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Boosting SMEs' digital transformation: the role of dynamic capabilities in cultivating digital leadership and digital culture

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Abstract

Digital transformation is crucial for the competitiveness of small and medium-sized enterprises (SMEs), yet many SMEs struggle with its implementation. Although digital leadership and digital culture are two established facilitators of digital transformation, their antecedents remain highly understudied. Drawing on the dynamic capabilities framework, we hypothesize that dynamic capabilities promote digital leadership and digital culture in SMEs. Our empirical study builds on questionnaire data from 98 SMEs located in Southern Germany. The findings support the enabling role of dynamic capabilities, indicating that dynamic capabilities enhance digital leadership and digital culture. Contrary to our expectations, the hypothesized mediation effects between dynamic capabilities, digital leadership, and digital culture were not supported, indicating that the translation mechanisms between digital leadership and digital culture might be less direct and straightforward than previously presumed. Thus, dynamic capabilities emerge as critical, yet separate, enablers of digital leadership and digital culture. By positioning dynamic capabilities as antecedents rather than outcomes, this study provides a novel perspective on central enablers of digital transformation, extending dynamic capabilities theory into this context. Overall, our findings offer important implications for facilitating SMEs' digital transformation, highlighting dynamic capabilities as essential for fostering digital leadership and digital culture. Despite its significance, our study faces some limitations that hinder the generalizability of our findings, including relatively small sample size or specific sample context. Future research should replicate and extend our analyses using larger and more diverse samples.

Keywords Digital culture · Digital leadership · Digital transformation · Dynamic capabilities · Small and medium-sized enterprises

JEL classification M15 · O32 · O33

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1 Introduction

Digital transformation has become a popular topic in business research (Kraus et al. 2021) as it represents a profound technological change that affects all levels of a company (Nadkarni and Prügl 2021; Pfister and Lehmann 2023). This change introduces new processes that fundamentally reshape how a company operates and creates value (Kraus et al. 2022). As a result, digital transformation has become vital for enhancing firm performance in today's competitive business landscape (Malodia et al. 2023).

However, implementing digital transformation in small and medium-sized enterprises (SMEs) is associated with difficulties (Gyamerah et al. 2025). Most SMEs have fallen behind due to their specific characteristics. For instance, SMEs face inherent resource scarcity (Eller et al. 2020) and have limited capabilities to scale their business model (Galli-Debicella 2021). In addition, SMEs often lack a holistic understanding of digital transformation, as their leaders tend to perceive it as a one-time project rather than an ongoing organization-wide change process (Zoppelletto et al. 2023).

Consequently, research suggests that SMEs rely on a successful digital transformation to stay competitive (Skare et al. 2023; Pfister and Lehmann 2023). Through the adoption and strategic integration of technologies, SMEs can improve their operational efficiency (Koporcic et al. 2025). Therefore, SMEs must actively embrace the current trends in digitalization (Kallmuenzer et al. 2025), which represents an essential component of digital transformation.

Although technology is necessary for successful digital transformation (Vial 2019), other enablers must also be considered (Dörr et al. 2023; Saihi et al. 2023). Consequently, alongside the technological dimension, a human dimension needs to be incorporated (Nadkarni and Prügl 2021). Notably, there is growing consensus in the literature on the importance of establishing *digital leadership* (e.g., Brunner et al. 2023; Cortellazzo et al. 2019; Huang et al. 2023; Gyamerah et al. 2025) and cultivating *digital culture* (e.g., Butt et al. 2024; Weritz et al. 2020; Ghafoori et al. 2024) to achieve successful digital transformation in an organization.

Accordingly, digital leaders select, promote, and enable the effective use of technologies among their employees (Op ´t Roodt et al. 2025). Their leadership introduces the necessary mindset needed for the transformational process (Konopik et al. 2022). Moreover, digital leaders play a critical role in shaping the strategic direction for digital transformation and in ensuring that digital initiatives are effectively aligned with the organization's core business objectives (Canhoto et al. 2021; Singh et al. 2020). Furthermore, digital leadership promotes a trust-based organizational culture that supports collaboration and enables individuals to thrive in the digital age (Tigre et al. 2023).

Organizational culture affects various aspects of an organization during digital transformation (Ghafoori et al. 2024), including technology adoption (Dasgupta and Gupta 2019; Jackson 2011). Digital transformation requires a digital mindset and subsequent cultural change (Fitzgerald et al. 2014). Thus, digital culture is crucial for the success of digital transformation (Warner and Wäger 2019; Weritz et al. 2020).

Consequently, one critical challenge for SMEs lies in effectively leveraging digital leadership and digital culture to boost digital transformation. Against this back-

drop, the *dynamic capabilities framework* provides a fitting theoretical lens, as it encompasses a firm's ability to sense opportunities, seize identified opportunities, and transform resources (Teece 2007; Teece et al. 1997). Several studies highlight the importance of dynamic capabilities in the digital context (e.g., Matarazzo et al. 2021; Mikalef and Gupta 2021; Warner and Wäger 2019; Weritz et al. 2024; Soluk and Kammerlander 2021), resulting in a dedicated research stream for the interplay of dynamic capabilities and digital transformation (Kraus et al. 2022; Abbad and Rowe 2024).

However, there is insufficient knowledge about the interplay of both enablers—digital leadership and digital culture—with the dynamic capabilities framework. Recent research either conceptualizes digital leadership as a dynamic capability itself (e.g., Konopik et al. 2022) or highlights its role in fostering dynamic capabilities for digital transformation (e.g., Huang et al. 2023; Gyamerah et al. 2025). While these studies illustrate the crucial role of digital leadership in promoting dynamic capabilities, they do not explore vice versa how dynamic capabilities—as a crucial organizational foundation—can enhance digital leadership.

In examining the interplay between digital culture and dynamic capabilities, digital culture is frequently conceptualized as a moderator that facilitates the translation of dynamic capabilities into organizational outcomes (e.g., An et al. 2024). However, Warner and Wäger (2019) challenge this perspective by emphasizing that the process of building dynamic capabilities in the context of digital transformation itself initiates an ongoing strategic renewal, including the renewal of organizational culture. Nevertheless, research has not yet examined whether dynamic capabilities can actively promote and shape digital culture.

To the best of our knowledge, there is a lack of quantitative empirical research on how dynamic capabilities influence digital leadership and digital culture in the context of SMEs' digital transformation. We depart from previous research by positioning dynamic capabilities as an *antecedent*—not as an outcome—of digital leadership and digital culture. This perspective offers a new angle on well-established and validated constructs of digital transformation research and highlights the enabling role of dynamic capabilities in digital transformation, as suggested by previous research (e.g., Heubeck 2023; Fachrunnisa et al. 2020; Warner and Wäger 2019). Specifically, we aim to contribute to the literature by answering the following two research questions:

RQ1. To what extent do dynamic capabilities promote digital culture and digital leadership in the context of SMEs' digital transformation?

RQ2. What are the interdependencies between digital leadership and digital culture in the context of dynamic capabilities within SMEs' digital transformation?

Drawing on dynamic capabilities literature, we hypothesize that dynamic capabilities foster both digital leadership and digital culture in SMEs. We also explore potential mediation effects between these factors to better understand the underlying mechanisms. We tested our hypotheses on a sample of primary questionnaire data from 98 SMEs in Southern Germany and found general support for the facilitating role of dynamic capabilities for digital culture and digital leadership. Despite our theoretical expectations, we found no support for a mediation relationship between dynamic capabilities, digital culture, and digital leadership.

Our study makes two central theoretical contributions. First, we offer a conceptual extension by proposing that dynamic capabilities act as organizational building blocks that precede and enable the development of digital leadership and digital culture. While prior research often positions digital leadership and digital culture as facilitators (e.g., Gyamerah et al. 2025; Huang et al. 2023) or moderators (e.g., An et al. 2024) of dynamic capabilities, we complement this view by reversing the perspective: dynamic capabilities, understood as higher-order routines (Winter 2003), provide the structural and cognitive foundations from which these transformation-enabling constructs can emerge. This theoretical shift helps better understand how organizations actively construct the conditions necessary for digital transformation (Leso et al. 2024).

Second, we contribute to a more differentiated view of how dynamic capabilities shape the socio-organizational foundations of digital transformation by showing that digital leadership and digital culture emerge as distinct, non-interdependent outcome paths. Contrary to our theoretical expectations—and to prevailing assumptions of sequential or mediating relationships (e.g., Cortellazzo et al. 2019; Butt et al. 2024)—our findings reveal that both constructs are directly influenced by dynamic capabilities but do not causally affect one another. This suggests that leadership and culture reflect parallel manifestations of adaptive capacity rather than components of a linear process. Particularly in SMEs, where change is often informal and context-driven (Zoppelletto et al. 2023), this dual-path perspective refines existing assumptions by accounting for the non-hierarchical, emergent nature of capability-driven digital transformation (Schoemaker et al. 2018; Warner and Wäger 2019).

2 Theory

2.1 The role of digital leadership within SMEs' digital transformation

In line with Müller et al. (2024), who focus on the role of business leaders in digital transformations, we adopt the perspective of "leadership as a social influence process" (Banks et al. 2022, p. 1). This perspective emphasizes "the activities of an organized group in its efforts toward goal setting and goal achievement" (Stogdill 1950, p. 4). Against this backdrop, we view digital leadership as "an emerging construct that broadly encompasses leading both the transition and the organization in a digital environment" (Hossain et al. 2025, p. 3).

Digital leaders drive organizational change by leveraging digital technologies and combining technical expertise with their strategic vision (McCarthy et al. 2022; Cortellazzo et al. 2019). In other words, they unite both technology and business competencies (Hossain et al. 2025) and effectively coordinate various digital transformation initiatives (Singh et al. 2020).

Moreover, digital leaders promote the digital vision both internally and externally (Benitez et al. 2022). They mobilize digital transformation initiatives by living and communicating the company's mission throughout the workforce (Porfírio et al. 2021). As such, digital leadership represents a socio-technological phenomenon across multiple organizational levels (Schuster et al. 2023). By fostering a culture

of experimentation and readiness for change, digital leaders prepare the workforce for digital transformation (Konopik et al. 2022). They also guide decisions on which technologies to adopt and how quickly they should be implemented (Porfírio et al. 2021). Further, they act as role models with regard to ethical behavior in digital transformation contexts (Cortellazzo et al. 2019).

Digital leaders require a broad set of digital, business, and strategic leadership skills (Benitez et al. 2022). Müller et al. (2024) elaborate this further by identifying three core competencies—technical, business, and people-oriented—embedded in four archetypal competency portfolios: (1) the challenger, who excels in exploring market innovation, (2) the bricoleur, who supports operational efficiency, (3) the organizer, who ensures active stakeholder involvement, and (4) the competitor, who enhances competitive positioning. This framework underscores that effective digital leadership should be context-specific and dynamically adjusted to the complexities of digital transformation.

Furthermore, with regard to digital skills, Op 't Roodt et al. (2025) emphasize three core competencies of digital leaders: (1) digital interaction, defined as effectively selecting and utilizing digital media appropriate to situational needs; (2) digital openness, described as leaders' enthusiasm and receptiveness towards embracing technological innovations; and (3) digital role modeling, characterized by leaders providing guidance and establishing clear frameworks for their teams' digital media usage.

Additionally, successful digital transformation necessitates flexible organizational structures for continuous adaptation and requires leaders to have digital transformation awareness (understanding digital dynamics), digital transformation acceleration (rapid implementation of digital initiatives), and digital transformation harmonization (effective integration of digital activities) (Hanelt et al. 2021).

In sum, digital leadership emerges as both a driving force (Malodia et al. 2023; Müller et al. 2024) and a key enabler for digital transformation (Leso et al. 2024). Thereby, leadership factors such as strategy, culture, and talent development were found to be more critical to digital transformation than technological issues (Kane et al. 2019). This is especially true for SMEs, where decision-making tends to be leader-centric, resulting in the conclusion that a successful digital transformation is closely tied to the skills of the digital leader (Gyamerah et al. 2025). Moreover, digital transformation is frequently initiated by the entrepreneurs themselves (Li et al. 2018). This infers that SMEs must leverage digital leadership to facilitate digital transformation.

2.2 The role of digital culture within SMEs' digital transformation

Another crucial enabler for successful digital transformation is digital culture (Saihi et al. 2023; Ghafoori et al. 2024). In line with previous research, we define digital culture as an organizational culture that encompasses the shared values, beliefs, and behavioral patterns that enable and support digital transformation (Upadhyay and Kumar 2020; An et al. 2024).

Digital culture fosters virtual collaboration and actively supports the development of employees by nurturing their capabilities to remain competitive in the digital envi-

ronment (Grover et al. 2022). It is tightly interconnected with technology, data, and innovation, aiming to foster flexibility, agility, and creativity within organizations operating in digital environments (An et al. 2024).

Moreover, digital culture affects various aspects of an organization during digital transformation (Ghafoori et al. 2024). It is characterized by openness to change, agility, and a commitment to continuous learning (Hartl and Hess 2017). A strong emphasis on "testing before implementing" reflects the values of experimentation and iterative learning in the deployment of digital technologies (Butt et al. 2024). In this context, digital culture fosters digital transformation by embedding a start-up mindset and the acceptance of failures, supporting organizational reinvention toward a shared future purpose, and encouraging individuals to try again with the same passion after setbacks (Butt et al. 2024).

Successful digital transformation depends on cultivating a digital mindset and fostering a corresponding cultural change (Fitzgerald et al. 2014). Digital culture shapes how individuals perceive and accept digital technologies by influencing core beliefs related to usefulness, ease of use, social expectations, and support structures—making culture a critical antecedent to successful digital technology adoption (Dasgupta and Gupta 2019). When organizational values are widely shared, the organization is better equipped to adopt new technologies effectively (Jackson 2011).

In addition, a data-driven culture strongly influences both product and process innovation, thereby enhancing the firm's competitiveness within the industry (Chatterjee et al. 2024), which is essential for successfully navigating the challenges of digital transformation. Digital culture also fosters the digitalization of organizational processes (Proksch et al. 2024). However, a control-oriented organizational culture can hinder digital transformation by obstructing the openness and creativity required for digital innovation (Müller et al. 2019).

Diverse cultural backgrounds within the workforce influence how organizations adopt and manage digital technologies (Wang and Esperança 2023). Therefore, digital transformation should not replace existing cultural values; instead, it should serve to renew and build upon the foundational elements of culture and further develop them (Warner and Wäger 2019).

Overall, digital culture functions as a crucial enabler of digital transformation in SMEs (Leso et al. 2024; Isensee et al. 2020). Given the informal and bottom-up character of digital transformation in SMEs, change is often promoted by peer-driven initiatives that encourage a digital mindset and support the development of a digital culture through supportive and non-judgmental engagement with employees (Zoppelletto et al. 2023). A risk-averse organizational culture is a key barrier to successful digitalization in SMEs (Kallmuenzer et al. 2025). This indicates that SMEs must establish a digital culture to facilitate digital transformation.

2.3 Dynamic capabilities as a theoretical lens for digital transformation

Dynamic capabilities have emerged as a pivotal theoretical framework in strategic management, particularly suited for analyzing how businesses adapt to rapid environmental changes (e.g., Teece 2007; Peteraf et al. 2013; Schilke et al. 2018; Eisenhardt and Martin 2000). Company capabilities can be divided into two broad categories:

dynamic and ordinary (Teece 2014; Winter 2003). Accordingly, the ordinary "capability is ordinary in the sense of maintaining the status quo" (Helfat and Winter 2011, p. 1244). This implies that they are primarily concerned with routine administrative, operational, and governance functions (Teece 2014).

On the contrary, there are dynamic capabilities that are geared toward strategic change (Helfat and Winter 2011) and are defined as "the capacity of an organization to purposefully create, extend, and modify its resource base" (Helfat et al. 2007, p. 1). In line with the resource-based view, dynamic capabilities can serve as strategic resources that are valuable, rare, and difficult to imitate, thereby contributing to competitive advantage (Peteraf et al. 2013; Gupta et al. 2024).

Dynamic capabilities can be categorized into three core activities: sensing opportunities and threats, seizing opportunities, and transforming resources (Teece 2007). These three core activities play a vital role in guiding how firms adapt, although they often remain hidden from external observers (Schoemaker et al. 2018). *Sensing* refers to a firm's ability to systematically scan, interpret, and learn from its environment in order to identify emerging technological and market opportunities as well as potential threats (Teece 2007). *Seizing* captures the capability to mobilize resources and invest in new products or services, enabling the firm to capitalize on identified opportunities through effective value creation (Teece 2007, 2014). *Transforming* refers to the firm's capacity to continuously renew, recombine, and reconfigure its tangible and intangible assets (Teece 2007).

Since digital transformation represents a massive and rapid change—strategically within the company and in the environment—dynamic capabilities seem to be a suitable theoretical lens for our research. In this vein, several studies have investigated the interplay between dynamic capabilities and digital transformation in similar contexts (Warner and Wäger 2019; Matarazzo et al. 2021; Heubeck 2023; Cannas 2023; Orero-Blat et al. 2025), resulting in a distinct research stream that combines digital transformation and dynamic capabilities. Kraus et al. (2022) identify dynamic capabilities as one of five dominant themes in the digital transformation literature related to business and management. In their recent literature review, Abbad and Rowe (2024) further confirm the timeliness of dynamic capabilities by proposing a process model that sequentially articulates three categories of digital transformation capabilities: digital sensing, digital seizing, and digital reconfiguring. The same breakdown is made by Leso et al. (2024), who identify five thematic fields of action for digital transformation regarding the microfoundations of sensing, seizing, and reconfiguring capabilities: (1) designing and managing transformation, (2) promoting digital value propositions, (3) acting in digital business ecosystems, and (4) systematizing structural change. They also specify a fifth category containing supporters and enablers of digital transformation, including digital leadership and digital culture.

Thus, we can conclude that dynamic capabilities play a crucial role in digital transformation as they provide a framework for understanding how organizations adapt, innovate, and maintain competitive advantage in a rapidly changing digital world (Teece 2018). This is relevant as particularly SMEs need to adapt to this new digital reality (Gonçalves et al. 2024).

3 Hypotheses development

In dynamic and digitally evolving environments, SMEs must continuously adapt to remain competitive (Canhoto et al. 2021). Against this background, organizational structures must be flexible and favor separate business units, agile forms, and dedicated digital functions (Verhoef et al. 2021). In this context, dynamic capabilities—defined as a firm's ability to sense opportunities and threats, seize those opportunities, and reconfigure its resource base accordingly—are essential organizational routines that enable strategic change (Teece 2007). While dynamic capabilities are often discussed as generic enablers of adaptation (e.g., Helfat and Winter 2011), we argue that in the specific context of SMEs undergoing digital transformation, they serve a more foundational role: dynamic capabilities function as the *organizational building blocks* for developing two established facilitators of digital transformation—digital leadership and digital culture.

We position dynamic capabilities as higher-order, organization-wide routines (Winter 2003) that precede and enable the formation of specialized digital competencies. In this sense, dynamic capabilities are not merely mechanisms for change but are the very conditions under which digital leadership and digital culture can emerge. Dynamic capabilities often emerge from and build upon historically embedded routines and organizational memory (Zollo and Winter 2002). As such, dynamic capabilities are cumulative and path-dependent, drawing from a firm's unique experience base and past adaptation mechanisms (Eisenhardt and Martin 2000; Teece et al. 1997).

Because of this historically rooted nature, dynamic capabilities—though adaptive—tend to stabilize around established schemas and processes (Zollo and Winter 2002). They evolve slowly over time and often carry an organization's legacy ways of sensing, interpreting, and responding to change (Eisenhardt and Martin 2000). In contrast, we view digital leadership and digital culture as more fluid and future-oriented forces. They are not merely adaptations of past competencies but rather involve a deliberate break or reorientation of the firm's strategic mindset and cultural identity in light of emerging digital realities. They challenge embedded routines and usher in new values like agility, experimentation, and customer-centricity (Zoppelletto et al. 2023; Tigre et al. 2023).

Digital leadership integrates strategic, technological, and interpersonal competencies to guide organizations through digital transformation by promoting a clear digital vision and fostering change readiness (Hossain et al. 2025). It involves context-specific skills such as digital interaction, openness to innovation, and role modeling (Op 't Roodt et al. 2025). In SMEs, where leadership is often centralized, digital leadership is a key enabler of successful digital transformation (Gyamerah et al. 2025).

Building on this, we argue that dynamic capabilities may play a foundational role in the development of digital leadership. Specifically, we suggest that the sensing and seizing dimensions of dynamic capabilities could help SME leaders recognize the strategic relevance of digital technologies, articulate a coherent digital vision, and mobilize organizational efforts around them. Furthermore, reconfiguring capabilities may support leaders in adapting internal structures and processes, thereby enabling the implementation of digital initiatives and reinforcing leadership legitimacy during

transformation processes. We state our first hypothesis (see Fig. 1 for the research model) as follows:

H1. Dynamic capabilities foster digital leadership within SMEs.

Digital culture encompasses the shared values, norms, and behavioral patterns that support openness to technological change, promote agility and experimentation, and foster a continuous learning mindset across the organization (Upadhyay and Kumar 2020; Hartl and Hess 2017; An et al. 2024). It shapes how individuals perceive, adopt, and engage with digital technologies and is therefore considered a critical enabler of successful digital transformation, particularly in SME contexts where informal, bottom-up processes dominate (Dasgupta and Gupta 2019; Zoppelletto et al. 2023; Leso et al. 2024).

Building on this conceptualization, we argue that dynamic capabilities may catalyze the emergence of digital culture in SMEs undergoing digital transformation. In particular, we suggest that the transformation dimension of dynamic capabilities—which involves the ongoing renewal of organizational resources, structures, and routines—provides the structural and cognitive conditions under which a digital mindset and corresponding cultural patterns can evolve. Warner and Wäger (2019) offer empirical support for this view by demonstrating that digital transformation, as a process driven by dynamic capabilities, often results in a strategic renewal that explicitly includes changes in organizational culture. Their findings show that firms engaging in digital transformation through dynamic capabilities ultimately refresh their internal culture by fostering digital values, practices, and ways of thinking. Accordingly, we propose that dynamic capabilities not only facilitate adaptation on a structural and strategic level but also actively promote the development of digital culture as part of a broader transformation process. Therefore, we propose the following hypothesis:

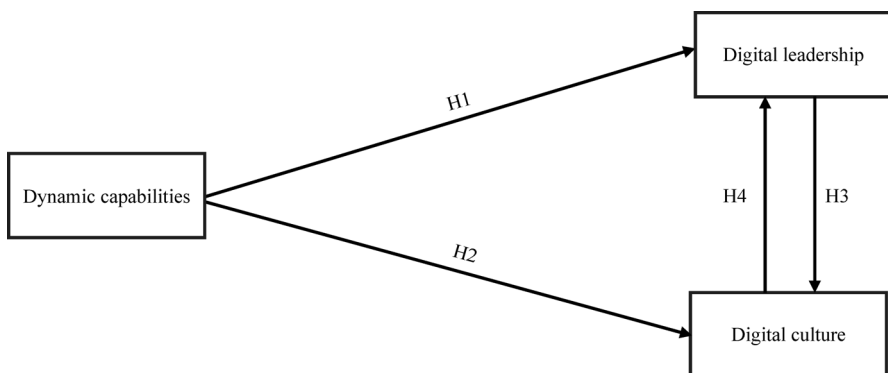**H2.** Dynamic capabilities foster digital culture within SMEs.

Fig. 1 Research Model

Beyond the independent effects of dynamic capabilities on digital leadership and digital culture, we argue that these two constructs may also interact, suggesting a potential mediation mechanism through which one construct channels the effects of dynamic capabilities onto the other. While digital leadership and digital culture are often treated as parallel enablers of digital transformation (e.g., Konopik et al. 2022; Leso et al. 2024), extant literature also points to significant interdependencies between them (e.g., Porfírio et al. 2021).

On the one hand, digital leadership may foster the emergence of digital culture by shaping shared values, guiding behavioral norms, and providing direction throughout the digital transformation process. Digital leaders promote a digital vision, act as role models, and foster a culture of experimentation and openness to change (Porfírio et al. 2021; Cortellazzo et al. 2019). They influence how employees perceive and engage with technology, thereby setting the tone for organizational learning and adaptability (Op 't Roodt et al. 2025; Müller et al. 2024). Particularly in SMEs, where leaders hold significant sway over organizational values and practices, leadership actions can be expected to shape cultural dynamics more directly (Gyamerah et al. 2025). From this perspective, digital leadership may represent a transmission mechanism through which dynamic capabilities translate into a supportive digital culture. Thus, we hypothesize:

H3. Digital leadership mediates the relationship between dynamic capabilities and digital culture.

Conversely, a pre-existing or evolving digital culture may enable or reinforce digital leadership. A culture characterized by openness to technological change, continuous learning, and a tolerance for failure creates an environment in which digital leaders can more easily exercise their roles (Ghafoori et al. 2024; Butt et al. 2024). Such a culture legitimizes visionary leadership, encourages risk-taking, and facilitates the acceptance of transformative agendas (Fitzgerald et al. 2014; Dasgupta and Gupta 2019). In particular, shared digital mindsets can lower resistance to change and increase alignment with leadership initiatives aimed at digital innovation and organizational transformation (Zoppelletto et al. 2023; An et al. 2024). In this view, digital culture may act as a facilitating mechanism that enhances the effectiveness of digital leadership as an outcome of dynamic capabilities. Therefore, we suggest the following hypothesis:

H4. Digital culture mediates the relationship between dynamic capabilities and digital leadership.

4 Method

4.1 Data collection and sample

For the empirical test of the research model, we surveyed SMEs from a southern German region in Baden-Wuerttemberg. The official SME report of the state of

Baden-Wuerttemberg 2021 shows the essential importance of SMEs for this federal state (MW BW 2021). A structural analysis by the Institute for SME Research at the University of Mannheim describes that in 2019, over 99% of companies in Baden-Wuerttemberg were defined as SMEs, employing half of all employees (MW BW 2021). Furthermore, the report highlights the challenges regarding SMEs' digital transformation, making this region suitable for our study.

The questionnaire, including initial pre-tests, was created between February and April 2024. It was part of a larger, more practically focused study of SMEs in this region and was developed in collaboration with another research team. After the pilot phase and questionnaire adjustments, the data collection phase finally occurred in May 2024. In cooperation with a local bank, the managing directors of 952 companies were contacted by letter, which contained a link to the online survey (we used QuestionPro as a survey tool). To determine an appropriate sample size for our analysis, we conducted an a priori power analysis using the software G*Power 3 (Faul et al. 2007). Based on the assumptions of an F-test for linear multiple regression (fixed model), with an expected high effect size ($f^2 = 0.35$), a significance level of $\alpha = 0.05$, and a statistical power of 0.95, the calculated minimum required sample size was 70 participants.

We received 168 responses, from which 104 were completed (response rate: 10.9%). The response rate aligns with those reported in prior research using similar survey-based approaches (e.g., Hernández-Linares et al. 2024; Heubeck and Meckl 2022). We then removed one conspicuous response in which the participant ticked the first box for each question. In addition, we removed five responses, as these were companies with a turnover of more than 50 million and, thus, were no longer SMEs. As a result, we obtained 98 usable responses from SMEs, which is suitable for our study. Table 1 shows the sample characteristics, including demographic data of the SMEs.

Several methods and tests were used to avoid common method bias. First, various pre-tests were conducted with three research assistants, two professors, and three target group entrepreneurs to ensure the questions' comprehensibility and clarity (MacKenzie and Podsakoff 2012). Second, the social desirability bias was minimized by an introductory text in the study, which ensured that no personal data of the participants was collected via the questionnaire and that no identification of individual respondents was possible. During the data analysis, we also conducted common method and non-response bias tests (see Chap. 4.3).

4.2 Variable measurements

For the measurement items, we used well-researched and accepted scales (Kump et al. 2019; Rossmann 2018) and constructed using a 5-point Likert scale ranging from 1 "strongly agree" to 5 "strongly disagree." Details of the constructs and their measurement items are shown in Table 5 in the appendix.

To measure the independent variable, *dynamic capabilities*, we used the dynamic capabilities scale of Kump et al. (2019), which is based on Teece (2007). Using the sensing, seizing, and transforming capacities proposed by Teece (2007), a total of 14 items were assessed (five for sensing, four for seizing, and five for transforming). We

Table 1 Sample characteristics

Variable		N	%
Industry	Manufacturing	26	26.5
	Services	72	73.5
Employees	0–9	32	32.7
	10–49	44	44.9
	50–249	18	18.4
	250–499	4	4.1
Firm age (in years)	0–10	17	17.3
	11–20	22	22.4
	21–50	31	31.6
	>50	28	28.6
Revenue (in Mio €)	≤0.5	15	15.3
	0.5–2	27	27.6
	2–10	35	35.7
	10–50	21	21.4
Management position (respondent)	CEO and/or owner	79	80.6
	Other members of the board	6	6.1
	Manager	10	10.2
	Employee	3	3.1

$N=98$

required a German translation of the original scale for our survey, which was conducted in German. To obtain this, we reached out to the authors of the original scale, who provided us with their validated German translation.

To measure the dependent variables, *digital leadership* and *digital culture*, we used the scale of Rossmann (2018), who proposed a conceptualization and measurement model for firms' digital maturity by deriving eight dimensions for measuring digital maturity. These eight dimensions are required capabilities to achieve digital maturity. Two of these dimensions are leadership capability and culture capability, each measured by four items. As the original study relates to the digital context, these two constructs are termed digital culture and digital leadership in our study. The original scale was in English. We applied the back-translation methodology here and translated the statements into German.

Digital leadership and digital culture are dependent variables that may be influenced by other factors. Based on previous research in similar contexts, we included several control variables. We controlled for two variables for SMEs' size: number of employees and revenue (Kellermanns et al. 2012; Malodia et al. 2023). We further controlled for company age and the company's industry (Zahra et al. 2006; Chesbrough and Rosenbloom 2002; Weritz et al. 2024). In addition, we controlled for the management level, asking the person completing the questionnaire what position they held in the company (Heubeck and Meckl 2022).

4.3 Statistical procedure

We used IBM SPSS Statistics for the data analysis. First, we constructed the variables for dynamic capabilities, digital leadership, and digital culture using a princi-

pal component factor analysis. For an optimal allocation of the items, we applied a varimax rotation. We excluded missing values listwise. For assessing the basic eligibility of the data for factor analysis, we conducted Bartlett's test of sphericity and measured the sampling adequacy criterion (MSA) as well as the Kaiser-Meyer-Olkin (KMO) criterion (Hair et al. 2014). We only formed a factor if it comprised at least three variables, each with factor loadings exceeding 0.30 (Hair et al. 2014). To determine the number of extracted factors, we used the Kaiser-Guttman (KG) criterion, the scree test (Thompson 2004), and the latent root criterion, which specifies factor loadings of >0.40 and eigenvalues of at least 1 (Gower 1966). The quality criteria were assessed using Cronbach's alpha for reliability, the average variance extracted (AVE), and the Fornell-Larcker ratio (FLR) for validity. Cronbach's alpha values of >0.60 were defined as acceptable for reliability due to the exploratory nature of our research (Hair et al. 2014). Acceptable variability was defined as an AVE of >0.50 and an FLR<1 (Fornell and Larcker 1981). In addition, an AVE between 0.40 and 0.50 counted as acceptable validity if Cronbach's alpha coefficient also exceeded 0.60 (Fornell and Larcker 1981).

We tested for common method bias by conducting Harman's single factor test and defined the often-used value of $<50\%$ as acceptable (Harman 1976; Podsakoff et al. 2003). Our analysis revealed a single-factor variance of 32.87%, which is well below the commonly accepted threshold, indicating that common method bias is unlikely to be a concern in our study. Furthermore, to conduct a non-response bias test, we compared data obtained at the beginning (33%) and at the end (33%) of the collection period. To identify significant differences, we performed a sample t-test on our constructs. None of the variables showed a statistically significant difference between the two groups since all p-values exceeded 0.05. These results indicate that non-response bias is unlikely to pose a significant issue in our study. To test our hypotheses, we used multiple regression analysis. Thereby, we defined the significance levels as extremely significant ($p \leq 0.001$), highly significant ($p \leq 0.01$), and significant ($p \leq 0.05$). Besides, we defined the strength of the effects as strong ($b > 0.35$), moderate ($b > 0.15$), and weak ($b > 0.02$) (Cohen 1988).

Our research model proposes that dynamic capabilities foster digital leadership (H1) and digital culture (H2). Furthermore, it posits that digital leadership is a strengthening mediator in the direct positive relationship between dynamic capabilities and digital culture (H3). Conversely, it suggests that digital culture is a strengthening mediator in the direct positive relationship between dynamic capabilities and digital leadership (H4). Specifically, we tested Hypotheses 1 and 2 (i.e., direct effects) through regression analysis based on factor analysis. We tested Hypotheses 3 and 4 (i.e., the indirect effects) through regression analysis employing the bootstrapping method using Hayes' (2021) PROCESS macro for SPSS. The confidence intervals were calculated based on 5000 bootstrap samples, with standard errors adjusted using heteroscedasticity-robust inference HC4 (Cribari-Neto). For mediation to be established, the independent variable needs to have a significant effect on the mediator, and the mediator needs to have a significant effect on the dependent variable (Baron and Kenny 1986).

5 Results

5.1 Measurement model

We conducted a principal components factor analysis with all items and constructs. The Bartlett test of sphericity was highly significant for all factors ($p<0.001$). The KMO and MSA criteria confirmed these findings to confirm the basic data eligibility for factor analysis. Table 2 summarizes the results of the factor analysis. We made two modifications to the dynamic capabilities measurement scale and the three sub-dimensions: sensing, seizing, and transforming. Specifically, the third sensing item and the fourth seizing item were excluded due to a low factor loading (<0.400). No other modifications were necessary for the subdimensions. All sub-dimensions met the criteria explained above. The final factor for dynamic capabilities was extracted, comprising the three sub-dimensions mentioned.

We then analyzed composite factors for both digital leadership and culture constructs. Three factors could be extracted here. Subsequently, we removed the second item of digital leadership, as it strongly loaded on a third unrelated factor. After removing this item, we extracted two factors. In contrast to the measurement scale we used, the first factor, digital leadership, consisted of the items DL1, DL4, and DC2. The second factor, digital culture, consisted of the items DC1, DC3, DC4, and DL3.

Table 2 Factor analysis results

Factor	Item	Std. FL
Sensing (KMO=0.757; $p<0.001$; AVE=0.570; FLR=0.508; α=0.738; N=98)	Sensing 1	0.727
	Sensing 2	0.789
	Sensing 4	0.671
	Sensing 5	0.823
Seizing (KMO=0.655; $p<0.001$; AVE=0.590; FLR=0.271; α=0.629; N=98)	Seizing 1	0.760
	Seizing 2	0.758
	Seizing 3	0.786
Transforming (KMO=0.734; $p<0.001$; AVE=0.512; FLR=0.534; α=0.773; N=98)	Transforming 1	0.682
	Transforming 2	0.729
	Transforming 3	0.808
	Transforming 4	0.706
	Transforming 5	0.642
Dynamic capabilities (KMO=0.720; $p<0.001$; AVE=0.739; FLR=0.531; α=0.864; N=98)	Sensing	0.860
	Seizing	0.867
	Transforming	0.851
Digital leadership (KMO=0.675; $p<0.001$; AVE=0.735; FLR=0.644; α=0.815; N=98)	Digital leadership 1	0.849
	Digital leadership 4	0.814
	Digital culture 2	0.906
Digital culture (KMO=0.664; $p<0.001$; AVE=0.504; FLR=0.549; α=0.662; N=98)	Digital culture 1	0.785
	Digital culture 3	0.675
	Digital culture 4	0.644
	Digital leadership 3	0.728

α=Cronbach's alpha; AVE=Average variance extracted; FLR=Fornell-Larcker ratio; KMO=Kaiser-Meyer-Olkin; N=Sample size; p=Significance value for the Bartlett test of sphericity; Std. FL=Standardized factor loadings

Table 3 Bivariate results

	Variable	1	2	3	4	5	6	7	8
1	Dynamic capabilities	1							
2	Digital leadership	0.415***	1						
3	Digital culture	0.506***	0.218*	1					
4	Company age	−0.147	0.104	−0.026	1				
5	Company size	0.006	−0.152	−0.044	0.200*	1			
6	Revenue	−0.038	−0.064	−0.051	0.354***	0.733***	1		
7	Management position	0.128	−0.084	0.228*	0.147	0.383***	0.408***	1	
8	Industry	−0.088	−0.020	0.021	0.131	−0.010	0.105	0.305**	1

*** $p<0.001$, ** $p<0.01$; * $p<0.05$; $N=98$
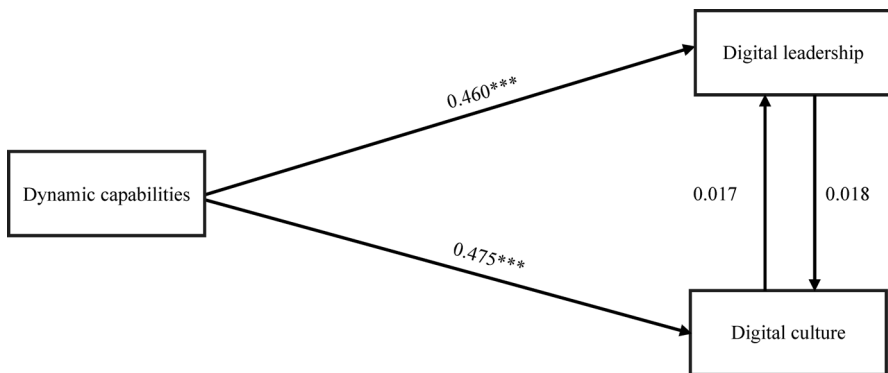
Fig. 2 Research model with regression effects, $N=98$, *** $p<0.001$

These results indicate that one item from each factor of the original scale loaded onto the opposite construct. This discrepancy becomes understandable upon examining the two items and their corresponding questions. The DL3 item, initially intended to measure digital leadership, demonstrates a more substantial loading on digital culture. This shift in factor loading suggests that the DL3 item's content is more aligned with the constructs underlying digital culture rather than digital leadership, which accounts for the observed variance. The DL3 item states: "The culture of leadership in our firm is based on transparency, cooperation, and decentralized decision-making processes." Since culture is explicitly mentioned in this context, the alignment seems logical. Conversely, the DC2 item originally intended to load on digital culture, but instead loaded on digital leadership, reads: "Digitization has an impact on the decision-making agility of our firm." Intuitively, it can be argued that a company's decision-making agility is also an aspect of leadership. Consequently, we derived two consistent factors: one for digital leadership and one for digital culture.

5.2 Bivariate and regression results

In the next step, we calculated the correlations listed in Table 3. The regression analysis results can be found in the appendix (Tables 6, 7, 8) and are summarized in Fig. 2. An overview of the results of the hypotheses tests is presented in Table 4.

Table 4 Summary of hypotheses test results

Hypothesis		Results
H1	Dynamic capabilities foster digital leadership within SMEs.	Supported
H2	Dynamic capabilities foster digital culture within SMEs.	Supported
H3	Digital leadership mediates the relationship between dynamic capabilities and digital culture.	Not supported
H4	Digital culture mediates the relationship between dynamic capabilities and digital leadership.	Not supported

Hypothesis 1 stated that SMEs' dynamic capabilities are positively related to digital leadership. Our data analysis supports Hypothesis 1, as we found an extremely significant, strong effect of dynamic capabilities on digital leadership ($b=0.460, p<0.001$).

Hypothesis 2 predicted that SMEs' dynamic capabilities of a company are positively related to digital culture. Our data analysis shows that Hypothesis 2 can be accepted due to dynamic capabilities' extremely significant, strong effect on digital culture ($b=0.475, p<0.001$).

Hypothesis 3 posited that digital leadership mediates the relationship between dynamic capabilities and digital culture. The analysis showed that digital leadership has a positive but statistically insignificant effect on digital culture ($b=0.017$, $p=0.867$), an initial indication that there is no mediator effect. The indirect effect of dynamic capabilities on digital culture via digital leadership is positive but statistically insignificant ($b=0.080$, 95% *CI*: $-0.871, 0.138$). Therefore, Hypothesis 3 is rejected.

Hypothesis 4 stated that digital culture mediates the relationship between dynamic capabilities and digital leadership. The analysis showed that digital leadership has a positive but statistically insignificant effect on digital culture ($b=0.018, p=0.867$), an initial indication against a mediating effect. The indirect effect of dynamic capabilities on digital leadership via digital culture is positive but statistically insignificant (b$=0.089$, 95% *CI*: $-0.115, 0.113$), leading to the rejection of Hypothesis 4.

6 Discussion

This study set out to explore how dynamic capabilities—positioned as antecedents—foster two established enablers of SMEs' digital transformation: digital leadership and digital culture. Drawing on the dynamic capabilities framework, we positioned these capabilities not as outcomes but as foundational routines that actively shape the socio-organizational conditions of digital transformation. Our findings provide empirical support for this core assumption: dynamic capabilities significantly foster both digital leadership and digital culture. This reinforces the theoretical proposition that sensing, seizing, and transforming capabilities do not merely accompany digital change but serve as higher-order enablers that structure and activate firm-level readiness for digital transformation.

At the same time, our results challenge some prevailing assumptions about the interdependence of digital leadership and digital culture. While prior work has often implied interdependent or aligned relationships between digital leadership and digital culture (e.g., Cortellazzo et al. 2019; Butt et al. 2024), we could not confirm such interdependence in our data. Instead, our analysis suggests distinct outcome paths, each directly influenced by dynamic capabilities. In other words, our findings reveal that both constructs are directly influenced by dynamic capabilities but do not causally affect one another. Rather than contradicting the transformation logic, this finding refines it by suggesting that leadership and culture constitute complementary—yet structurally distinct—manifestations of adaptive capacity. Especially in SME contexts—characterized by informal structures and bottom-up processes (Zoppelletto et al. 2023)—parallel development paths may be more realistic than tightly coupled, hierarchical relationships.

6.1 Theoretical contributions

Our study makes two important theoretical contributions. First, our study offers a significant conceptual extension to the existing literature by reconfiguring the role of dynamic capabilities in the context of digital transformation. Prior research predominantly portrays digital leadership as a dynamic capability itself (e.g., Konopik et al. 2022) or as a facilitator of dynamic capabilities (e.g., Gyamerah et al. 2025; Huang et al. 2023). Respectively, digital culture is seen as a moderator that facilitates the translation of dynamic capabilities into outcomes (e.g., Am et al. 2024). In contrast, we extend this understanding by a change in the perspective, proposing that dynamic capabilities as higher-order organizational building blocks can precede and enable the emergence of digital leadership and digital culture rather than being shaped by them.

Drawing on the dynamic capabilities framework (Teece 2007; Helfat et al. 2007; Winter 2003), we conceptualize sensing, seizing, and transforming not only as mechanisms of strategic adaptation but also as foundational capacities that structure the firm's ability to develop context-specific transformation competencies. In this view, dynamic capabilities serve as meta-level routines that orchestrate the formation of lower-level organizational phenomena such as digital leadership behavior or digital cultural orientations. This understanding aligns with the notion of dynamic capabilities as "higher-order capabilities" (Winter 2003) that provide the scaffolding upon which more granular competencies can emerge.

By positioning dynamic capabilities as organizational building blocks for digital leadership and digital culture, our study responds to recent calls to better understand how firms can actively construct transformation-enabling conditions (Leso et al. 2024; Abbad and Rowe 2024). Especially in the SME context, where informal structures and bottom-up processes dominate (Zoppelletto et al. 2023), the interpretation of dynamic capabilities as building blocks for digital leadership and digital culture offers valuable theoretical refinement. It highlights that SMEs should not treat leadership and culture as isolated levers but as outcomes of more deeply rooted organizational routines that evolve over time through accumulated adaptation experiences (Zollo and Winter 2002; Eisenhardt and Martin 2000).

Second, our study contributes to a more differentiated understanding of how dynamic capabilities influence the socio-organizational foundations of digital transformation by revealing that digital leadership and digital culture operate as distinct and non-interdependent outcome paths. Contrary to prior assumptions that suggest a sequential or mediating relationship—where digital leadership fosters a digital culture or vice versa (e.g., Cortellazzo et al. 2019; Butt et al. 2024)—our findings indicate that both constructs are directly shaped by dynamic capabilities, but they do not mediate each other's effects.

This result suggests that in SMEs' digital transformation contexts, there is not a linear progression from dynamic capabilities to digital leadership to digital culture or from dynamic capabilities from digital culture to digital leadership. Instead, we propose that digital leadership and digital culture should be conceptualized as parallel expressions of the firm's dynamic transformation capacity, each activated through distinct mechanisms of dynamic capabilities.

In this light, our study advances a non-hierarchical, non-sequential model of digital transformation in SMEs—one that reflects the emergent, iterative, and often non-linear dynamics inherent in organizational adaptation processes (Schoemaker et al. 2018; Warner and Wäger 2019).

By introducing this dual-path perspective, we extend current theory in two important ways. First, we challenge over-simplified assumptions of causality between digital leadership and digital culture in digital transformation contexts, which may overlook alternative configurations or mutual independence. Second, we highlight the strategic versatility of dynamic capabilities: they enable multiple, parallel channels of digital transformation, not just singular pathways. This insight opens the door for future research to explore contingent patterns of capability deployment and transformation logic—especially in organizations facing structural constraints but high adaptive potential, such as SMEs.

6.2 Practical contributions

Our findings have several practical contributions, which can be used for concrete recommendations for SMEs undergoing digital transformation. Accordingly, our first practical contribution is that SMEs should actively strengthen the three core dimensions of dynamic capabilities—sensing, seizing, and transforming—through targeted practices.

To enhance sensing capabilities, SMEs should establish mechanisms for systematically monitoring technological trends, competitor activity, and customer needs. This includes integrating digital dashboards to visualize real-time data and detect weak signals (Schoemaker et al. 2013) or engaging in cross-industry trend scouting (Ellström et al. 2022).

To strengthen seizing capabilities, SMEs should create structures that enable "probe-and-learn experimentation," including experiments and rapid prototyping (Day and Schoemaker 2016). A concrete action would be the establishment of a digital innovation lab, where employees can experiment with minimum viable products (Warner and Wäger 2019).

To develop transforming capabilities, SMEs should join a digital ecosystem to interact with multiple external partners (Warner and Wäger 2019). Another action here is to decompose digital transformation into specified projects and prioritize these projects in alignment with the digital strategy (Ellström et al. 2022). Finally, SMEs can hire external digital experts, such as chief digital officers or consultants, to redesign internal structures and improve digital maturity (Warner and Wäger 2019).

Our second practical implication arises from the finding that our data did not support the theorized mediation effects between digital leadership and digital culture. Our results indicate that—at least within the SME context—these elements may develop more independently than expected.

For practitioners, this implies that digital leadership and digital culture should not be treated as automatically reinforcing. Instead, both areas may require separate, targeted interventions. Leadership development initiatives, for instance, should not rely on cultural change as a natural byproduct. Likewise, efforts to foster a digital culture may not, by themselves, lead to strong leadership behavior. SMEs should, therefore, consider pursuing complementary but distinct strategies for both domains—each with its own set of tools, responsibilities, and timelines—to more effectively build the socio-organizational basis for digital transformation.

6.3 Limitations and future research

Like any research, our study faces several inherent limitations that can serve as starting points for future research. First, we focused on SMEs from a specific region in Southern Germany. It is important to acknowledge the limitations in terms of generalizability, particularly across different organizational and cultural contexts. As a first step, further studies could be carried out in other regions in Germany to make generalizable statements for Germany. In a second step, this could be extended to other countries to examine the extent to which cultural factors or the region's technological maturity play a role.

Another limitation concerns the relatively small sample size, which may affect the statistical power of our analyses and increase the risk of estimation bias. Although we conducted an a priori power analysis using G*Power and confirmed that the sample size was sufficient to detect large effects with high confidence, the limited number of observations may still constrain the ability to identify more subtle or indirect relationships. Moreover, smaller samples can reduce the robustness and generalizability of the findings. Future research should, therefore, replicate and extend our analyses with larger and more diverse samples to strengthen the external validity of the results.

A further methodological limitation concerns potential endogeneity. Our model assumes that dynamic capabilities precede and shape digital leadership and digital culture. However, based on cross-sectional data, we cannot entirely exclude reverse causality or omitted variable bias. It is conceivable that digital leadership and culture also contribute to developing dynamic capabilities—a direction supported by other strands of research (e.g., Gyamerah et al. 2025; Huang et al. 2023). Yet, our study does not reject this inverse relationship. Instead, we offer a theoretically motivated shift in perspective. While much of the existing literature conceptualizes digital leadership and digital culture as antecedents or moderators of dynamic capabilities, we

propose the reverse view and argue that dynamic capabilities act as higher-order foundations from which these constructs emerge. Nevertheless, future studies should use longitudinal or quasi-experimental designs to test for reciprocal relationships and better account for endogeneity.

Moreover, the non-significant mediation effects may also reflect limitations in measurement precision, as two items showed partial construct overlap in the factor analysis. While conceptually robust, this empirical convergence could have diluted statistical power to detect indirect effects. Nonetheless, these results do not weaken our theoretical model; instead, they point to the need for more granular investigation into the mechanisms linking dynamic capabilities, digital leadership, and digital culture.

Next, our study did not measure digital transformation as a construct in our model. Since the promotional effect of digital leadership and digital culture has already been established in the literature by numerous studies (Brunner et al. 2023; Ghafoori et al. 2024; Schuster et al. 2023), we decided to make this the fundamental assumption of our study. However, future research could measure the exact strength of these effects, especially in comparison to other enablers such as technical infrastructure or digital readiness. This could be particularly helpful for practitioners, as SMEs would have a kind of priority list and could allocate their limited budget in a value-adding way.

Finally, we only looked at dynamic capabilities on the organizational level. Previous research (Heubeck 2024; Helfat and Martin 2015) argues that firm-level capabilities are sometimes too abstract and difficult to grasp. Thus, studying dynamic capabilities at an individual level might make sense in the context of digital transformation. For example, Scuotto et al. (2021) found that individual digital capabilities are crucial for a company facing market changes. In other words, future research could investigate the role of individuals in developing digital culture and digital leadership.

Appendix

See the Tables 5, 6, 7 and 8.

Table 5 Questionnaire items derived from Kump et al. (2019) and Rossmann (2018)

Construct	Item
Sensing	SE1 Our company knows the best practices in the market
	SE2 Our company is up-to-date on the current market situation
	SE3 Our company systematically searches for information on the current market situation*
	SE4 As a company, we know how to access new information
	SE5 Our company always has an eye on our competitors' activities
Seizing	SZ1 Our company can quickly relate to new knowledge from the outside
	SZ2 We recognize what new information can be utilized in our company
	SZ3 Our company is capable of turning new technological knowledge into process and product innovation
	SZ4 Current information leads to the development of new products and services*
Transforming	T1 By defining clear responsibilities, we successfully implement plans for changes in our company
	T2 Even when unforeseen interruptions occur, change projects are seen through consistently in our company
	T3 Decisions on planned changes are pursued consistently in our company
	T4 In the past, we have demonstrated our strengths in implementing changes
	T5 In our company, change projects can be put into practice alongside the daily business
Digital leadership	DL1 Our executives support the implementation of the digital strategy
	DL2 The digital strategy is only implemented in individual functional areas (inverse)**
	DL3 The culture of leadership in our firm is based on transparency, cooperation and decentralized decision-making processes
	DL4 The digital strategy of our firm has an influence on the task and role profiles of executives
Digital culture	DC1 Decisions within our firm are transparent to our own employees
	DC2 Digitization has an impact on the decision-making agility of our firm
	DC3 In day-to-day business, employees and executives exchange information about the digital transformation of our firm
	DC4 Continuous change is part of our corporate culture

*Removed due to low factor loading; **Removed due to high factor loading on an unrelated factor

Table 6 Regression results: direct effects hypotheses with dependent variable digital leadership

Digital leadership	Model 1				Model 2				Model 3			
	b	β	se	VIF	b	β	se	VIF	b	β	se	VIF
Study variables												
Dynamic capabilities					0.469***	0.469***	0.094	1.066	0.460***	0.460***	0.108	1.399
Digital culture									0.018	0.018	0.109	1.432
Control variables												
Company age	0.044	0.134	0.036	1.163	0.066*	0.199*	0.033	1.184	0.066*	0.198*	0.033	1.203
Company size	−0.256	−0.210	0.187	2.286	−0.251	−0.206	0.167	2.286	−0.249	−0.205	0.168	2.296
Revenue	0.063	0.062	0.163	2.492	0.090	0.089	0.145	2.496	0.091	0.090	0.146	2.506
Management position	−0.048	−0.038	0.150	1.354	−0.176	−0.139	0.029	1.403	−0.181	−0.143	0.140	1.476
Industry	−0.010	−0.035	0.032	1.148	0.008	0.026	0.029	1.166	0.008	0.026	0.029	1.166
Constant	0.266		0.333		0.170		0.297		0.171		0.299	
R^2	0.046				0.252				0.252			
p	0.496				<0.001				<0.001			

b = regression coefficient, β = standardized regression coefficient, N = sample size, p = significance value, R^2 = coefficient of determination, se = standard error, VIF = variance inflation factor, ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, $N = 98$.

Table 7 Regression results: direct effects hypotheses with dependent variable digital culture

Digital culture	Model 1				Model 2				Model 3			
	b	β	se	VIF	b	β	se	VIF	b	β	se	VIF
Study variables												
Dynamic capabilities					0.483***	0.483***	0.090	1.066	0.475***	0.475***	0.103	1.360
Digital leadership									0.017	0.017	0.102	1.337
Control variables												
Company age	−0.003	−0.009	0.036	1.163	0.020	0.059	0.032	1.184	0.018	0.055	0.033	1.237
Company size	−0.107	−0.880	0.183	2.286	−0.102	−0.084	0.161	2.286	−0.098	−0.081	0.164	2.343
Revenue	−0.111	−0.110	0.159	2.492	−0.084	−0.083	0.140	2.496	−0.085	−0.084	0.141	2.506
Management position	0.417	0.329	0.147	1.354	0.285	0.225	0.131	1.403	0.288*	0.228*	0.133	1.429
Industry	−0.020	−0.068	0.031	1.148	−0.001	−0.005	0.028	1.166	−0.002	−0.005	0.028	1.167
Constant	0.057		0.326		−0.042		0.287		−0.045		0.289	
R^2	0.083				0.302				0.302			
p	0.149				<0.001				<0.001			

b=regression coefficient, $β$=standardized regression coefficient, N=sample size, p=significance value, R^2=coefficient of determination, se=standard error, VIF=variance inflation factor, ***$p<0.001$, **$p<0.01$, *$p<0.05$, $N=98$.

Table 8 Bootstrapping regression results

Indirect effect	b	se	Confidence interval		
			Lower	Upper	Level (%)
Dynamic capabilities → digital leadership → digital culture	0.080	0.0562	−0.871	0.138	95
Dynamic capabilities → digital culture → digital leadership	0.089	0.0569	−0.115	0.113	95

se = Standard error, b = coefficient, N = Sample size; $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$; number of bootstrap samples = 5000, bootstrap inference for model coefficients, N = 98

Data availability The authors cannot share the collected data due to confidentiality reasons.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Ethics approval Not applicable.

Consent to participate Consent was obtained from all individual participants included in the study.

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