journal of Enterprise Information Management, 26(5), 500-515.

Ritala, P., Husted, K., Olander, H. & Michailnova, S. (2018). External knowledge sharing and radical innovation: the downsides of uncontrolled openness. Journal of Knowledge Management, 22(5), 1104-1123.

Ritala, P. & Stefan, I. (2021). A paradox within the paradox of openness: The knowledge leveraging conundrum in open innovation. Industrial Marketing Management, 93, 281-292.

Roberts, J. (2006). Limits to communities of Practice. Journal of Management Studies, 43(3), 623-639.

Sandkuhl, K., Shilov, N. & Smirnov, A. (2020). Facilitating digital transformation: success factors and multi-aspect ontologies. International Journal of Integrated Supply Management, 13(4), 376-393.

Schneckenberg, D., Truong, Y. & Mazloomi, H. (2015). Microfoundations of innovative capabilities: The leverage of collaborative technologies on organizational learning and knowledge management in a multinational corporation. Technological Forecasting and Social Change, 100(356-368).

Shaw, R.S., Chen, C.C., Harris, A.L. & Huang, H.J. (2009). The impact of information richness on information security awareness training effectiveness. Computers & Education, 52(1), 92-100.

Sheehan, N.T., Foss, N.J. (2017). Using Porterian activity analysis to understand organizational capabilities. Journal of General Management, 42(3), 41-51.

Sheer, V.C. (2011). Teenagers' Use of MSN Features, Discussion Topics, and Online Friendship Development: The Impact of Media Richness and Communication Control. Communication Quarterly, 59(1), 82-103.

Simonin, B.L. (1999). Ambiguity and the process of knowledge transfer in strategic alliances. Strategic Management Journal, 20(7), 595-623.

Simons, H. (2013). Case study research: In-depth understanding in context'. The Handbook of Qualitative Research. Oxford: Oxford University Press.

Strauss, A.L. (1987). Qualitative analysis for social scientists. Cambridge: Cambridge University Press.

Sumelius, J. & Sarala, R. (2008). Knowledge development in MNC subsidiaries: The influence of MNC internal and external knowledge and control mechanisms. Thunderbird International Business Review, 50(4), 245-258.

Sun, Y., Fang, S. & Zhang, Z.J. (2021). Impression management strategies on enterprise social media platforms: An affordance perspective. International Journal of Information Management, 60.

Szulanski, G., Ringov, D. & Jensen, R.J. (2016). Overcoming Stickiness: How the Timing of Knowledge Transfer Methods Affects Transfer Difficulty. Organization Science, 27(2), 304-322.

Teece, D.J. (2000). Strategies for Managing Knowledge Assets: the Role of Firm Structure and Industrial Context. Long Range Planning, 33(1), 35-54.

Teece, D.J. (2014). The Foundations of Enterprise Performance: Dynamic and Ordinary Capabilities in an (Economic) Theory of Firms. Academy of Management Perspectives, 28(4), 328–352.

Teece, D.J. (2019). A capability theory of the firm: an economics and (Strategic) management perspective. New Zealand Economic Papers, 53(1), 1-43.

Thalmann, S., Manhart, M., Ceravolo, P. & Azzini, A. (2014). An Integrated Risk Management Framework. International Journal of Knowledge Management, 10(2), 28-42.

Valenzuela S., Correa, T. & de Zuniga, H.G. (2018). Ties, Likes, and Tweets: Using Strong and Weak Ties to Explain Differences in Protest Participation Across Facebook and Twitter Use. Political Communication, 35(1), 117-134.

Vargo, S.L. & Lusch, R.F. (2008). Service-dominant logic: continuing the evolution. Journal of the Academy of Marketing Science, 36(1-10).

Wadhwa, A., Freitas, I.M.B. & Sarkar, M.B. (2017). The Paradox of Openness and Value Protection Strategies: Effect of Extramural R&D on Innovative Performance. Organization Science, 28(5), 873-893.

Wagstaff, M.F., Salvaj, E. & Villanueva, S. (2020). Champions in the time of COVID-19: tracing paths to recovery in Ibero-America. Management Research, 18(4), 379-399.

Wang, W.T. & Li, H.M. (2012). Factors influencing mobile services adoption: a brand-equity perspective. Internet Research, 22(2), 142-179.

Weyer, S., Schmitt, M., Ohmer, M. & Gorecky, D. (2015). Towards Industry 4.0 – Standardization as the crucial challenge for highly modular, multi-vendor production systems. IFAC-PapersOnline, 48, 579-584.

Windsperger, J. & Gorovaia, N. (2011). Knowledge attributes and the choice of knowledge transfer mechanism in networks: the case of franchising. Journal of Management and Governance, 15, 617– 640.

Winter, S.G. (1987). Knowledge and competence as strategic assets. In: Teece, D.J. (Ed.) The competitive challenge. Strategies for industrial innovation and renewal (pp. 159-184). Cambridge: Cambridge (Mass.).

Yan, A. & Gray, B. (1994). Bargaining power, management control, and performance in United States-China joint ventures: a comparative case study. Academy of Management Journal, 38, 393-416.

Yin, R.K. (2004). The Case Study Anthology. London: Sage.

Zander, U. & Kogut, B. (1995). Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test. Organization Science, 6(1), 1-145.

Zhao, Z.J. & Anand, J. (2009). A multilevel perspective on knowledge transfer: evidence from the Chinese Automotive industry. Strategic Management Journal, 30(9), 959-983.

Chapter E: Conclusion

In the motivation (Section 1 of Chapter A) of this thesis, it has been demonstrated that digitalization is a significant challenge for traditional (capital-intensive) industry companies (Rahmati et al., 2021; Riemer and Johnston, 2019). In particular, German industries such as, e.g., manufacturing, automotive, or chemicals and pharma companies have to cope with the impacts of digitalization on their operational capabilities (Manhart and Thalmann, 2015; Tan et al., 2015), which now are at risk to become obsolete during times of disruptive change (Lenka et al., 2016). Not only the management of these traditional companies is neglecting a holistic point of view regarding their status quo of digitalization and their contribution to the company's performance (Hess et al., 2016). But also, they cannot see the urgency to sustain the advantageousness of their capabilities (Kumar et al., 2016). However, there is only insufficient research on the economic effects of digitalization, and their impacts on the creation and transfer of operational capabilities from a theoretical perspective (Teichert, 2019; Thordsen et al., 2020; Koch and Windsperger, 2017). These problems could be incorporated into a research framework that was leading the investigation of this thesis (see Fig. A-2).

1. Summary of the Results

The economic impacts of digitalization (**research question 1**) were the origin of the three empirical studies in this thesis and could be attributed to the increasingly rapid development of the internet- and communication technologies. The economic impacts could be explained by a tremendous increase in the environmental dynamics (Cozzolino and Rothaermel, 2018; Kane et al., 2016), which can be seen in the market or business environments characterized by volatility, unpredictability, complexity, and ambiguity ("VUCA", Bennett and Lemoine, 2014; Cousins, 2018). Furthermore, it was shown by explanations of economic interdependence, that digitalization standardizes interfaces between traditional value chain activities (Gulot et al., 2020) and reduces interdependencies between the chain activities to a certain level (cf. Cano-Kollmann et al., 2016; Cyert and March 1963). Because decision-making units can act more independently (Weyer et al., 2015) the coordination of internal and external stakeholders can be operated at low transaction costs (Hagiu and Wright, 2015). And considering the theory of multisided markets, the establishment of digital platforms (Kapoor et al., 2021) facilitates a much stronger interaction of more than two players (cf. Wagner et al., 2021; Gawer, 2014). Hence, the collaboration of, e.g., customers, partners or suppliers gets intensified (Adner and Kapoor, 2010). While the interacting parties, such as buyers and sellers (Rochet and Tirole, 2003), can benefit from complementarities (cf. Huth, 2015) or network synergies (cf. Jacobides, 2018; Hannah and Eisenhardt, 2018) in so-called ecosystems (Adner, 2017), they can co-create and capture value in competition (Vargo and Lusch, 2008; Gans and Ryall, 2017).

It was demonstrated that these economic impacts force traditional companies to improve or even completely renew their processes, products and services, and business models (Scott and Orlikowski, 2021). In consequence, the firms also need to review and update the status quo of their digital capabilities to maintain their competitiveness (Kamalaldin et al., 2020; Teece, 2018; Lenka et al., 2017) and tap the potential enhancements in profitability (**research question 2a**). By drawing on a maturity assessment analysis in Chapter B (de Bruin et al., 2015; Azizian et al., 2009) which is based on a digital maturity index (DMI) comprising strategic (digital business index and dynamic capability index) and operational sub-indices (digital activity index and operational capability index), the status quo of digitalization in 160 German traditional companies was measured. Showing an average level of 3.92 out of 7 (1, no digitalization, up to 7, full digitalization) the results revealed room for improvement. Therefore, it not only could be shown that the affected companies are boosting the digitalization not enough. But also, the respondents barely perceived a contribution to profitability (EBIT rise). For the majority of companies (44%), there was a small EBIT improvement of as little as 5% or less. However, 21% of the firms also noted an improvement of 15% or more, and respondents with higher revenues have already achieved more advanced levels of digital maturity. It became clear that digitalization can make a positive contribution to company's profitability but exploiting this potential is capital-intensive. In more detailed results, six archetypes of *digital champions*, *high potentials*, *innovators*, *optimizers*, and *followers* could be aggregated from cluster analysis, ranging from 1.6 (*laggards*) to 6.4 (*champions*) of digital maturity.

By comparing these archetypes regarding their sub-indices, paths for incremental improvement in maturity were derived (**research question 2b**). The results, in particular, could show that companies with a lower level of digital maturity (such as *laggards* and *followers)* are behind in the field of operational capabilities (with averages of 1.62, and 3.16), while stronger companies have already made remarkable progress here (5.08 for *high potentials*, and 6.43 for *champions*). The results of the maturity assessment thus point out, that the thorough creation of (digital) operational capabilities is one of the key activities to keep up with the already more advanced companies in times of digitalization (Hunt and Madhavaram, 2020). The results were therefore the basis for further investigations.

Nevertheless, the creation of new operational capabilities in general is affected by the impacts of digitalization (**research question 3a**). In Chapter C, it could be seen from a structural equation analysis of 200 German traditional companies that the total effects of digitalization on the creation of operational capabilities was positive. In this regard, more in detail research could reveal that the significance of the requirements for the creation of operational capabilities is shifted in times of digitalization. That is, meeting the requirements of VRIN characteristics and the adaption to environmental dynamics has changed (Barney, 1991; Day and Schoemaker, 2016; Eller et al., 2020). In this context, results could make clear that companies are adapting the capabilities' underlying resources to the dynamic environment even stronger to avoid a mismatch of external impacts and the operational capability base. In contrast, the decreasing tacitness due to lower transaction costs caused by digital standardization, as well as the increase in complexity in the case of larger activities in value-creating networks that come from the net-like integration of the resources, do not have a significant impact. Beyond that, exposing the capability's underlying resources to value-creating networks, such as ecosystems (Adner, 2017) can increase the specificity and value creation of the resource position.

The results of this study thus could show that stronger adaption to the environmental dynamics as well as the participation in value-creating networks contribute to an improvement in the advantageousness of the operational capabilities (**research question 3b**). In particular, companies can benefit from the creation of operational capabilities in times of digitalization, if they follow an approach that is less compartmentalized and isolated within the company. In this context they can expose certain resources to external partners and enable the co-creation of capabilities in networks. However, this highlights the importance of the remaining strategically important resources and operational capabilities. Their advantageousness is dependent on their internal transferability ("scaleability"; Giustiziero et al., 2021) and their protection from becoming disclosure (Alexy et al., 2018).

The facilitation and protection of operational capability transfers results in in a trade-off (see Coff et al., 2006; Ritala and Stefan, 2021). It gets intensified under the impacts of digitalization (**research question 4a**), since mainly the greater autonomy of decision-makers in transfers improves internal coordination but also digital platforms open up untapped opportunities for interaction. Therefore, balancing (I) the decentralization of decision-making in transfers and (II) information richness of communication mechanisms can mitigate the trade-off (Gaur et al., 2019; Molina and Llorens-Montes, 2006; Nisar et al., 2019) but the companies need to optimize these parameters according to the digitalization impacts. The results from a single case study (Yin, 2009; Yin, 2015) on a traditional German manufacturing company in Chapter D identified six sub-parameters of (I) and (II) in total that were optimized in the company's transfer networks based on digital platforms and video-conference technology. On the one hand, (I) the decentralization of decisions can be optimized by *openness to transfer*, *interoperability of software infrastructure,* and *allocation of administration* of the transfer activities. On the other hand, (II) the information richness was optimized by different *levels of abstraction of the transferred information*, *alignment of sender and receiver*, as well as the *intensity of collaboration*.

The results show, that by reshaping their decentralization and information richness under the influence of digitalization, companies can transfer their strategically important operational capabilities more easily within the organization, while still safeguarding them against disclosure (**research question 4b**). Therefore, they can adjust the sub-parameters of (I) and (II) identified in the case study differently within their transfer networks depending on the underlying communication technology: the company uses platform-based networks with low decentralization and information richness for the transfer of operational capabilities in the case of many participants being involved and avoids the risk of content distributed uncontrollably (Ritala et al., 2018). In contrast, the company is relying on video-based networks for collaborative exchanges between participants and more intensive interaction in smaller groups that need more freedom to transfer. In this case, the balancing parameters own characteristics of higher autonomy and information richness. Thus, by reshaping their decentralization and information richness under the influence of digitalization, companies can transfer their strategically important operational capabilities more easily within the organization, while still safeguarding them against disclosure.

From these results implications for research and practice could be derived, which will be presented in the following section.

2. Implications

2.1 Implications for Research

Looking at the results of this thesis, certain implications for research may be derived. First, this study managed to shed light on the theory-based operational and strategic reactions to digitalization. Especially the activation of capabilities and the change of processes, products and services, and business models could not only be operationalized in the context of maturity levels but also validated by an empirical study. This can provide a deeper understanding of the key economic components of digitalization and connects them with potential response options. The maturity measurements often set up by practitioners in literature (Thordsen et al., 2020) can thus be substantiated with theoretical considerations. By implementing a cluster analysis within maturity assessment analysis, it was possible to support the commonly used descriptive methodology of maturity assessments (Colli et al., 2018; de Bruin et al., 2005). That is why the maturity measurement of this study not only quantifies the status quo of digitalization but also offers starting points for making better use of the opportunities offered by digitalization. The results around the hesitant transformation at the companies investigated may reveal behavioral economics findings: There is a short-term orientation caused by a lack of investments which could be shown in the poor profitability improvements for companies with low digital maturity. There are also different behaviors of the archetypes of companies and their efforts to improve their digital maturity. This can be the basis for a dynamic theory of digitalization, which compiles the sequential steps of maturity progess into a dynamic adaption hypothesis (e.g., Porter, 1991) and provides insights into the evolution of industry structures (see Menzel and Kammer, 2019). Furthermore, the study results were able to show that the digitalization backlog partly is based on missing (digital) operational capabilities, and this underlines the relevance of research on their creation in times of digitalization.

In consequence, concerning the effects of digitalization on the requirements for operational capabilities a fundamental economic understanding of digitalization and its effects was created. Previous research is often based on technological perspectives (e.g., Venkatesh et al., 2016; Dhyne et al., 2021), and could thus be expanded by adding theoretical explanations for the increase in environmental dynamics, coordination and interaction on digital platforms. This study opened the black box of the creation of operational capabilities and enabled more transparency about the requirements for their advantageousness from the perspective of the resource- and competence-based view (Barney, 1991; Colombo and Grilli, 2005; Zahra, 2021). Thus, the study results confirmed the validity of existing theoretical foundations of advantageous operational capabilities but could also reveal different levels of significance of the requirements in times of digitalization. That is, limited substitutability and imitability are losing importance for capabilities which become accessible to other stakeholders. In particular, the growing importance of joint creation of operational capabilities in networks was demonstrated. In this context, there are indications that theoretical considerations regarding the requirements for operational capabilities need to be seen from the perspective of ecosystems (see Adner, 2017; Jacobides et al., 2018). Thus, the findings also support current research on the compatibility of the resource-based view and business ecosystems theory (Gueler and

Schneider, 2021; Nana et al., 2022) but complement these investigations with insights into the retention of strategically important operational capabilities that need to be transferred within the organization to maintain a competitive advantage (Contractor, 2018).

Therefore, implications could be made for the internal transfer of operational capabilities by focussing on the balance between the transfer and protection of operational capabilities with the help of decentralization of decision-making (Rangus and Slavec, 2017; Sumelius and Sarala, 2008) and information richness of communication mechanisms (Daft and Lengel, 1986). The results from qualitative research indicated that both balancing parameters contribute to a better mediation of the trade-off if optimized adequately. With the identification of sub-parameters, both the construct of decentralization and information richness could be differentiated, while in previous research these had remained at the generic level of decision autonomy of subsidiaries as well as codifiability of communication media (e.g., Geleilate et al., 2020; Klitmøller and Lauring, 2013). The results can thus also deepen existing explanations on factors and technologies influencing the transfer of knowledge and capabilities (see Di Stefano and Micheli, 2022; Stadler et al., 2022) within multinational companies and can be taken to contribute to the discussion of joint value creation and governance in ecosystems of different companies (e.g., Dyer et al., 2018; Cusumano et al., 2019; Cusumano et al., 2021). Furthermore, the findings also enable to differentiate current research in the area of the scaleability of ”digital resources“ (Giustiziero et al., 2021) within companies, which is explaining why digital companies are more successful than traditional ones.

2.2 Implications for Practice

The step-by-step sequential research structure within this thesis has generated a framework that supports traditional industry companies to respond to digitalization adequately (see Fig. E-1).

The procedure includes the gradual measurement of the company’s level of digital maturity (see 1. in Fig. E-1). The digital maturity index can be applied by the management to create a deeper understanding of their digital status quo. Therefore, this thesis contributes to raising awareness of the need for change and addresses the main causes of slow digital transformation (Fitzgerald et al., 2014; Agostini and Nosella, 2020). The results have shown that the management should expand the often prevalent and limited pilot projects (Zangiacomi et al., 2019) in relation to its transformation efforts and thus allocate more capital to reach a critical level of investment which makes the profitability improvements to become noticeable. Therefore, the studies also show that it is worth investing into digitalization. Besides this, the assessment index can enable benchmarking, which makes it possible to identify individual best practices instead of “one-fits-all solutions” (cf. Tabrizi et al., 2019) by learning from other companies. For the management of companies with a particularly low level of maturity it is possible to identify improvement opportunities via the strategic and operational dimensions of digitalization. This comprises the development of strategies or the optimization of digital activities, the development of new capabilities and the improvement of business models via participation in structural ecosystems (Jacobides et al., 2018; Kapoor, 2018). In particular, the study on digital maturity included the investigation of operational capabilities and thus underlines the importance to maintain the advantageousness of operational capabilities through adaptation, co-creation, and transfers within the organization.

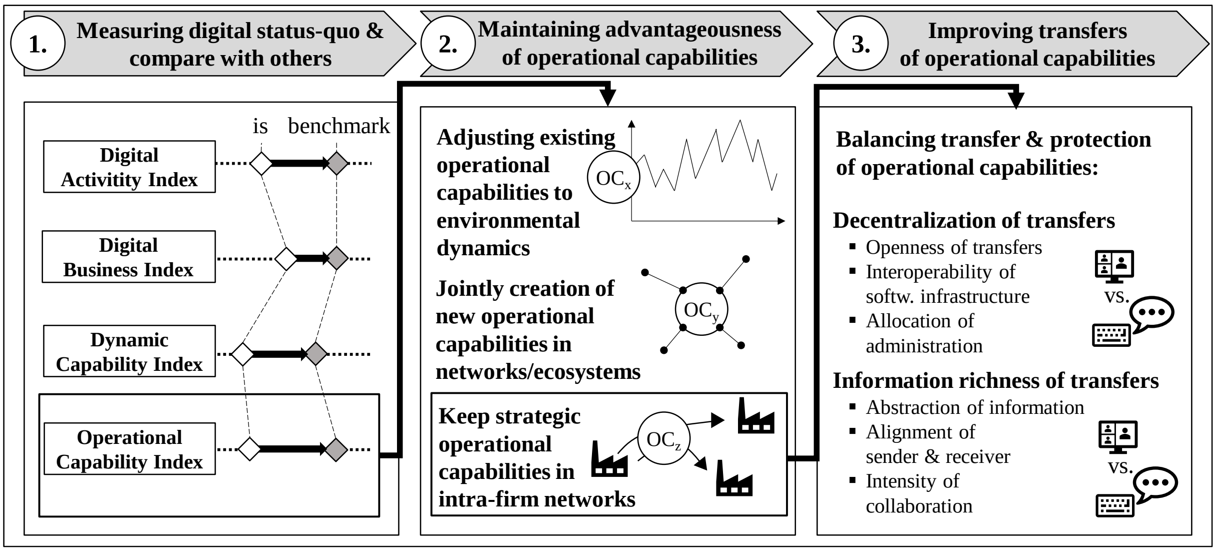

Fig. E-1: Framework for responses to the impacts of digitalization (source: own compilation)

In this context, the results support the creation of operational capabilities under the impacts of digital change (see 2. in Fig. E-1). Demonstrating that there is a drop in significance regarding the inimitability and non-substitutability of some parts of the resource position in times of digitalization, companies can benefit if they put more focus on participating in value-creating networks. To do this, they must contribute their resources more openly and can thus build new capabilities together with partners. That requires the companies to swap the narrative of protectionism for a more open exchange with externals (see also Cozzolino and Verona, 2022; Schreieck et al., 2021). However, not all operational capabilities may be brought into partner networks and ecosystems but should stay within the company to keep their strategic competitive advantage (Bogers, 2011). The results of this study thus support traditional companies in classifying their operational capabilities more clearly in terms of their strategic importance (Alexy et al., 2018), and demonstrate the significance of governance in ecosystems (Dyer et al., 2018; Cusumano et al., 2019).

This makes it clear that companies should create advantageous intra-firm transfers based on individual optimization parameters regarding the conflict between high transferability and protection against disclosure to others (see 3. in Fig. E-1). Balancing the trade-off works on the level of decentralization of decision-making as well as information richness of the communication mechanisms. For this purpose, a setting of parameters is available now, which can be configured according to the type of network, i.e., platform-based (e.g., Liu and Bakici, 2019) or video-technology-based networks (e.g., Karnouskos, 2017). Large platform exchange networks can quickly transfer capabilities within the enterprise. At the same time, they can only protect from loss of capabilities if the parameters of administration and access management are designed in a less decentralized manner. That is why these networks can be used mainly for the transfers of, e.g., best practices. Video-based networks can transfer operational capabilities less extensively but must also have a higher degree of decentralization of the participants' decisions for the focused exchange and collaborative creation of operational capabilities. In these networks, strategic operational capabilities, e.g., innovative product technologies can be build up and transferred. Thus, the study results can also provide orientation for the design of knowledge and information automatization, and the creation of virtual organizations (Choi, 2022; Snow et al., 2017). This means, for example, that the knowledge and capability management can be decentralized even more without losing valuable know-how.

3. Limitations and Outlook

The limitations in the three articles lie in the research methods, data selection, and data evaluation procedures. In favor of a large number of participants, the self-assessment conducted as part of the maturity measurement (Chapter B) has a higher degree of subjectivity and lower reliability and validity than maturity assessments by outside experts. Further studies can start here and verify the results of the self-assessment by an independent expert assessment. In this context, for example, case study investigations of individual participants can reveal qualitative correlations in the sense of an in-depth study that could not be made visible by employing quantitative data.

In the context of the study, regarding the effects of digitalization on the benefits of operational capabilities (Chapter C), further qualitative investigations are also needed to validate the quantitative research findings. Especially in the case of dependencies that could not be hypothesized before, more in-depth investigation is needed to gain more understanding of the underlying constructs.

Regarding the case study on the investigation of the trade-off between high transferability and protection against disclosure (Chapter D), in future studies, additional companies must be included to make the results more generalizable. For example, a multiple-case study can be applied to compare a broad range of companies. In addition, the data collection process could be subjective (e.g., in the case of identifying interview partners and conducting the interviews). Findings therefore can be seen as initial indications and cannot provide general validity. Further quantitative research can verify the sub-parameters identified in the study using a large-scale survey and come closer to generalizability. Although the results show that the boundaries between individual subsidiaries and parent companies are blurring, the theoretical considerations of multinational corporations remain valid and necessary. However, further studies need to incorporate ecosystems (Cha, 2020; Li et al., 2018), considering the interdependencies between internal protection and external contribution of resources as well as capabilities to ecosystem partnerships. Finally, a better understanding of the underlying automation of capabilities across digital platforms and connection to externals is also needed.

Across all studies, the data collected in every of the studies of this work are based on surveys of German capital-intensive industry companies. Conclusions about correlations among international companies with other countries of origin are only permissible to a limited extent. The transferability of the results to other industries, e.g., software and telecommunication companies, is also not possible without restrictions. Further studies with participants from abroad and from other industries are needed to extend the validity of the assumptions and implications and to reach country-specific and industry-specific peculiarities in even more depth. They are also required to, for example, better explain the conflicting effects between impacts of digitalization.

References

Adner, R. (2017): Ecosystems as Structure. In: *Journal of Management*, Vol. 43 (1), pp. 39-58.

Adner, R., Kapoor, R. (2010): Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. In: *Strategic Management Journal*, Vol. 31 (3), pp. 306-333.

Agostini, L., Nosella, A. (2020): The adoption of Industry 4.0 technologies in SMEs: results of an international study. In: *Management Decision*, Vol. 58 (4), pp. 625-643.

Alexy, O., West, J., Klapper, H., Reitzig, M. (2018): Surrendering control to gain advantage: Reconciling openness and the resource-based view of the firm. In: *Strategic Management Journal*, Vol. 39 (6), pp. 1704-1727.

Azizian, N., Sarkani, S., Mazzuchi, T. (2009): A comprehensive review and analysis of maturity assessment approaches for improved decision support to achieve efficient defense acquisition. In: *Proceedings of the World Congress on Engineering and Computer Science*, Vol. 2, pp. 20-22.

Barney, J. (1991): Firm Resources and Sustained Competitive Advantage. In: *Journal of Management*, Vol. 17 (1), pp. 99-120.

Bennett, N., Lemoine, G. J. (2014): What a difference a word makes: Understanding threats to performance in a VUCA world. In: *Business Horizons*, Vol. 57 (3), pp. 311-317.

Bogers, M. (2011): The open innovation paradox: knowledge sharing and protection in R&D collaborations. In: *European Journal of Innovation Management*, Vol. 14 (1), pp. 93-117.

Cano-Kollmann, M., Cantwell, J., Hannigan, T. J., Mudambi, R., Song, J. (2016): Knowledge connectivity: An agenda for innovation research in international business. In: *Journal of International Business Studies*, Vol. 47 (3), pp. 255-262.

Cha, H. (2020): A paradigm shift in the global strategy of MNEs towards business ecosystems: A research agenda for new theory development. In: *Journal of International Management*, Vol. 26 (3), 100755.

Choi, H. Y. (2022): Working in the Metaverse: Does Telework in a Metaverse Office Have the Potential to Reduce Population Pressure in Megacities? Evidence from Young Adults in Seoul, South Korea. In: *Sustainability*, Vol. 14 (6), pp. 3629.

Colli, M., Madsen, O., Berger, U., Møller, C., Wæhrens, B. V., Bockholt, M. (2018): Contextualizing the outcome of a maturity assessment for Industry 4.0. In: *Ifac-papersOnLine*, Vol. 51 (11), pp. 1347-1352.

Coff, R. W., Coff, D. C., Eastvold, R. (2006): The Knowledge-Leveraging Paradox: How to Achieve Scale without Making Knowledge Imitable. In: *Academy of Management Review*, Vol. 31(2), pp. 452-465.

Colombo, M. G., Grilli, L. (2005): Founders' human capital and the growth of new technology-based firms: A competence-based view. In: *Research Policy*, Vol. 34 (6), pp. 795-816.

Contractor, F. J. (2018): Can a firm find the balance between openness and secrecy? Towards a theory of an optimum level of disclosure. In: *Journal of International Business Studies*, Vol. 50, pp. 261-274.

Cousins, B. (2018): Design thinking: Organizational learning in VUCA environments. In: *Academy of Strategic Management Journal*, Vol. 17 (2), pp. 1-18.

Cozzolino, A., Rothaermel, F. T. (2018): Discontinuities, competition, and cooperation: Coopetitive dynamics between incumbents and entrants. In: *Journal of Strategic Management*, Vol. 39 (12), pp. 3053-3085.

Cozzolino, A., Verona, G. (2022): Responding to Complementary-Asset Discontinuities: A Multilevel Adaptation Framework of Resources, Demand, and Ecosystems. In: *Organization Science* (not published yet).

Cusumano, M. A., Gawer, A., Yoffie, D. B. (2019): The business of platforms: Strategy in the age of digital competition, innovation, and power. New York, Harper Business.

Cusumano, M. A., Gawer, A., Yoffie, D. B. (2021): Can self-regulation save digital platforms?. In: *Industrial and Corporate Change*, Vol. 30 (5), pp. 1259-1285.

Cyert, R., March, J. (1963): A Behavioral Theory of the Firm. Englewood Cliffs, NJ, Prentice-Hall.

Daft, R. L., Lengel, R. H. (1986): Organizational information requirements, media richness and structural design. In: *Management Science*, Vol. 32 (5), pp. 513-644.

Day, G. S., Schoemaker, P. J. (2016): Adapting to fast-changing markets and technologies. In: *California Management Review*, Vol. 58 (4), pp. 59-77.

De Bruin, T., Rosemann, M., Freeze, R., Kaulkarni, U. (2005): Understanding the Main Phases of Developing a Maturity Assessment Model. In: Bunker, D., Campbell, B., Underwood, J. (eds.): *Australasian Conference on Information Systems (ACIS). Australasian Chapter of the Association for Information Systems*, CD Rom, pp. 8-19.

Dhyne, E, Konings, J., Van den Bosch, J., Vanormelingen, S. (2021): The Return on Information Technology: Who Benefits Most? In: *Information Systems Research*, Vol. 32 (1), pp. 194-211.

Di Stefano, G., Micheli, M. R. (2022): To Stem the Tide: Organizational Climate and the Locus of Knowledge Transfer. In: *Organization Science* (not published yet).

Dyer, J. H., Singh, H., Hesterly, W. S. (2018): The relational view revisited: A dynamic perspective on value creation and value capture. In: *Strategic Management Journal*, Vol. 39 (12), pp. 3140-3162.

Eller, R., Alford, P., Kallmünzer, A., Peters, M. (2020): Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. In: *Journal of Business Research*, Vol. 112, pp. 119-127.

Fitzgerald, M., Kruschwitz, N., Bonnet, D., Welch, M. (2014): Embracing digital technology: a new strategic imperative. In: *MIT Sloan Management Review*, Vol. 55 (2), pp. 1–12.

Gans, J., Ryall, M. D. (2017): Value capture theory: A strategic management review. In: *Strategic Management Journal*, Vol. 38, pp. 17-41.

Gaur, A. S., Ma, H., Ge, B. (2019): MNC strategy, knowledge transfer context, and knowledge flow in MNEs. In*: Journal of Knowledge Management*, Vol. 23 (9), pp. 1885-1900.

Gawer, A. (2014): Bridging different perspectives on technological platforms: Towards an integrative framework. In: *Research Policy*, Vol. 43 (7), pp. 1239-1249.

Gueler, M. S., Schneider, S. (2021): The resource-based view in business ecosystems: A perspective on the determinants of a valuable resource and capability. In: *Journal of Business Research*, Vol. 133, pp. 158-169.

Gulot, G., Orzes, G., Sartor, M., Nassimbeni, G. (2020): The future of manufacturing: A Delphi-based scenario analysis on industry 4.0. In: *Technological Forecasting & Social Change*, Vol. 157, 120092.

Geleilate, J.-M. G., Andrews, D. S., Fainshmidt, S. (2020): Subsidiary autonomy and subsidiary performance: A meta-analysis. In: *Journal of World Business*, Vol. 55 (4), 101049.

Giustiziero, G., Kretschmer, T., Somaya, D., Wu, B. (2021): Hyperspecialization and hyperscaling: A resource-based theory of the digital firm. In: *Strategic Management Journal* (ahead of print).

Hagiu, A., Wright, J. (2015): Multi-sided platforms. In: *International Journal of Industrial Organization*, Vol. 43 (1), pp. 162-174.

Hannah, D. P., Eisenhardt, K. M. (2018): How firms navigate cooperation and competition in nascent ecosystems. In: *Strategic Management Journal*, Vol. 39 (12), pp. 3163-3192.

Hess, T., Matt, C., Benlian, A., Wiesböck, F. (2016): Options for formulating a digital transformation strategy. In: *Management Information Systems Quarterly Executive*, Vol. 15 (2), pp. 123-139.

Hunt, S. D., Madhavaram, S. (2020): Adaptive marketing capabilities, dynamic capabilities, and renewal competences: The "outside vs. inside" and "static vs. dynamic" controversies in strategy. In: *Industrial Marketing Management*, Vol. 89, pp. 129-139.

Huth, S. (2015): Synergiemanagement im intra-organisationalen Netzwerk. Hamburg, Dr. Kovac.

Jacobides, M. G., Cennamo, C., Gawer, A. (2018): Towards a theory of ecosystems. In: *Strategic Management Journal*, Vol. 39 (8), pp. 2255-2276.

Kamalaldin, A., Linde, L., Sjödin, D., Parida, V. (2020): Transforming provider-customer relationships in digital servitization: A relational view on digitalization. In: *Industrial Marketing Management*, Vol. 89, pp. 306-325.

Kane, G. C., Buckley, N., Kiron, D., Phillips, A. N., Palmer, D. (2016): Aligning the Organization for Its Digital Future. In: *MIT Sloan Management Review and Deloitte University Press*, Vol. 58 (1), pp. 1-30.

Kapoor, R. (2018): Ecosystems: broadening the locus of value creation. In: *Journal of Organization Design*, Vol. 7 (1), pp. 1-16.

Kapoor, R., Bigdeli, A. Z., Dwivedi, Y. K., Schroeder, A., Beltagui, A., Baines, T. (2021): A socio-technical view of platform ecosystems: Systematic review and research agenda. In: *Journal of Business Research*, Vol. 128, pp. 94-108.

Karnouskos, S. (2017): Massive open online courses (MOOCs) as an enabler for competent employees and innovation in industry. In: *Computers in Industry*, Vol. 91, pp. 1-10.

Klitmøller, A., Lauring, J. (2013): When global virtual teams share knowledge: Media richness, cultural difference and language commonality. In: *Journal of World Business*, Vol. 48 (3), pp. 398-406.

Koch, T., Windsperger, J. (2017): Seeing through the network: Competitive advantage in the digital economy. In: *Journal of Organization Design*, Vol. 6 (6), pp. 1-30.

Kumar, V., Loonam, J., Allen, J. P., Sawyer, S. (2016): Exploring enterprise social systems & organisational change: implementation in a digital age. In: *Journal of Information Technology*, Vol. 31 (2), pp. 97-100.

Lenka, S., Parida, V., Wincent, J. (2017): Digitalization capabilities as enablers of value co-creation in servitizing firms. In: *Psychology & Marketing*, Vol. 34 (1), pp. 92-100.

Li, S., Xu, L. D., Zhao, S. (2018): 5G Internet of Things: A survey. In. *Journal of Industrial Information Integration*, Vol. 10, pp. 1–9.

Liu, Y., Bakici, T. (2019): Enterprise social media usage: The motives and the moderating role of public social media experience. In: *Computers in Human Behavior*, Vol. 101, pp. 163-172.

Manhart, M., Thalmann, S. (2015): Protecting organizational knowledge: a structured literature review. In: *Journal of Knowledge Management*, Vol. 19 (2), pp. 190-211.

Menzel, M.-P., Kammer, J. (2019): Industry evolution in varieties of capitalism: A comparison of the Danish and US Turbine industries. In: Industrial and Corporate Change, Vol. 28 (6), pp. 1381-1403.

Molina, L. M., Llorens-Montes, F.J. (2006): Autonomy and teamwork effect on knowledge transfer: knowledge transferability as a moderator variable. In: *International Journal of Technology Transfer and Commercialisation*, Vol. 5 (3), pp. 263-280.

Nana, A., Laviolette, E. M., Theodoraki, C. (2022): A Resource-based View (RBV) of Entrepreneurial Sourcing Within the Pre-incubation Ecosystem. In: *Academy of Management Proceedings*, Vol. 2022 (1), 17712.

Nisar, T. M., Prabhakar, G., Strakova, L. (2019): Social media information benefits, knowledge management and smart organizations. In: *Journal of Business Research*, Vol. 94 (C), pp. 264 - 272.

Porter, M. E. (1991): Towards a dynamic theory of strategy. In: *Strategic Management Journal*, Vol. 12 (S2), pp. 95-117.

Rahmati, P., Tafti, A., Westland, J. C., Hidalgo, C. (2021): When all products are digital: Complexity and intangible value in the ecosystem of digitizing firms. In: *Management Information Systems Quarterly*, Vol. 45 (3), pp. 1025-1058.

Rangus, K., Slavec, A. (2017): The interplay of decentralization, employee involvement and absorptive capacity on firms' innovation and business performance. In: *Technological Forecasting and Social Change*, Vol. 120, pp. 195-203.

Riemer, K., Johnston, R. B. (2019): Disruption as worldview change: A Kuhnain analysis of the digital music revolution. In: *Journal of Information Technology*, Vol. 34 (4), pp. 350-370.

Ritala, P., Stefan, I. (2021): A paradox within the paradox of openness: The knowledge leveraging conundrum in open innovation. In: *Industrial Marketing Management*, Vol. 93, pp. 281-292.

Ritala, P., Husted, K., Olander, H., Michailnova, S. (2018): External knowledge sharing and radical innovation: the downsides of uncontrolled openness. In: *Journal of Knowledge Management*, Vol. 22 (5), pp. 1104-1123.

Rochet, J. C., Tirole, J. (2003): Platform competition in two-sided markets. In: *Journal of the European Economic Association*, Vol. 1 (4), pp. 990-1029.

Schreieck, M., Wiesche, M., Krcmar, H. (2021): Capabilities for value co-creation and value capture in emergent platform ecosystems: A longitudinal case study of SAP's cloud platform. In: *Journal of Information Technology*, Vol. 36 (4), pp. 365-390.

Scott, S., Orlikowski, W. (2021). The Digital Undertow: How the Corollary Effects of Digital Transformation Affect Industry Standards. In: *Information Systems Research*, Vol. 33 (1), pp. 311-336.

Snow, C. C., Fjeldstad, Ø. D., Langer, A. M. (2017): Designing the digital organization. In: Journal of Organization Design, Vol. 6 (1), pp. 1-13.

Stadler, C., Helfat, C. E., Verona, G. (2022): Transferring Knowledge by Transferring Individuals: Innovative Technology Use and Organizational Performance in Multiunit Firms. In: *Organization Science*, Vol. 33 (1), pp. 253-274.

Sumelius, J., Sarala, R. (2008): Knowledge development in MNC subsidiaries: The influence of MNC internal and external knowledge and control mechanisms. In: *Thunderbird International Business Review*, Vol. 50, pp. 245-258.

Tabrizi, B., Lam, E., Girard, K., Irvin, V. (2019): Digital transformation is not about technology. In: *Harvard Business Review*, Vol. 13, pp. 1-6.

Tan, B., Pan, S. L., Lu, X., Huang, L. (2015): The role of IS capabilities in the development of multi-sided platforms: The digital ecosystem strategy of Alibaba.Com. In: *Journal of the Association for Information Systems*, Vol. 16 (4), pp. 248–280.

Teece, D. J. (2018): Business models and dynamic capabilities. In: *Long Range Planning*, Vol. 51 (1), pp. 40-49.

Teichert, R. (2019): Digital transformation maturity: A systematic review of literature. In: *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, Vol. 67 (6), pp. 1673-1687.

Thordsen, T., Murawski, M., Bick, M. (2020): How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models. In: *Responsible Design, Implementation and Use of Information and Communication Technology: 19th IFIP WG 6.11 Conference on e-Business, e-Services, and e-Society, I3E 2020*, Skukuza, South Africa, April 6–8, 2020, Proceedings, Part I, Vol. 12066, 358–369.

Vargo, S. L., Lusch, R. F. (2008): Service-dominant logic: continuing the evolution. In: *Journal of the Academy of Marketing Science*, Vol. 36, pp. 1-10.

Venkatesh, V., Bala, H., Sambamurthy, V. (2016): Implementation of an Information and Communication Technology in a Developing Country: A Multimethod Longitudinal Study in a Bank in India. In: *Information Systems Research*, Vol. 27 (3), pp. 471-464.

Wagner, G., Preser, J., Paré, G. (2021): Exploring the boundaries and processes of digital platforms for knowledge work: A review of information systems research. In: *The Journal of Strategic Information Systems*, Vol. 30 (4), 101694.

Weyer, S., Schmitt, M., Ohmer, M., Gorecky, D. (2015): Towards Industry 4.0 – Standardization as the crucial challenge for highly modular, multi-vendor production systems. In: *IFAC-PapersOnline*, Vol. 48, pp. 579-584.

Yin, R. K. (2009): Designing case studies. Case study research: Design and methods. Thousand Oaks, CA: SAGE.

Yin, R. K. (2015): Qualitative research from start to finish. Guilford Publications.

Zahra, S. A. (2021): The resource-based view, resourcefulness, and resource management in startup firms: A proposed research agenda. In: *Journal of Management*, Vol. 47 (7), pp. 1841-1860.

Zangiacomi, A., Pessot, E., Fornasiero, R., Bertetti, M., Sacco, M. (2020): Moving towards digitalization: a multiple case study in manufacturing. In: *Production Planning & Control*, Vol. 31 (2-3), pp. 143-157.