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THE IMPACT OF CEOS' TECHNOLOGICAL FRAME ON ORGANIZATIONAL AGILITY AND THE MEDIATING EFFECT OF DIGITAL BUSINESS CAPABILITIES: AN EMPIRICAL ANALYSIS

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Research Paper

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Abstract

The information systems (IS) literature elaborates on how firms develop organizational agility based on organizational capabilities to sense and respond to rapidly changing environments. However, the underlying mechanism of how companies and their chief executive officers (CEOs) understand and implement digital technologies to foster organizational agility is lacking. The technological frame concept provides an impetus to explain the process by which CEOs' sensemaking of digital technologies influences organizational agility. Our paper draws on the individual-level perspective of the technological frame concept and proposes a mediating role of digital business capabilities, composed of digital strategy, digital integration, and digital control. Our quantitative research design is based on findings derived from 386 German CEOs and confirms that CEOs' technological frame influences organizational agility through digital business capabilities. Thereby, we expand the concept of the technological frame on the individual level and contribute to the IS literature by revealing the mechanism of how CEOs' sensemaking influences organizational agility.

Keywords: Technological frame, digital business capabilities, organizational agility, micro-level.

1 Introduction

A recent information systems (IS) study argues that in highly turbulent markets associated with the introduction of digital technologies, the sensemaking of CEOs is crucial for understanding a given firm's organizational agility development (Pinsonneault and Choi, 2022). Organizational agility is particularly important for sensing and reacting to current digital threats and opportunities and refers to a specific dynamic capability (DC) (Tallon et al., 2019; Grover, 2022; Pinsonneault and Choi, 2022). In this context, strategic management scholars extensively illustrate how micro-foundations, specifically CEOs' cognition, represent the underlying foundation of how firms develop strategies (Adner and Helfat, 2003; Kaplan, 2011) and DCs that identify, seize, and transform a firm's resources for creating a competitive advantage and improving firm performance (Teece, Pisano and Shuen, 1997; Helfat and Martin, 2015; Helfat and Peteraf, 2015). To date, most IS research exclusively focuses on unraveling how specific information technology (IT) resources and capabilities foster organizational agility (Tallon et al., 2019; Steininger *et al.*, 2022), and thereby lacks a more comprehensive understanding of organizational agility. An example from practice shows how Procter & Gamble's IT resources and capabilities failed to identify a new shaving trend (McGrath, 2019; Pinsonneault and Choi, 2022). Even more dramatically, the example of Tesla in the automotive industry reveals how CEOs' cognitive frames and interpretations are a determining factor for evaluating the uncertain competitive threat which is followed by seizing the potential and transforming the firm accordingly (Teece, 2018; Pinsonneault and Choi, 2022). Given the importance of micro-foundations for firm-level strategy and DCs, additional research and empirical analysis are needed to examine their interrelationship with organizational agility, which is a key requirement in today's digital world.

This study aims to uncover how CEOs' cognitive frames facilitate understanding and making use of digital technologies and thereby build the foundation for firms' digital business capabilities (DBCs) that foster organizational agility. Hence, our study fills two research gaps. Firstly, scholars find that IT per se does not generate value but needs to be aligned with the strategy and firm's business capabilities (Liang et al., 2017; Park, Sawy and Fiss, 2017), and is interrelated with the interpretation and assessment of CEOs, particularly in small and medium-sized enterprises (SMEs) (Doz and Kosonen, 2010; Chan et al., 2019; Doz, 2020). Individuals who encounter new technologies draw on their technological frame for making sense of these and assessing their potential consequences (Orlikowski and Gash, 1994; Leonardi and Barley, 2010). Previous research found that CEOs' inappropriate cognitive frames and lack of understanding are responsible for the failure of change and the lack of implementation of support mechanisms (Tripsas and Gavetti, 2000). Furthermore, a novel study proposes that, compared to traditional IT capabilities, DBCs composed of digital strategy, digital implementation, and digital control allow for more effective management of today's complex and digital environment (Bharadwaj et al., 2013; Wielgos, Homburg and Kuehnl, 2021). The IS research is salient concerning how a CEO's technological frame is associated with a firm's DBC achievement. Secondly, while IS scholars elaborate on the enabling effect of IT capabilities on organizational agility (Queiroz et al., 2018; Ravichandran, 2018; Ashrafi et al., 2019), the strategic management literature offers valuable insights into the underlying mechanism of how differences in CEOs' cognitions and interpretations can influence specific DCs through strategy and business capabilities (Kaplan, 2011; Eggers and Kaplan, 2013; Felin, Foss and Ployhart, 2015). However, the IS literature does not provide a comprehensive view of how firms can enhance their organizational agility in times of digital turbulence and thereby has failed to investigate the underlying mechanisms that are triggered by CEOs' individual interpretation impact through DBC on their firms' organizational agility development. Hence, we aim to address this gap by drawing on Weick's sensemaking theory and the DC theory to examine how organizational agility is promoted by CEOs' technological frame through the development of DBCs which help to sense digital trends, mobilize adequate resources and strategies, and continuously transform a firm's resources and capabilities (Teece, 2007; Steininger et al., 2022).

Our paper follows recent research calls to further explore the micro-level of organizational agility by investigating the impact of CEOs' sensemaking in today's digital environment on the organizational level (Spieth et al., 2021; Wielgos, Homburg and Kuehnl, 2021; Pinsonneault and Choi, 2022). In this context, we also assess the linking mechanism of DBCs (Wielgos, Homburg and Kuehnl, 2021; Grover, 2022), whereby our study addresses the following research questions: (RQ1) How is the technological frame of CEOs related to the DBC of firms? (RQ2) How do firms' DBCs mediate the relationship between their CEOs' technological frames and organizational agility? In summary, our paper contributes to the IS literature in two ways: First, this study extends the concept of the technological frame on the micro-level by providing empirical insights derived from selected German CEOs' technological frames and their importance for the development of DBCs, whereby we aim to reveal how CEOs' technological frames affect DBCs (Spieth et al., 2021). Second, our paper draws on the DC theory for unraveling the interdependencies and mechanisms of how DBCs mediate the relationship between CEOs' sensemaking of technologies and organizational agility.

2 Conceptual Background

2.1 Sensemaking theory, technological frame, and micro-level perspective

In this work, we draw on Weick's sensemaking theory which describes how an individual's sensemaking helps to reduce the complexity of their surroundings and to assess their environment (Daft and Weick, 1984; Weick, 1995). The theory thus describes a cognitive process that helps to explain an individual's sensemaking, interpretation, and evaluation of technologies (Spieth et al., 2021). During the sensemaking process, information is interpreted through the individual's frames (Weick, 1995). In the context of technology evolution, we relate to the theoretical framework of the "technological frame" introduced by Orlikowski and Gash (1994), whereby the technological frame refers to a socio-cognitive process and sensemaking structure of individuals who make sense of the technology, surrounding conditions, and potential consequences in a particular situation and context (Orlikowski and Gash, 1994; Klos and Spieth, 2021). Hence, actors draw on their technological frame for making sense of technology and its potential consequences (Orlikowski and Gash, 1994; Leonardi and Barley, 2010), whereby individuals create expectations and develop assumptions about a given technology based on their cognitive schemata which are relevant for the subsequent development and use of the technology in question (Orlikowski and Gash, 1994; Cornelissen and Werner, 2014). The perception of technology differs between individuals depending on their personal backgrounds, experiences, and environmental context, especially in contexts that are associated with high ambiguity (Powell and Colyvas, 2008; Helfat and Peteraf, 2015; Klos and Spieth, 2021).

The micro-level perspective has attracted increasing attention in strategic management and information systems research (Palmié, Rüegger and Parida, 2023). Specifically, the focus lies on the role and impact of CEOs since they have the most influential position to shape firm outcomes and hence influence DCs (Eggers and Kaplan, 2009; Felin, Foss and Ployhart, 2015; Scuotto et al., 2022). Significantly, through their perception, sensemaking, and bounded rationality, CEOs build the pre-dominant basis for firm outcomes as a cause-effect relationship (Kaplan and Tripsas, 2008; von den Driesch et al., 2015). The research found that differences in the cognition of CEOs impinge on their actions and affect a firm's capabilities and DCs, particularly under conditions of environmental change (von den Driesch et al., 2015; Vera et al., 2022). A recent study extends the theoretical framework introduced by Orlikowski and Gash (1994), reconceptualized technological frames on the micro-level, and developed a suitable measurement instrument (Spieth et al., 2021). The increased research on technological frame highlights the fact that it is not only relevant for a group's sensemaking of technology but helps to explain the heterogeneity of individual responses and ultimately, becomes the driver of a firm's DCs (Azad and Faraj, 2008; Leonardi, 2011; Young, Mathiassen and Davidson, 2016). We follow previous scholars' lead and adopt the reconceptualization of the technological frame at a micro-level to understand how CEOs assess their increasingly dynamic and complex digital environment and thereby draw on the concept of the technological frame (Orlikowski and Gash, 1994). Due to the complex nature of the concept, a technological frame may be understood as a higher-order construct that is comprised of several dimensions: personal attitude, application value, organizational influence, industry influence, and peer influence (Spieth et al., 2021).

2.2. Digital business capabilities as an organizational capability

Organizational capabilities are defined as a complex combination of a firm's abilities, skills, and accumulated knowledge which can generate value by repeatedly transforming input into outputs (Collis, 1994; Grant, 1996). These unique firm capabilities emerge from strategic actions and complex interactions between resources, develop over time and support the achievement of organizational goals through static and dynamic activities and procedures (Collis, 1994; Teece, 2017; Mikalef et al., 2020). The purpose of capabilities is to create business value (Kohli and Grover, 2008) and, rooted in the DC theory, organizational capabilities are part of DCs, which help to reconfigure a firm's resource base for developing a competitive advantage (Teece, Pisano and Shuen, 1997; Schilke, Hu and Helfat, 2018). Specifically, the research argues that organizational capabilities aim to allow for efficient management of a firm's routines and resources (Teece, 2012, 2017; Irwin et al., 2022; Schulze and Brusoni, 2022). However, firms need to align their resources with a strategy to realize business value (Grover, 2022). Today, digital technologies, based on a combination of different ITs can create new value for customers and suppliers and, ultimately, transform entire businesses as they affect an organization on different levels (Bharadwaj et al., 2013; Benbya et al., 2020; Salmela et al., 2022). In our study, we concentrate on digital capabilities by drawing on the newly developed DBC measurement instrument. The higher-order construct is reflected in three elements: (1) digital strategy, (2) digital integration, and (3) digital control (Wielgos, Homburg and Kuehnl, 2021). Furthermore, DBC, which has a broader scope than traditional IT capabilities, can affect a firm's entire business and resource base (Bharadwaj et al., 2013; Verhoef et al., 2021). Previous empirical studies have confirmed the important role of digital strategy in transforming a business, not only on a functional level but also on an organizational-level (Chan et al., 2019; Correani et al., 2020). Moreover, scholars have demonstrated the relevance of integrating and implementing technological processes throughout an organization for generating and delivering new value (Lee et al., 2015). In this context, digital integration is defined as a firm's capability to integrate processes and link them throughout the organization which is enabled by digital technologies (Wielgos, Homburg and Kuehnl, 2021). Lastly, integrating control mechanisms for tracking a firm's resource reallocations and status which aim to create value is a key success factor for a firm's digital business transformation (Verhoef et al., 2021). Hence, digital business control is referred to as the degree to which a firm uses digital technologies to monitor processes whose goal is to create new value (Wielgos, Homburg and Kuehnl, 2021).

2.3 Organizational agility and the dynamic capability perspective

The concept of agility was introduced in the 1980s and was examined in the context of volatile markets from a capability perspective (Brown and Agnew, 1982; Goldman and Nagel, 1993). Scholars across different literature streams have conceptualized agility in divergent ways and have not agreed on a shared distinct definition (Tallon et al., 2019; Salmela et al., 2022). Particularly, organizational agility is often used for describing a firm's ability to rapidly identify and react to environmental changes to thereby capitalize on new opportunities (Tallon et al., 2019; Ahmed et al., 2022; Bresciani et al., 2022). Recently, IS scholars argued that the concept of agility has converged by referring to it as a crucial DC needed in dynamic environments (Teece, Peteraf and Leih, 2016; Ciampi et al., 2022; Levallet and Chan, 2022). Following the definition and application in IS literature, DCs reflect a firm's ability to adjust its resource and capability base for developing a long-term competitive advantage (Peteraf, Di Stefano and Verona, 2013; Steininger et al., 2022). DCs are based on the ability to identify and evaluate opportunities (sensing), mobilize and integrate resources for coping with opportunities (seizing), and continuously adapt these (transforming) (Teece, 2007, 2012). The organizational agility concept has gained increased attention in examining the enabling effect of technologies as resources and capabilities for developing organizational agility in today's digital world (Pinho et al., 2022; Salmela et al., 2022; Troise et al., 2022). In our work, we follow previous researchers' definitions and draw on the concept of organizational agility as a higher-order construct (Liang et al., 2017). Organizational agility is comprised of two capabilities, namely sensing and responding (Sambamurthy, Bharadwaj and Grover, 2003; Liang et al., 2017; Felipe et al., 2020). Sensing capabilities enable and support the firm's assessment of new technological opportunities for meeting customer needs (Tallon et al., 2019) whereas responding capabilities refer to the firm's ability to generate value by aligning IT resources with organizational capabilities and strategy (Grover, 2022). Summarizing, organizational agility is built on firm-level capabilities which aim to reconfigure operational processes that rapidly detect opportunities and support reactions to them (Sambamurthy, Bharadwaj and Grover, 2003; Overby, Bharadwaj and Sambamurthy, 2006; Tallon and Pinsonneault, 2011). First, we examine the technological frame as an antecedent of DBCs to explore how the cognition of CEOs affects organizational agility. We then investigate the role of DBCs in enabling organizational agility. Figure 1 provides a full visualization of our research model.

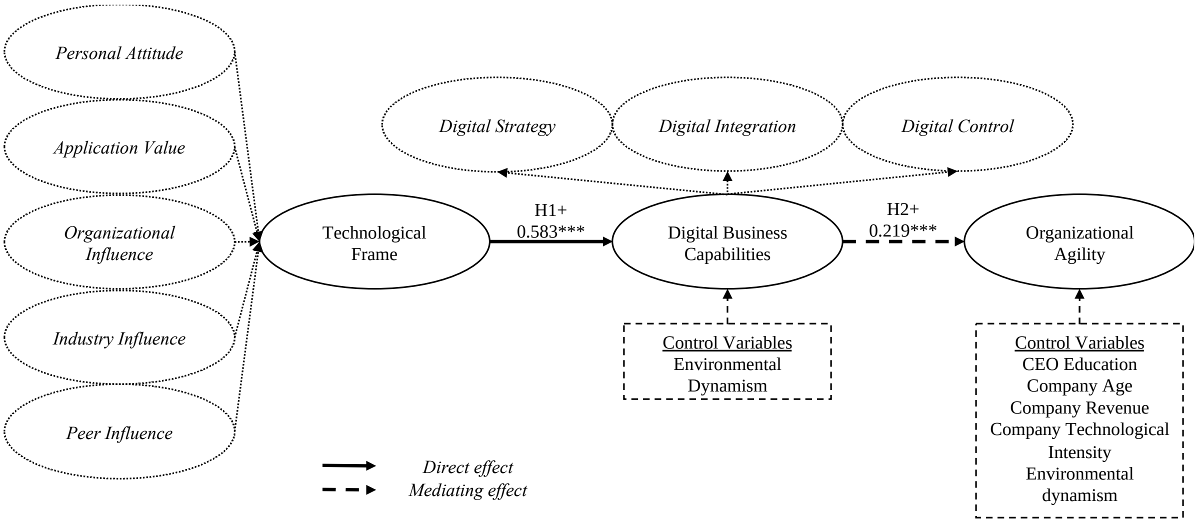

Figure 1. Overall research model.

3 Hypotheses Development

3.1 CEO technological frame and digital business capabilities

The cognitive process of CEOs' understanding, sensemaking, and evaluation of new technologies and their consequences may foster DBCs for several reasons. Firstly, the cognition and technological frames of CEOs are important for developing DBCs. When relying on Weick's sensemaking theory (Weick, 1995), the technological frame can be understood as a knowledge structure that promotes the articulation of strategy and new organizational routines and thereby, organizational capabilities. Practical findings underline the importance of the CEOs' cognition and understanding of the firm's capability development as seen in the Polaroid case (Tripsas and Gavetti, 2000). While resource allocation and investments in new technological capabilities based on management's beliefs have helped Polaroid to adjust to novel trends and shifts in customer demands, these capabilities have also led to firm inertia (Tripsas and Gavetti, 2000). Furthermore, CEOs have a significant influence on a firm's strategy and performance, which is explained by their individual characteristics and biases (Vera et al., 2022). Previous research found that CEOs not only affect the formulation of strategy but also its implementation (Hambrick and Crossland, 2018). As two elements of the DBC concept, digital strategy, and implementation seem to be directly influenced by CEOs' cognitive processes. Firms that incorporate novel technologies into their processes can adapt their business routines which are moderated by managers' technological frames (Mishra and Agarwal, 2010). Specifically, CEOs directly determine their firm's digital strategy (Bharadwaj et al., 2013) and digital implementation depends on a CEO's ability to reduce tensions and complexity which is explained by the concept of the technological frame (Chan et al., 2019). Ultimately, while the CEO's cognition and their firm's capabilities are intertwined, the mechanism by which their interplay leads to organizational agility is not evident. Secondly, firms' DBCs reflect CEOs' competencies and commitment to championing IT (Bassellier, Benbasat and Reich, 2003; Aral and Weill, 2007). By definition, the technological frame describes the process of interpreting and evaluating technologies and thereby helping to cope with IT and technologies (Orlikowski and Gash, 1994). These firm capabilities are grounded in IT knowledge and management's ability to successfully implement IT systems (Chakravarty, Grewal and Sambamurthy, 2013). The research suggests that the failure of IT adoption is explained by the executives' lacking IT understanding (Levy and Powell, 1998; Tripsas and Gavetti, 2000), whereby the rapid development of novel technologies and the excessive amount of data that is available can be overwhelming for CEOs (Pinsonneault and Choi, 2022). Empirical work has highlighted the importance of IT competencies for efficient IT usage by IT personnel which is based on their knowledge and experience related to IT (Bassellier, Benbasat and Reich, 2003). Specifically, individuals' technological frame as a means for sensemaking is particularly important in ambiguous and digital situations (Powell and Rerup, 2018) as differences in the technology perception of stakeholders shape and may even impede new technology design and implementation mechanisms (Puri, 2006). In this context, the judgment of CEOs has an especially significant influence on others, as well as on the digital strategy and the subsequent implementation of digital tools (Correani et al., 2020; Ahmed et al., 2022). A qualitative study argues that the technological frame of CEOs affects innovations while organizational technology capabilities complement this relationship (Mishra and Agarwal, 2010). In line with this, a conceptual study suggests that the exchange of rumors among actors affects new product development through novel technologies (Seidel, Hannigan and Phillips, 2020). The technological frame of CEOs can directly influence the expectations of others concerning the technology in question and the status of the CEO is thus highly relevant to technology development (Anthony, 2018; Hoppmann, Anadon and Narayanamurti, 2020). Hence, a positive valence is essential for recognizing the potential of novel digital technology and thus, for corporate change (Oreg, Vakola and Armenakis, 2011; Spieth et al., 2021). Moreover, this positive perception can enhance daily work (Meyer and Allen, 1997), and thereby improve the firm's routines and organizational capabilities, as seen in DBCs. CEOs can leverage their technological frame for making sense of digital technologies and their consequences for the different business levels and thereby influence the development of a firm's DBCs based on digital strategy, integration, and control. We argue that CEOs' technological frames can be understood as playing a facilitating role in a firm's DBCs and hypothesize:

> *Hypothesis 1: CEOs' technological frame is positively related to their firm's digital business capabilities.*

3.2 The mediating role of digital business capabilities

We focus our investigation on the capability process for several reasons. First, in line with previous research examining technological frames on the organizational level (Benner and Tripsas, 2012), our study argues that a CEO's cognition and their firm's capabilities are intertwined, and hence, foster organizational agility. Specifically, the study by Brenner and Tripsas (2012) shows that the introduction of digital camera features can be the result of a firm's technological capabilities but also, most importantly, affected by managerial cognition, whereby the two aspects are difficult to disentangle (Benner and Tripsas, 2012). Hence, our study argues that CEOs' technological frames are intertwined with firms' organizational capabilities, as seen in DBCs, and thereby, promote organizational agility. Furthermore, we suggest that organizational capabilities, which reflect the firm's routines and the CEO's cognitive processes and frames (Teece, Pisano and Shuen, 1997; Kaplan and Tripsas, 2008; Eggers and Kaplan, 2013), promote the development of DCs and thus, organizational agility (Felin et al., 2012; Bharadwaj et al., 2013; Teece, 2017). Studies reveal that the implementation and use of new technologies and resources reflect key drivers for firm IT capabilities which in turn are the building block of organizational agility (Lu and Ramamurthy, 2011). Additionally, digital technologies enable different forms of DCs and are required for turbulent environments (Pavlou and El Sawy, 2011). While IT capabilities were found to relate to organizational agility, a recent study confirms previous research and highlights a positive effect of DBCs on organizational agility (Li et al., 2018; Ahmed et al., 2022). However, only firms which can continuously adjust their technological resource base and align their overall strategy with capabilities, based on their CEOs' abilities, will be able to leverage organizational agility (Gao et al., 2020; Ciampi et al., 2022; Steininger et al., 2022). Therefore, we argue that DBCs represent an important element of today's firm capabilities and are a potential predictor of organizational agility (Wielgos, Homburg and Kuehnl, 2021). While IT capabilities foster organizational agility, DBCs are similar but distinct from these (Wielgos, Homburg and Kuehnl, 2021). However, while IS research has made remarkable progress in investigating the influence of IT capabilities and digital capabilities for organizational agility, the micro-level perspective has helped to examine how CEOs' individual understandings shape their firms' organizational capability developments (Eisenhardt and Martin, 2000; Eggers and Kaplan, 2013). Therefore, exploring how the technological understanding and sensemaking of CEOs affect DBCs and indirectly impact organizational agility comprises a crucial step toward deriving a more comprehensive and holistic understanding of this topic.

Secondly, the cognition of CEOs plays a crucial and direct role in the development of DBCs that enable organizational agility since managerial behavior is responsible for combining internal and external resources and thereby facilitating a firm's capability development (Eisenhardt and Martin, 2000; Kemper, Schilke and Brettel, 2013; Teece, Peteraf and Leih, 2016). Previous research investigating the micro-level of firm capability development focused on general cognitive factors and CEOs' level of experience (Eiteneyer, Bendig and Brettel, 2019; Li and Patel, 2019), thereby ignoring the interpretation process specifically related to technology. In line with this argumentation, the top management's competencies are of tremendous importance for a firm's digitalization process reflected in DBCs (Teece, 2012; Bresciani et al., 2022; Ferraris et al., 2022). Only one study focused on examining the causal mechanism between individuals' technical capabilities and organizational agility through specific IT infrastructure capabilities (Fink and Neumann, 2007). More specifically, actors who make use of their frame can effectively manage change and strategic firm-level DCs (Young, Mathiassen and Davidson, 2016). Hence, CEOs' technological frame as cognition is highly significant when exploring the development of firm capabilities and resulting DCs in the digital world.

Thirdly, CEOs' technological frame fosters organizational agility through the process of organizational capabilities. CEOs' technological frame and perception of IT use have become the overall organizational frame, overriding others' perceptions and decisions (McGovern and Hicks, 2004). Specifically, CEOs use strategic language based on their technological frame for influencing their stakeholders' perceptions of technology, thereby leading to change (Puri, 2006). Novel research confirms the influential role of the top management team's technological frame for employees' sensemaking of new technologies with the support of a strategy aimed to capitalize on technologies (Truelove, 2022). Furthermore, organizational frames can shape entire market expectations (Bojovic, 2022) whereby technology integration and control follow the preceding sensemaking processes which are based on expectations and are shaped by information exchange, language, and strategy (Davidson and Pai, 2004; Spieth et al., 2021). Hence, we argue that DBCs constituted of digital strategy, implementation, and control mechanisms help us to examine the direct consequences for firm capabilities and indirect consequences for organizational agility caused by CEOs' technological frame. To this end, we derived the following hypothesis:

> *Hypothesis 2: DBCs mediate the relationship between CEOs' technological frame and organizational agility.*

4 Research Methodology & Analysis

4.1 Sample and data collection

We conducted a web-based survey based on an email-based survey design and collected data from CEOs located in Germany (Dillman, 1991). First, we translated the measurement scales from English into German and followed the double translation approach for coherence (Brislin, 1970). We pre-tested our survey with six academics and three German CEOs and incorporated their feedback. As our survey focused on individual-level and organizational-level factors, we exclusively relied on CEO data (Chatterjee and Hambrick, 2007). Further, we focused on firms with a wide range of ages, and sizes, and from various industries to enhance the generalizability of the findings. While the chosen measurement scales were developed and applied in the digital context (Spieth et al., 2021; Wielgos, Homburg and Kuehnl, 2021), we selected manufacturing SMEs that are facing increasing digital opportunities to simultaneously facilitate the applicability of the questionnaire (Wiens et al., 2010; Chan et al., 2019). Based on these conditions, we drew a random sample from the LexisNexis databank (Bosch-Sijtsema and Bosch, 2015). The survey collection process took place from May to August 2022, and we sent three reminders after the survey was sent out via email. For preventing common method bias (CMB), we indicated that all answers are treated as confidential and anonymous and that no answer is "correct" or "incorrect" (Podsakoff et al., 2003). In total, we obtained 618 responses (corresponding to a response rate of 9%). We excluded responses from non-CEO positions such as Chief Financial Officers or Chief Information Officers (225), companies with more than 500 employees (3), unengaged responses (1), or responses characterized by a lack of self-reported knowledge (3). After the exclusion process, our data set was left with 386 observations for analysis. When compared to previous studies, our approach and final sample size can be considered suitable (Bendig, Strese, et al., 2018). For the analysis of our results, we used SmartPLS 4.0 software and applied the partial least squares (PLS)-structural equation modeling (SEM) analysis for evaluating our proposed hypotheses (Sarstedt, Ringle and Hair, 2021). The SmartPLS application is suitable for evaluating the parameters of second-order constructs consisting of two levels which are also referred to as higher-order models or hierarchical latent variables in the PLS-SEM context (Sarstedt, Ringle and Hair, 2021). Additionally, it is suitable to test small sample sizes and latent constructs without measurement error (Hair et al., 2012; Sarstedt, Ringle and Hair, 2021).

4.2 Measurements

For analyzing our proposed research model, we relied on multi-item measurement scales and applied a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), following Podsakoff et al. (2012). We applied the newly developed second-order construct technological frame comprising five formative subdimensions by Spieth et al. (2021) as a dependent variable. In the questionnaire, we adjusted the wording from “supervisor influence” to “peer influence” to retain the original meaning while making it applicable to the CEO level. As a mediator variable, our study applied the second-order construct of DBCs, reflected by three subdimensions, namely digital strategy, digital integration, and digital control, established by Wielgos et al. (2021). We captured the dependent variable with the well-established construct of organizational agility developed by Liang et al. (2017). In line with previous studies, we controlled for individual and firm characteristics and included CEO education, company age, revenue, and technological intensity. In alignment with the literature, we also controlled for environmental dynamism. Lastly, as recommended by scholars, we eliminated all insignificant control variables (Aguinis and Vandenberg, 2014).

4.3 Bias testing

We conducted common method and non-response tests. Apart from trying to reduce the CMB as previously described, we additionally checked potential biases and followed Kock et al. (2015). We did not find any CMB, as all Variance Inflation Factor (VIF) values of the inner model are below the recommended threshold of 3.3 (Kock, 2015). Further, we applied Harman’s single factor test and did not find any bias since the first factor yielded 33.67% of the variance extracted and thus did not explain most of the variance (below 50%) (Podsakoff et al., 2003; Kock, 2020). Therefore, we are not concerned with any potential CMB. Second, we compared the results from a *t*-test to control for differences between the early and late responses. The fact that no significant differences were observed indicates that concerns regarding a non-response bias are unfounded (Armstrong and Overton, 1977).

4.4 Measurement model assessment

We assessed our measurement model’s reliability and validity by conducting the conformity composite analysis (CCA) for confirming our two second-order constructs (Sarstedt, Ringle and Hair, 2021). For the reflective scale of organizational agility, we first investigated the item loadings whereby the desired loading values are >0.708 at a 5% significance of a two-tailed test (Hair, Ringle and Sarstedt, 2011; Sarstedt, Ringle and Hair, 2021). Based on poor factor loadings, we eliminated one item (as_1) from organizational agility as it did not conform to the required values between 0.40 and 0.70 (Sarstedt et al., 2016). We established construct reliability by assessed the Cronbach’s alpha (α) and composite reliability (CR) values which were in line with the desired thresholds (>0.70 and <0.95) (Hair, Howard and Nitzl, 2020; Sarstedt, Ringle and Hair, 2021). For convergent validity, we relied on the construct’s average variance extracted (AVE) thresholds (>0.50) which were surpassed after one item elimination (Hair, Howard and Nitzl, 2020). Further, we assessed the potential inter-correlations for establishing discriminant validity to interpret a construct’s distinctiveness by using the Fornell & Larcker and heterotrait-monotrait ratio (HTMT) method with cut off scores of 0.85 and 0.90 (Fornell and Larcker, 1981; Sarstedt, Ringle and Hair, 2021). Concluding our measurement model assessment, we can confirm the indicator reliability, CR, and discriminant validity. Table 1 provides an overview of the correlations with the square root of AVE and Table 2 presents the descriptive statistics.

Construct correlations	(1)	(2)	(3)
(1) Technological frame	**n/a**		
(2) DBC	0.675***	**0.857**	
(3) Organizational agility	0.325***	0.411***	**0.719**
CEO education	0.048	0.034	0.154*
Company age	0.016	0.062	-0.137**
Company size	0.155***	0.249**	0.154***
Company revenue	0.138**	0.178***	0.180***
Corporate technological intensity	-0.226***	-0.246***	0.270***
Environmental dynamism	0.359***	0.422***	0.278***
*** Significant at 0.001; ** Significant at 0.01; * Significant at 0.05; † Significant at 0.1 Note: The square root of the AVE is shown on the diagonal for all reflective constructs.			

Table 1. Construct correlations.

Construct statistics	Technological frame	DBC	Organizational agility
Mean	3.9	5.2	5.2
SD	1.5	1.3	1.2
VIF	1.2–1.9	1.8–2.0	1.4–1.7
AVE	n/a	0.735	0.516
CR	n/a	0.825	0.842
α	n/a	0.820	0.769
AVE = Average Variance Extracted; CR = Composite Reliability; VIF = Variance Inflation Factor (in this paper: VIF range of the latent variables)			

Table 2. Descriptive statistics.

We applied the disjoint two-stage approach for assessing and confirming the higher-order constructs of the technological frame and DBCs on two levels (Becker, Klein and Wetzels, 2012; Sarstedt, Ringle and Hair, 2021). First, we assessed the factor loadings of all reflective lower-order items (Hair, Howard and Nitzl, 2020) and eliminated one item due to poor factor loading performance, while all other items loaded well and are statistically significant. For the reflective second-order construct, DBC, we followed the proposed procedure (Sarstedt, Ringle and Hair, 2021). We obtained good factor loadings above the required threshold (>0.708) and an adequate AVE (Hair, Howard and Nitzl, 2020). In addition, the latent variables meet the requirements (>0.5), Cronbach's alpha (0.820), rho_A (ρA = 0.825), and rho_C (ρC = 0.893). Moreover, we established the discriminant validity of the construct based on the HTMT and Fornell & Larcker criterion (Sarstedt, Ringle and Hair, 2021). For the reflective-formative second-order construct, technological frame, we continued with the second step of the disjoint-two-stage approach by validating the second-order formative construct (technological frame) based on its latent variable scores of the validated first-order reflective construct (Sarstedt, Ringle and Hair, 2021). All VIF scores meet the most current guidelines (<3) (Becker et al., 2015; Sarstedt, Ringle and Hair, 2021). We subsequently tested the significance and relevance by assessing their outer weights, outer loadings, and their significance (Sarstedt, Ringle and Hair, 2021). All values apart from the outer weight of the technological frame's subdimension, "organizational influence," are significant. We kept the latent variable "organizational influence" in our final model as the outer loading value was above the required threshold (>0.50) (Sarstedt, Ringle and Hair, 2021). Concluding, we confirm the validity of the second-order formative construct, the technological frame, based on its first-order reflective latent variables.

4.5 Structural model assessment and hypotheses testing

For assessing the structural model, we utilized SmartPLS 4.0 and applied the PLS-SEM approach (Sarstedt, Ringle and Hair, 2021). We tested our hypotheses based on the two-tailed bootstrapping procedure with 10,000 iterations to identify the statistical significance (p-value) of the path coefficients (β), following the structural model assessment procedure (Sarstedt, Ringle and Hair, 2021). The assessment was commenced by identifying potential multicollinearity issues of the structural model constructs. All VIF scores are below the recommended threshold of 3. In the second step, we evaluated our path coefficients' sizes (β) and significances (p-value) for testing our hypotheses (Hair, Howard and Nitzl, 2020). In the last step of the structural model assessment procedure, we assessed our latent variables' predictive accuracy (R^2) and relevance (Q^2) (Hair, Howard and Nitzl, 2020). Our results show a positive and significant relationship between technological frame and DBCs ($\beta = 0.583$; $p = 0.000$) and between DBCs and organizational agility ($\beta = 0.300$; $p = 0.000$). When investigating the strength of these relationships, we found a strong effect of the technological frame on DBC ($f^2 = 0.620$), while the effect of DBC on organizational agility turns out to be small ($f^2 = 0.060$). In line with the requirements described by Baron and Kenny (1986), we found two statistically significant direct relationships, namely technological frame with organizational agility, and DBC with organizational agility. In addition, the direct path from the technological frame to organizational agility with the inclusion of the mediator is close to zero (Baron and Kenny, 1986). Table 3 presents the results of our direct path coefficient, significance level, and model predictability of PLS-SEM.

Direct effects		Path to…	
	The direct path from…	(2) DBC	(3) Organizational agility
Independent variable	(1) Technological frame	0.583***	*not hypothesized*
Mediator	(2) DBC	–	0.300***
Control	CEO education	0.034	0.154**
	Company age	0.054	-0.137**
	Company size	0.249***	0.154***
	Company revenue	0.170***	0.180***
	Corporate technological intensity	-0.240***	-0.270***
	Environmental dynamism	0.423***	0.277***
Predictive accuracy	R^2	0.511	0.261
Predictive relevance	Q^2	0.492	0.185
a: Non-hypothesized relationships were not included in our model or table (indicated as –). Non-significant controls were removed from the final model. The direction of the path coefficients relationship progresses from columns to rows.			
*** Significant at 0.001; ** Significant at 0.01; * Significant at 0.05; † Significant at 0.1			

Table 3. Direct path coefficient, significance level, and model predictability of PLS-SEM.

Following the mediation analysis with the bootstrapping approach with 10,000 iterations (Preacher, Rucker and Hayes, 2007; Nitzl, Roldan and Cepeda, 2016), we assessed the significance of the indirect relationship between technological frame and organizational agility. Firstly, we found a positive and significant indirect association between the technological frame and organizational agility through DBC ($\beta = 0.175$; $p = 0.000$). As no zero is present in the bias-corrected confidence interval (Preacher and Hayes, 2004), we can confirm the indirect relationship. Secondly, we applied the bootstrapping procedure and found a positive and significant total effect ($\beta = 0.219$; $p = 0.000$), which represents the direct relationship between technological frame and organizational agility without the presence of the mediator (Preacher and Hayes, 2004). Thirdly, the direct relationship between technological frame and organizational agility in the presence of the mediator is positive but insignificant ($\beta = 0.043$; $p = 0.577$), thereby showing an indirect-only mediation (Baron and Kenny, 1986; Zhao, Lynch and Chen, 2010). When testing the mediation with variance accounted for (VAF) values (Nitzl, Roldan and Cepeda, 2016), we observed evidence of a mediation (VAF = 0.79). The results of the mediation analysis with the indirect, total, and direct effects are presented in Table 4.

Mediation relationship	Total effect (without mediator)	Direct effect (with mediator)	Indirect effect (through mediator)	Bias-corrected confidence interval	
				2.5%	97.5%
Technological frame → DBC → Organizational agility	0.219***	0.043	0.175***	0.094	0.267

Table 4. Mediation analysis with the total, direct, and indirect effects.

The results indicate that a CEO's technological frame affects a firm's agility through the firm's DBCs which have absorbed the entire direct effect (Nitzl, Roldan and Cepeda, 2016). As a result, we concluded the structural model assessment and failed to reject H1 and H2. We evaluated the predictive accuracy (R^2) and relevance (Q^2) of our model (Sarstedt, Ringle and Hair, 2021). We found that both DBC and organizational agility provide moderate R^2 values ($R^2 = 0.511$; $R^2 = 0.261$), thereby demonstrating a good explanatory power (Carrión, Nitzl and Roldán, 2017; Sarstedt, Ringle and Hair, 2021). Additionally, the predictive relevance of our model with thresholds >0.15 shows a strong relevance of DBC ($Q^2 = 0.493$) and a moderate relevance of agility ($Q^2 = 0.185$) which confirms the appropriateness of our model (Hair, Ringle and Sarstedt, 2013; Sarstedt, Ringle and Hair, 2021).

4.6 Post-hoc and robustness analyses

We evaluated the robustness of our model by testing for nonlinear effects, endogeneity, unobserved endogeneity, and non-formative models (Sarstedt et al., 2020). We used the quadratic effect function for all relationships and performed a bootstrapping procedure with 10,000 iterations for identifying nonlinear effects (Sarstedt et al., 2020). We confirmed the robustness of our model as we did not observe significant quadratic effects (p-value <0.01), while the significance of all other linear relationships did not change. We tested for potential reverse relationships or omitted variable errors by assessing the model's endogeneity (Hult et al., 2018; Sarstedt et al., 2020). Despite our careful selection of control variables for reducing endogeneity, we conducted two additional tests, the Gaussian Copula (GC) approach and the Instrumental Variable (IV) method to confirm our findings (Park and Gupta, 2012; Becker, Proksch and Ringle, 2022). We ensured that our endogenous variable meets the non-normal distribution condition based on the Cramer-von-Mieses significance test (Park and Gupta, 2012; Becker, Proksch and Ringle, 2022). As we did not find significant relationships (p-value <0.01) with the GC values, endogeneity does not seem to be an issue in our study. We performed the IV method with STATA 17.0 and selected a correlating construct with the independent variable technological frame (Bascle, 2008; Hult et al., 2018). We confirm that it meets the requirement of a statistically significant correlation with the technological frame (p-value = 0.000). We found acceptable results with F-statistics of 12 which surpassed the 15% maximal IV size (Stock and Yogo, 2005). This confirms that our choice of an instrument with the resource constraints constructs is not weak. Moreover, we performed the (Durbin-Wu)-Hausmann test (Hult et al., 2018; Lu et al., 2018). We did not find endogeneity issues. With the third test, we estimated the potential unobserved endogeneity (Hult et al., 2018). We applied the "finite mixture-PLS" method for finding unobserved endogeneity and confirmed that unobserved heterogeneity is not present (Sarstedt et al., 2020). Our final robustness test checked whether technological frame could be a higher-order reflective-reflective instead of a higher-order reflective-formative model by applying the Confirmatory Tetrad Analysis (CTA) (Gudergan et al., 2008; Hair et al., 2019). The bootstrapping procedure confirmed our original construct and model robustness.

5 Discussion & Implications

5.1 Theoretical implications

This study develops our understanding of whether and how CEOs' sensemaking and understanding of technologies – CEOs' technological frame – is related to a firm's DBCs. Furthermore, our paper explores the mediating role of DBCs between CEOs' technological frame and organizational agility by combining the concept of a technological frame and the DC theory. The findings indicate that organizational agility is indirectly influenced by CEOs' technological frames, namely sensemaking of a complex digital world, through the development of DBCs, composed of digital strategy, digital implementation, and digital control. The following findings facilitate the derivation of two main implications for theory. Firstly, in response to RQ1, our study found that CEOs' technological frames affect firms' DBCs directly and positively. With our findings, we offer new insights into the direct impact of CEOs' cognition on firm capabilities in the context of a digital world by considering CEOs' sensemaking of technology (technological frame) and DBCs. Specifically, CEOs who make sense of technologies based on their frame influence their firms' DBCs through the articulation of language reflected in the impact on the digital strategy element. Further, in line with previous findings, CEOs' technological frames have direct implications for the digital implementation and digital control elements as frames were shown to be relevant for technology use (Mishra and Agarwal, 2010). This study answers two research calls, namely to expand the concept of the technological frame on the micro-level and to explore the effect of an individual's sensemaking on a firm's capabilities (Tallon et al., 2019; Spieth et al., 2021; Pinsonneault and Choi, 2022). Additionally, we expand CEOs' characteristics by adding the element of a technological frame (Bendig, Enke, et al., 2018). Simultaneously, we follow calls for future research on exploring which competencies and skills CEOs need for DBC development (Wielgos, Homburg and Kuehnl, 2021). Thus, we further broaden the sensemaking theory and application for the IS literature by elaborating on CEOs' technological frames and their positive consequences for firm capability development, whereby we expand the IS literature and reveal the importance of CEOs' sensemaking for digital strategy as part of DBCs and organizational agility. Additionally, we empirically connect the main variables from the newly introduced concept of technological frame and the DC theory and add a new component to the micro-level perspective of CEO cognition for firm capability development.

Second, in addressing RQ2, we found that DBCs positively mediate the relationship between CEOs' technological frames and organizational agility. Interestingly, we only observed an indirect relationship between CEOs' technological frames and organizational agility through DBC. This indicates that, while the sensemaking and evaluation of digital technologies by CEOs are crucial for a firm's strategy, routines, and capabilities as suggested by the literature (Felin et al., 2012), our findings also shed light on the interrelationship between individual-level antecedents, capabilities, and dynamic capabilities. Thus, our study contributes to the DC theory by uncovering the underlying interdependencies. Further, our study extends our understanding of traditional IT capabilities in the context of digital environments for enabling organizational agility by relying on the newly developed DBC scale which not only focuses on supporting a firm's current value proposition but also the related firmwide changes (Gao et al., 2020; Wielgos, Homburg and Kuehnl, 2021; Ciampi et al., 2022). Furthermore, we show how CEOs' technological frames trigger DBC development which promotes organizational agility and we thereby respond to calls for research on exploring how DBCs foster firm outcomes, specifically agility (Wielgos, Homburg and Kuehnl, 2021). Lastly, we demonstrate the relevance of CEOs' technological frame of organizational ability through DBCs and explore the micro-level antecedents and mediating mechanisms fostering organizational agility (Tallon et al., 2019; Bresciani et al., 2022; Ferraris et al., 2022). Moreover, our study explores the indirect relationship between CEOs' sensemaking and organizational agility (Pinsonneault and Choi, 2022) whereby we offer fruitful insights for IS literature by expanding the current understanding and offering empirical insights on the interdependence and the mechanism of how DBCs, and not only IT capabilities, explain the relationship between CEOs' technological frame and organizational agility. Furthermore, our findings indicate that a firm's ability to identify new digital opportunities is indirectly associated with the CEO's technological frame. Hence, the firm's ability to adjust its resource base for capitalizing on digital opportunities is reflected in the firm's DBCs which comprise the alignment between digital strategy and implementation of digital technologies resources. Finally, the firm's ability to continuously reconfigure its resource base is rooted in the digital control element as part of DBCs. All three activities enable the development of organizational agility which is highly related to CEOs' sensemaking of digital technologies. Hence, in line with previous research, CEOs do not develop DCs by themselves but their sensemaking and technological frame impact DBCs which in turn affects organizational agility.

5.2 Managerial implications

Our findings offer valuable insights and practical instruments for CEOs and practitioners who cope with today's digital world. First, our results highlight that CEOs' understanding and interpretation of digital technologies foster firm capabilities which are reflected in digital strategy, digital implementation, and digital control activities. Thus, CEOs' interpretation and assessment of the turbulent digital world help to explain how SMEs develop a digital strategy and implement digital control and integration mechanisms. These reflect a firm's digital business capabilities. Hence, our empirical research confirms the usability of the newly developed instrument by Spieth et al. (2021), which can be applied to understanding how actors interpret and implement new technologies. Moreover, our study can help SMEs to better understand the importance of DBC development based on the three subdimensions. Second, our findings help to untangle the interconnection between CEOs' technological interpretations and organizational agility development by highlighting and uncovering the importance of DBCs. While CEOs are responsible for making sense of digital technologies and their potential, our study emphasizes the role of specific firm capabilities and the need to align their strategy and resources for capitalizing on digital opportunities. In this way, we shift the focus from IT to digital business capabilities, based on digital strategy, digital control, and digital integration. Furthermore, our study's results demonstrate how a firm's capabilities are crucial for linking the CEO's understanding to organizational agility. Thus, while the cognitive competencies of CEOs can be understood as a crucial starting point for embracing digital technologies, firms have to ensure that supporting and wide-reaching digital business capabilities that are based on the alignment of digital strategy, implementation, and control are implemented (Durán, Aguado and Perdomo-Ortiz, 2022). Ultimately, we show that a firm's ability to rapidly sense and respond to environmental changes depends on the interplay between the CEO's technological frame, including their ability to reduce the complexity of the data provided and make sense of it, and the firm's ability to adjust its available digital resources in accordance with the articulated strategy.

6 Limitations & Future Research

To conclude, we highlight the potential limitations of our study which can offer new opportunities for future research. Firstly, our micro-level analysis requires further investigation. By examining the newly developed scale technological frame, we only focused on the frame of CEOs in the SME context. Especially in the context of large or international corporates, exploring the interaction between different individual frames in the top management team could be valuable for understanding further organizational consequences fostered by the technological frames. Secondly, our research is solely based on the CEO as a key informant which could entail subjective results. Furthermore, a different research and sample design could be applied in future studies. In light of the increasing digital opportunities and pressure caused by the dynamic global situation, we investigated German manufacturing SMEs, and our research can serve as a starting point for future research on the impact of CEOs in SMEs in different countries or international contexts (Iborra, Safón and Dolz, 2020; Canhoto et al., 2021). Thirdly, we found that CEOs' technological frames only become effective through DBCs, and thereby affect organizational agility. Overall, our study represents a preliminary step toward uncovering the mechanism and causal chains between CEOs, organizational capabilities, and organizational agility.

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