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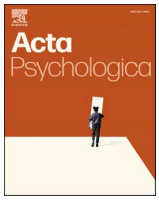

Using the new positive aspect of digital leadership to improve organizational sustainability: Testing moderated mediation model

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ABSTRACT

In the era of digital transformation, the role of digital leadership in companies is continuously demanded and its importance is increasingly emphasized. In relation to such research background, this study focuses on digital leadership, a new form of leadership rather than traditional leadership as suggested in previous studies, as a way to promote organizational sustainability and provide the moderated mediation model for organizational sustainability in a rapidly changing innovative business environment in the digital age. The main contribution of this study is to fill the gap in previous research and expand the research field on leadership types and organizational sustainability. To achieve our research goals, we conduct empirical study and the questionnaire was distributed to 552 organizational members from Chinese small and medium-sized information technology enterprises. The results presented that digital leadership had positive influence on digital organizational culture, digital capability, and Organizational sustainability. In addition, digital organizational culture and digital capability significantly mediated the relationship between digital leadership and organizational sustainability. Absorptive capacity significantly moderated the mediating effect of digital capability between digital leadership and organizational sustainability. Finally, innovation atmosphere significantly moderated the impact of digital organizational culture on organizational sustainability. The result indicates that digital leadership significantly enhances organizational sustainability both directly and indirectly through digital capabilities and digital organizational culture. Furthermore, absorptive capacity and innovation atmosphere positively moderate these relationships, with high levels of absorptive capacity and innovation atmosphere amplifying the impact of digital leadership on sustainability. This study contributes to the literature by providing a comprehensive understanding of the mechanisms through which digital leadership drives organizational sustainability, offering practical insights for SMEs undergoing digital transformation.

1. Introduction

In the current context of a highly digitalized global economy (Matyushok et al., 2021), small and medium-sized IT enterprises (SMEs) in China have secured critical market positions due to their flexibility and innovation capabilities (Tang et al., 2022). However, with the rapid advancement of technology and ever-changing customer demands, these enterprises face intense competition (Hussain, 2024). To maintain their competitiveness and achieve sustainable development, digital transformation has be-come an inevitable choice for SMEs (Ta & Lin, 2023). However, the previous studies have explored the impact of digital leadership on organizational performance (Shin et al., 2023; Mollah et al., 2023, Mollah, Ibrahim, et al., 2024), digital transformation (Yao et al., 2024), employee work engagement(Li et al., 2024), organizational agility(Karafakioglu & Afacan Findikli, 2024), job satisfaction and life satisfaction(Topcuoglu et al., 2023). Most of these studies have focused on large enterprises or multinational corporations, leaving a significant gap in understanding how digital leadership operates in the context of SMEs sustainability. The direct effect of digital leadership on performance or the impact on performance through organizational learning have been studied by Artüz and Bayraktar (2021a, 2021b), and the direct effect of digital leadership on performance or the indirect impact on performance through innovation performance have been studied by Işık (2024). However, empirical research on the impact of digital leadership on overall organizational sustainability and the impact on organizational sustainability through digital-related variables is quite

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insufficient. Furthermore, there is a lack of research verifying the moderated mediating effect on the relationship between digital leadership and organizational sustainability.

In order to fill the gaps mentioned above in previous studies and to contribute to the research, this study aims to fill such gaps by proposing a moderated mediation model that investigates how digital leadership enhances organizational sustainability through the mediating roles of digital capabilities and digital organizational culture, while considering the moderating effects of absorptive capacity and innovation atmosphere. By doing so, this study not only extends the theoretical understanding of digital leadership but also provides practical insights for SMEs navigating the complexities of digital transformation.

Digital leadership plays a pivotal role in this process, guiding enterprises in adopting new technologies, optimizing operational processes, and fostering employee innovation (Asif et al., 2024). Digital leadership goes beyond traditional leadership by emphasizing the integration of technology, adaptability, and innovation (Türk, 2023). It involves leaders effectively incorporating technological tools into their leadership styles to enhance team engagement and communication efficiency while demonstrating the foresight to respond to rapidly changing technological and market conditions (Cortellazzo et al., 2019). Moreover, digital leaders must promote an environment that encourages agility, creativity, and the continuous improvement of employees' digital skills, ensuring that the organization remains dynamic and future-ready in a highly volatile digital landscape (McCarthy, 2024).

Digital leadership encompasses not only the conventional responsibilities of leaders but also the new competencies required in a digital environment (Cortellazzo et al., 2019). At its core, digital leadership is about how leaders integrate technological tools into their leadership styles to enhance team collaboration, improve decision-making processes, and lead digital transformation (Benitez et al., 2022). Digital leaders should not only understand and utilize emerging technologies but also cultivate a digital organizational culture that supports innovation and continuous improvement (Gimpel et al., 2018). This type of leadership approach is essential in guiding SMEs through the complexities of the digital era, enabling them to remain competitive and achieve long-term sustainability. At the same time, an enterprise's digital capabilities are also crucial factors encompassing the understanding and application of new technologies, which directly impact its competitiveness and market adaptability (Khin & Ho, 2019). Furthermore, digital organizational culture is a fundamental pillar supporting an enterprise's digital transformation. It emphasizes collaboration, innovation, and continuous improvement, creating an environment conducive to the application of technology and innovation (Orieno et al., 2024). An innovation atmosphere further enhances internal creativity and the drive for change, enabling enterprises to continuously introduce new products and services to meet market demands (Ferreira et al., 2020). Absorptive capacity—the ability to identify, acquire, and utilize external knowledge—is critical for promoting enterprise innovation and enhancing competitiveness (Martín-de Castro, 2015). Therefore, an in-depth study of the relationships between digital leadership, digital capabilities, digital organizational culture, innovation atmosphere, and absorptive capacity is essential for the success of SMEs in the digital era. Understanding how these factors interact and influence each other can provide scientific guidance for enterprises, helping them formulate effective digital transformation strategies and ultimately achieve sustainable development.

Previous research has typically focused on the digital transformation of large enterprises or multinational corporations (Zoppelletto et al., 2023). By contrast, this study concentrates on IT SMEs in China, providing a unique perspective and practical experience in the context of digitalization. Earlier studies often centered on technological updates and business model changes at the enterprise level during digital transformation (Vaska et al., 2021). In contrast, this study focuses on the impact of digital leadership in SMEs, particularly in China's IT sector. It explores the relationships between digital capabilities, digital organizational culture, innovation atmosphere, and absorptive capacity, which are crucial for the sustainable development of SMEs in the digital era (Khin & Ho, 2019). By examining these factors, this study aims to fill a gap in the existing literature by providing a comprehensive analysis of how digital leadership can drive organizational sustainability in SMEs (Anning-Dorson, 2021). Understanding how digital leadership interacts with digital capabilities and organizational culture will pro-vide both academic insights and practical strategies for SMEs facing digital transformation challenges.

To achieve these objectives, the study addresses several critical research questions: How does digital leadership influence enterprises' digital capabilities and digital organizational culture? What roles do digital capabilities and digital organizational culture play in promoting sustainable development within SMEs? And how do innovation atmosphere and absorptive capacity moderate the relationship between digital leadership and organizational sustainability? These research questions are of paramount im-portance, given the current focus on how digital transformation affects organizational performance and sustainability (Chen et al., 2021). The answers to these questions will contribute significantly to the academic literature on digital leadership, providing a clearer understanding of the leadership styles required in digitally driven environments.

2. Literature review

This study is grounded in several theoretical frameworks that provide a comprehensive understanding of how digital leadership influences organizational sustainability through digital capabilities and digital organizational culture, while considering the moderating roles of absorptive capacity and innovation atmosphere.

Digital Leadership theory is developed through both technological development and need for a new leadership style model in the industry. Digital leadership theory suggests such digital leaders combine their own skill and technology knowledge with leadership qualities to develop organizational culture that facilitates the growth, improvement, and learning of organizational community members (Eberl & Drews, 2021a, 2021b; Sheninger, 2014a, 2014b; Tülübaş, 2023). Digital Leadership theory contributes to leaders develop leadership strategies and it is relevant to demand of digital age to achieve the organizational success (Lebrata et al., 2024).

Resource-Based View (RBV): The RBV (Barney, 1991) posits that organizations can achieve sustained competitive advantage by leveraging unique resources and capabilities. In this study, digital leadership is conceptualized as a critical organizational resource that enhances digital capabilities and fosters a digital organizational culture, thereby contributing to organizational sustainability. Digital capabilities, as a form of organizational resource, enable firms to effectively utilize digital tools and technologies to innovate and improve operational efficiency, which is essential for long-term sustainability.

Dynamic Capabilities Theory: The Dynamic Capabilities Theory (Teece et al., 1997) emphasizes the importance of an organization's ability to adapt to changing environments by integrating, reconfiguring, and leveraging resources. In this study, absorptive capacity and innovation atmosphere are considered dynamic capabilities that moderate the relationship between digital leadership and organizational sustainability. Absorptive capacity enables organizations to effectively acquire and utilize external knowledge, while innovation atmosphere fosters a creative environment that enhances the impact of digital leadership on sustainability.

Organizational Learning Theory: The Organizational Learning Theory (Argyris & Schön, 1997) highlights the importance of continuous learning and adaptation in achieving organizational goals. In this study, digital organizational culture is seen as a facilitator of organizational learning, promoting continuous improvement and innovation, which are critical for sustainability.

Creative Climate Theory: The Creative Climate Theory (Ekvall,

1996) suggests that an innovation atmosphere can stimulate creativity and risk-taking behaviors among employees. In this study, innovation atmosphere is proposed as a moderating factor that enhances the positive effects of digital organizational culture on organizational sustainability.

By integrating these theoretical frameworks, this study provides a holistic understanding of the mechanisms through which digital leadership drives organizational sustainability, offering both theoretical and practical insights for SMEs undergoing digital transformation.

2.1. Digital leadership

Digital leadership is defined as the use and implementation of leadership approaches compatible with the digital age (Khalil et al., 2022). It also refers to a person who adds value to the organization by integrating the technologies and abilities that they possess (Khawaja & Hamdan, 2023). Digital leadership reflects a leader who primarily uses technological intervention in leadership work (Salamzadeh et al., 2021). This type of leadership encompasses not only the conventional roles of leaders within organizations but also emphasizes the new responsibilities and skills required in a digital environment (Cortellazzo et al., 2019). The core of digital leadership lies in how leaders incorporate technological tools and platforms into their leadership styles to im-prove team engagement and communication efficiency (Benitez et al., 2022). Erhan et al. (2022) highlighted the role of digital leadership in fostering innovative behaviors within organizations, particularly in the context of rapid technological changes. Their findings suggest that digital leaders who effectively integrate technological tools into their leadership practices can significantly enhance organizational adaptability and innovation. Similarly, De Waal and Heijtel (2016) emphasized the importance of leadership behaviors in high-performance organizations, demonstrating that leaders who promote a culture of innovation and adaptability can drive sustainable organizational performance. These studies collectively underscore the pivotal role of digital leadership in navigating the complexities of the digital era.

Furthermore, leaders must design and implement strategies to ensure the realization of this vision and adapt to constantly changing technological and market conditions (Gimpel et al., 2018). Digital leadership requires leaders to possess technical knowledge and the ability to cultivate an organizational culture that supports innovation and experimentation. This culture encourages employees to embrace change, continuously learn new skills, and integrate digital thinking into their daily work (Lin & McDonough III, 2011). In the context of the Fourth Industrial Revolution, leaders must demonstrate high levels of adaptability and foresight to respond promptly to market and technological changes. This includes sensitivity to emerging trends and the ability to anticipate and plan future opportunities and challenges (Awedyk & Niezgoda, 2018).

Overall, digital leaders contribute to organizations by driving organizational transformation and facilitating organizational innovation (Basu, 2024). Furthermore, digital leadership plays a proactive role in empowering organizations to leverage collective fa-cilitation and improve collaboration (Hussein et al., 2024).

2.2. Digital capability

Digital capabilities refer to an organization's ability to effectively utilize digital tools and technologies to enhance operational efficiency, drive innovation, and maintain competitiveness (Khin & Ho, 2019). These capabilities involve not just the adoption of digital tools but also the organizational processes, culture, and skills necessary to leverage them. In a rapidly changing digital landscape, strong digital capabilities are critical for organizations to adapt, optimize operations, and create value.

Research indicates that digital capabilities are essential for long-term success, as they enable organizations to integrate emerging technologies like AI, big data, and cloud computing, which drive efficiency and innovation (Benitez et al., 2022). Building digital capabilities involves multiple factors, including technological innovation and generative and digitalization capabilities. Technological innovation capabilities form the foundation of digital capabilities. This is reflected in how organizations grasp the latest digital technologies, including artificial intelligence, big data analytics, and cloud computing, and apply these technologies to their business operations (Chirumalla, 2021).

In the context of SMEs, digital capabilities are particularly important because they allow these organizations to make the most of their limited resources, improve decision-making, and respond quickly to market changes. By adopting digital tools, SMEs can enhance customer engagement, streamline operations, and scale their businesses more effectively. Ultimately, digital capabilities are key to helping SMEs stay competitive, foster innovation, and ensure sustainable growth in the digital era.

2.3. Digital organizational culture

Digital organizational culture is a critical factor in successfully mastering digital transformation. It emphasizes a collaborative work environment, creativity, innovation, challenges, proactivity, and continuous improvement (Fischer & Montalbano, 2014). This culture needs to be developed through a shared digital strategy and reinforced both formally and informally to support behaviors that embrace new digital approaches (Klein & Todesco, 2021). Digital organizational culture refers to a set of shared values and beliefs formed within the context of digitalization, which guides the digital practices and operations of enterprises. It is defined and manifested in several ways. First, digital organizational culture represents a common understanding and shared assumptions of organizational practices in a digital environment among its members (Leal-Rodríguez et al., 2023). This culture helps businesses better manage and utilize technological resources during the innovation process (Agostini et al., 2020) and plays a crucial role in digital transformation, potentially facilitating or hindering success.

Moreover, the right digital organizational culture can become a source of competi-tive advantage for businesses (Velyako & Musa, 2024). Digital organizational culture emphasizes several core elements. Accountability and communication are vital in digital culture, with communication and collaboration among organizational units driving organizational development through goal setting and employee performance measurements (Oberer & Erkollar, 2018). Companies should embed digital thinking into their cultures to ensure successful digital transformation (Carcary et al., 2016).

2.4. Innovation atmosphere

Innovation atmosphere is a multidimensional concept that encompasses the per-ceptions and experiences of organizational members regarding shared innovation goals, the vitality and sustainability of innovation, and the degree of support for innovation (Yeh-Yun Lin & Liu, 2012). This atmosphere includes not only encouragement and support for innovation activities by the organization but also members' subjective descriptions of innovation capabilities and support levels in their work environment, reflecting individual psychological perceptions and their impact on behavior (Lloréns Montes et al., 2004). The innovation atmosphere in teams is reflected in a shared under-standing among team members of the innovation work environment, including aspects such as vision, goals, participation assurance, task orientation, and innovation support (Xie et al., 2016). The influence of the environment on individual behavior is significant, as revealed by theories such as the “broken windows” theory and Lewin's field theory. Organizational atmosphere profoundly affects individual behavior, knowledge-sharing behavior, and employee work engagement (Chen et al., 2020). A positive organizational innovation atmosphere can motivate members to exhibit proactive behavior, whereas the absence of such an

atmosphere may lead to a decline in member motivation (Afsar & Umrani, 2020).

Additionally, according to the conservation of resources (COR) theory, individuals actively maintain, protect, and build their resources. An innovative atmosphere within an organization helps create an open and supportive organizational culture, promoting a positive flow of resources among organizational members, which is of great significance for both leaders and regular employees (Erkutlu, 2012).

2.5. Absorptive capacity

Absorptive capacity is an organizational theory that describes an organization's ability to identify, evaluate, acquire, assimilate, transform, and apply external knowledge (Noblet et al., 2011). This concept was initially introduced in 1990 by Cohen and Levinthal, who defined it as an organization's ability to learn from external knowledge through knowledge recognition, assimilation, and utilization. Absorptive capacity is considered a byproduct of an organization's R&D activities and a critical factor in organizational learning (Strøm-Andersen, 2020). Absorptive capacity comprises multiple dimensions, initially defined by Cohen and Levinthal (1990) as having three main components: acquisition, assimilation, and application.

Subsequent researchers have expanded and refined this concept by proposing different definitions and dimensions. Absorptive capacity significantly impacts organizational decision-making, innovation, and knowledge transfer (Rafique et al., 2018). It is regarded as a predictor of innovation and knowledge transfer within organizations and is linked to organizational financial performance (Kostopoulos et al., 2011). Absorptive capacity is viewed as a dynamic capability that focuses on leveraging available resources and managing knowledge accessible to organizations (Liao et al., 2009).

2.6. Organizational sustainability

Organizational sustainability is a comprehensive concept that emphasizes the abil-ity to achieve long-term operations across three primary dimensions: economic, social, and environmental (Parris & Kates, 2003). Organizations must pursue economic growth while focusing on social well-being and environmental protection to ensure that re-sources and wealth are equitably shared across multiple generations (Beckerman, 1995). Assessing organizational sustainability involves traditional economic performance, as well as social and environmental performance, reflecting the equal importance of these three aspects. This management approach is defined as the processes or structures organizations use to transform inputs into products or services to achieve their sustaina-bility goals (Baumgartner & Rauter, 2017). Successful sustainability practices require the coordination and integration of leadership, strategy, structure, and systems. Despite these challenges, systematic research and continuous efforts can support sustainability (Broman & Robèrt, 2017). The corporate philosophy of sustainability views sustainability not only as a responsibility but also as an opportunity, requiring organizations to comprehensively consider economic, environmental, and social factors.

Human resource management plays a critical role in supporting organizational sustainability goals through the development of employees' digital capabilities and the enhancement of social performance. The development of organizational identity is a dynamic process that reflects both the external image and shared understanding of in-ternal members. Measures such as sustainability reporting and engagement in management activities can strengthen this identity (Ravasi & Schultz, 2006). Additionally, promoting organizational sustainability requires consideration of the interplay between internal and external factors, with information technology playing a crucial role (Watson et al., 2010).

3. Hypothesis development

3.1. Relationship between digital leadership and digital capability

In the digital age, digital skills such as technology use, communication, analysis, and critical thinking are crucial for career development and organizational competitiveness (Van Deursen & Van Dijk, 2014; Van Laar et al., 2017). For IT SMEs, these skills are vital for staying competitive through the efficient use of digital technology. A strong link exists between digital leadership and employees' digital capabilities, especially in the context of digital transformation. Digital leadership is the ability of leaders to guide organizations through digital transformation and achieve business goals using digital technologies (Türk, 2023).

The impact of digital leadership on digital capability is explained using digital leadership theory. This theory was developed according to a new leadership model and technological developments in the industry (Artüz & Bayraktar, 2021a, 2021b). It emphasizes that a digital leader combines their individual skills and technological knowledge with leadership qualities to create an organizational culture that facilitates learning, growth, and improvement (Eberl & Drews, 2021a, 2021b; Sheninger, 2014a, 2014b). Furthermore, digital leaders enhance organizational improvement by creating support, trust, empowerment, and innovation, where organizational members collaborate to increase the collective organizational capacity to keep up with the changing demands of the digital age (Karakose & Tülübaş, 2023; Sheninger, 2014a, 2014b). Digital leadership theory also emphasizes that leaders possessing digital leadership competence have the ability to exert influence, decide directions, and influence (Fachrurazi, 2023). Such leaders possess knowledge closely associated with digital skills for completing business activities (El Sawy et al., 2020; Fachrurazi, 2023). These statements explain that digital leaders possess digital capabilities and functions. They can also be seen as leaders who can influence subordinates in organizations. The main reasons for this are that digital leadership enables the imple-mentation and initiation of digital transformation and facilitates digital innovation while imparting skills and knowledge to subordinates. Furthermore, digital leaders convince their subordinates of digital transformation initiatives and purposes relating to digital transformation and vision and encourage and inspire subordinates toward achievement (Mwita & Joanthan, 2019).

In IT SMEs, aligning digital leadership with employees' digital capabilities is the key to successful digital transformation and competitive advantage (Benitez et al., 2022). Leaders who remain informed and create a supportive environment for innovation foster sustainable digital transformation, ensuring that employees can better utilize new technologies such as AI and IoT to improve efficiency and quality (Cetindamar et al., 2021; Fitzgerald et al., 2014). This approach not only enhances employees' digital capabilities but also enables IT SMEs to remain flexible, innovative, and competitive in a rapidly evolving digital landscape (Schwarzmüller et al., 2018). Based on the above statement, the following hypothesis is proposed:

H1. : Digital leadership has a positive influence on digital capability.

3.2. Relationship between digital leadership and digital organizational culture

Digital leadership profoundly shapes digital organizational culture. It redefines leaders' roles by emphasizing the importance of technology integration, adaptability, and innovation, in addition to driving organizations toward a more open, collaborative, and networked approach (Wang et al., 2022). Mollah, Amin, et al. (2024) demonstrated that digital leadership fosters a digital culture that promotes collaboration, creativity, and continuous improvement, which are essential for organizational success in the digital age. Their findings highlight that digital leaders who effectively integrate technological tools into their

leadership practices can significantly enhance the development of a digital organizational culture. This culture, in turn, supports innovation and adaptability, enabling organizations to thrive in a rapidly changing digital landscape.Digital leadership is essential as these companies often need to adapt quickly to market changes with limited resources. Digital leaders guide organizations through market and technological changes by building transformative visions, deeply understanding digital transformation, effectively utilizing digital tools, and maintaining flexibility and adaptability in dynamic environments. They anticipate and plan for future opportunities and challenges (Schiuma et al., 2022). Digital leadership encourages cross-departmental and cross-level communication, continuous learning, and innovation, thereby motivating teams to explore new ideas and technologies, maintain competitiveness, enhance technical skills, and drive innovation in business processes and customer experiences (Fang, 2023). This leadership fosters the development of a digital organizational culture, creating a work environment that focuses on innovation, challenges, and continuous improvement (Martínez-Caro et al., 2020).

In IT SMEs, digital organizational culture, through shared understanding and as-sumptions, helps businesses manage and utilize technological resources more effectively, drive or influence the success of digital transformation, and become a source of com-petitive advantage (Trushkina et al., 2020). Accountability and communication within a digital culture are crucial and serve as key drivers of organizational development (Flyverbom et al., 2019).

Therefore, these companies deeply embed digital thinking to ensure smooth digital transformation. Digital leadership empowers employees by involving them in formu-lating a digital strategy. Leadership plays a vital role in the digital transformation and ongoing development of enterprises, fostering innovation, enhancing digital organizational culture, and achieving competitive advantage (AlNuaimi et al., 2022). In addition, leaders must focus on maximizing the benefits of digital transformation with limited resources and budgets. They can achieve this by using existing digital tools and technologies flexibly, establishing efficient team collaboration platforms, and promoting knowledge sharing and innovation. Thus, in IT SMEs, digital leadership is a critical factor in driving digital transformation and an important safeguard for maintaining competitiveness and achieving sustainable development. Leaders need to continuously improve their own and their employees' digital skills to drive technological innovation and business process optimization in response to rapidly changing market environments and technological challenges. The combination of this leadership and digital culture will help IT SMEs stand out from fierce market competition and achieve substantial growth.

Based on the above theory, the following hypothesis is proposed:

H2. : Digital leadership has a positive influence on digital organizational culture.

3.3. The relationship between digital capability and organizational sustainability

In this digital era, digital capability goes beyond mastering technical applications and involves the flexible use of digital tools and technologies to drive innovation in products, services, and business models, thus enhancing productivity and operational efficiency (Paiola & Gebauer, 2020). The explanation that digital capability positively impacts organizational sustainability is based on the organizational capability theory. This theory is based on the integration of member's specialized knowledge (GRANT, R. M., 1996; Khani et al., 2011). The specific knowledge of organizational members is likely to induce organizational creativity, which contributes to organizational innovation and development. As such, high levels of both organizational innovation and development are expected to contribute to processes that promote organizational sustainability and can be viewed as key elements. The main viewpoint of organizational capability theory suggests that organizations need to focus on sustainable capability-building to foster long-term competitiveness and fulfill organizational goals in relation to the impact of the external environment. Furthermore, organizational capability theory emphasizes that internal factors, such as capability, are an improvement element in determining organizational degree, scope, and growth. In other words, a high level of organizational capability can be conducive to the realization of the ultimate organizational goals in a specific external environment (Liu et al., 2022).

Drawing on the organizational capability theory statement above, generative ca-pability involves leveraging digital technologies to capture new business opportunities and transform them into viable products or services, thus requiring market insights and strategic flexibility (Zhang et al., 2023). Digitalization capability includes building digital infrastructure, optimizing workflows, and fostering a digital culture that enhances in-formation sharing and decision-making (Chirumalla, 2021). In particular, it allows or-ganizations to create opportunities to improve their competitive advantage (Heredia et al., 2022) and quickly capturing such technological opportunities increases organiza-tional performance (Han & Lee, 2024). In addition, digital capabilities may allow organizations to adopt sustainable practices, leading to a high level of operational effi-ciency, resource conservation, and organizational sustainability.

Based on the above theory, the following hypothesis is proposed:

H3. : Digital capability will have a positive influence on organizational sustainability.

3.4. Relationship between digital organizational culture and organizational sustainability

Digital organizational culture has emerged with the wave of digitalization, reflecting a set of shared values and beliefs that guide an enterprise's digital practices and operations (Nylén, 2015). This culture is crucial for IT SMEs because it can drive the digitalization process even with limited resources. Digital organizational culture pro-motes collaboration, creativity, innovation, and continuous improvement. By fostering such a culture, IT SMEs can enhance their employees' innovation capabilities and team spirit, thereby gaining a competitive advantage. According to the organizational learning theory (Argyris & Schön, 1997), a digital organizational culture that promotes continuous learning and innovation allows organizations to constantly evolve their sustainability practices. Digital tools can support this by providing real-time data for decision-making and enabling collaborative learning across organizations. By fostering a culture that values learning and adaptability, organizations are better equipped to implement sustainable practices that improve environmental performance and operational efficiency over time. A healthy digital organizational culture efficiently manages and utilizes technological resources, thereby enhancing competitive advantage (Kiron et al., 2016).

In IT SMEs, the core of the digital organizational culture lies in accountability and communication. Setting clear goals and evaluating performance strengthens communi-cation and collaboration and drives organizational development (Oberer & Erkollar, 2018). A flat management structure can promote effective communication and decision-making, thereby accelerating digital transformation. To ensure success, digital thinking must be embedded in the culture through regular training and workshops, keeping employees updated on the latest technologies and trends.

Social cognitive theory (Bandura, 1986) underscores the importance of leaders in modeling desired digital behaviors. Leaders and employees in a digital organizational culture can model sustainable behaviors by utilizing digital tools that promote sustain-ability (e.g., energy management systems and paperless processes). Through social in-teraction and digital platforms, organizations can spread sustainable practices throughout the company. A culture that actively encourages the observation and replication of sustainable actions can lead to more ingrained

sustainability practices, con-tributing to the overall organizational goal of long-term sustainability. Leaders in IT SMEs, who often participate directly in daily operations, can shape the company's digital culture by demonstrating their commitment to digital technologies. This motivates employees to engage in digital transformation actively. IT SMEs foster knowledge sharing and innovation by creating a flexible work environment and encouraging cross-departmental collaboration. Establishing such a culture enhances digital capabilities, strengthens market competitiveness, and enables sustainable development. The combined efforts of digital leadership and employees will help enterprises thrive in the rapidly changing digital era.

Based on the above theory, the following hypothesis is proposed:

H4. : Digital organizational culture has a positive influence on organizational sustainability.

3.5. Relationship between digital leadership and organizational sustainability

Digital leadership is a product of information technology development that rede-fines the boundaries of traditional leadership and broadens its scope. In addition to tra-ditional leadership duties, digital leadership involves the integration of technological tools and platforms into leadership practices to enhance team engagement and communication efficiency (Antonopoulou et al., 2021). Digital leadership requires leaders to articulate a clear blueprint for digital transformation, implement technological innovations, and reshape organizational culture and business models (Benitez et al., 2022).

Digitalization has become a determining variable in innovation. The digital era is characterized by rapid market changes, and organizational innovation-based capabili-ties capture market opportunities, ultimately highlighting the importance of digital leadership (Niu et al., 2022). IT companies promote operational activities comprising various factors that digitally innovate, transform, and provide skilled leadership to meet customers' expectations of increasing organizational success and sustainability (Mollah, Amin, et al., 2024). In this regard, digital leadership is considered a factor that pro-motes organizational sustainability. The main reason for this is that digital leaders have dynamic capabilities to effectively manage uncertainty and adapt to technological changes and culture (de Araujo et al., 2021), which is a supportive factor that promotes organizational sustainability(Mollah, Ibrahim, et al., 2024).

Additionally, digital leadership is expected to have a strong relationship with in-novative behavior and innovation, promoting organizational sustainability. Employees led by digitally skilled leaders can focus on various new ideas, which help contribute toward organizational goals (Erhan et al., 2022). Furthermore, digital leaders possess another style of transformational leadership: they should act proactively to achieve organizational objectives and goals. Therefore, leaders enhance subordinates' motivation and support creative and innovative ideas (Erhan et al., 2022). This approach reinforces leaders' roles in the development of subordi-nates' innovative behaviors (Chen et al., 2014). Therefore, digital leadership leads to subordinates' innovation and innovative behavior, thereby contributing to organizational sustainability. Malakyan (2019) demonstrated that digital leadership has a positive in-fluence on corporate innovation and leads to sustainable performance. According to the role of digital leadership and its effects, digital leadership can induce innovative behaviors among organizational members in a rapidly changing digital environment. Therefore, organizational members' innovative behavior is considered a factor that in-creases and contributes to promoting organizational sustainability.

Based on the above theory, the following hypothesis is proposed:

H5. : Digital leadership will have a positive influence on organizational sustainability.

3.6. Mediating role of digital organizational culture

Digital organizational culture plays a mediating role in the relationship between digital leadership and organizational sustainability by promoting innovation, enhancing employees' digital literacy, and strengthening team collaboration. Mollah, Ibrahim, et al. (2024) further support this notion by showing that digital culture acts as a bridge between digital leadership and competitive performance, emphasizing the importance of a supportive and innovative organizational environment. Their study underscores that digital leadership, through the cultivation of a digital culture, can drive sustainable organizational outcomes by fostering a culture of continuous learning and adaptability.It supports the continuous development of organizations by promoting innovation, enhancing employees' digital literacy, and strengthening team collaboration (Muniroh et al., 2022). According to Fischer and Montalbano's (2014)organizational culture model, digital leadership shapes all three levels of an organization's digital culture by embedding technological practices, norms, and values into the organizational fabric. Digital culture drives sustainability by influencing how employees behave, make decisions, and adopt digital tools to improve their environmental, social, and economic outcomes. Culture acts as the mechanism through which leadership im-pacts sustainability. It mediates this relationship, encouraging employees to engage in innovation and explore new technologies to solve problems (Duerr et al., 2018).

Digital leaders in IT SMEs create an innovative atmosphere that motivates employees to propose and implement new ideas, boost creativity, and enhance overall competitiveness. Organizational learning theory (Argyris & Schön, 1997) emphasizes that digital leadership fosters a learning culture within an organization, promoting the continuous learning, adaptation, and application of digital technologies. This culture enables organizations to embrace sustainability by learning and implementing sustain-able practices over time. Organizational learning driven by leadership creates a digital culture that mediates the relationship between leadership and sustainability, ensuring that sustainable practices are not only adopted but also continuously improved upon. Skilled digital talent can increase productivity and make quick, accurate decisions in complex environments (Dragičević & Bošnjak, 2019).

Additionally, a digital organizational culture emphasizes teamwork and knowledge sharing. By establishing open communication channels, digital leaders can foster sus-tainable practices and corporate social responsibility through digital tools (Niu et al., 2022). For example, companies can use big data analysis to optimize resource allocation, reduce waste, and achieve sustainable development. Digital organizational culture pro-vides a solid foundation for the relationship between digital leadership and organizational sustainability by fostering innovation, enhancing digital literacy, and strengthening collaboration. Digital leaders must actively promote this culture to ensure sustainable development during the digital transformation.

Based on the above theory, the following hypothesis is proposed:

H6. : Digital organizational culture mediates the relationship between digital leadership and organizational sustainability.

3.7. Mediating role of digital capability

Digital capability is crucial to IT enterprises, particularly in the relationship be-tween digital leadership and organizational sustainability. Digital capabilities encompass technical skills, data analysis, digital thinking, and innovation, all of which are crucial for promoting sustainable development. According to the resource-based view (Barney, 1991), digital capability driven by digital leadership is a key organizational re-source. When leaders cultivate digital capabilities, they help the organization develop VRIN resources, such as advanced technologies and skills, which contribute to sustain-ability. Digital capability mediates this relationship by enabling the organization to

leverage technology to improve efficiency, innovation, and long-term sustainability. It can be considered a valuable organizational resource that enhances operational efficiency and innovation capacity by helping organizations utilize technological resources more effectively (Paiola & Gebauer, 2020). Employees with strong digital capabilities can conduct market analyses, forecast trends, and make strategic decisions, enabling organizations to respond quickly to market changes, improve competitiveness, and achieve sustainable development (Moore & Manring, 2009).

Dynamic capabilities theory (Teece et al., 1997) further supports the idea that digital leadership fosters these capabilities, allowing organizations to continuously adapt to changing environments. Digital leadership is essential for developing dynamic capabil-ities, including the ability to respond to technological changes and market shifts. Digital capability serves as a mediating factor because it enables the organization to adapt and innovate continuously, ensuring sustainability. Digital leadership fosters this capability, which in turn allows the organization to respond more effectively to external pressures and remain sustainable in a volatile environment; leaders with strong digital capabilities can formulate digital strategies, communicate them effectively, and manage teams more efficiently (Kıyak & Bozkurt, 2020). By enhancing their digital capabilities, leaders can better motivate employees, optimize processes, and improve overall performance, thereby driving sustainable development.

Digital capabilities also boost innovation capacity. Employees with digital skills are more likely to embrace new technologies and conduct experiments using innovative methods (Khin & Ho, 2019). Supported by digital leadership, digital tools can be used to identify problems, iterate quickly, and propose solutions to enhance an organization's adaptability and create new growth opportunities (Khin & Ho, 2019). Therefore, IT en-terprises can better leverage technological resources, improve efficiency, and promote innovation by developing digital capabilities for both employees and leaders, thereby contributing to sustainable development.

Based on the above theory, the following hypothesis is proposed:

H7. : Digital capability mediates the relationship between digital leadership and organizational sustainability.

3.8. Moderating role of absorptive capacity in the impact of digital leadership on digital capability

Absorptive capacity is a critical factor for IT enterprises to gain a competitive ad-vantage in a rapidly changing digital environment. This not only influences the effectiveness of digital leadership but also moderates the impact of digital leadership on digital capability. The absorptive capacity theory (Cohen & Levinthal, 1990) explains that absorptive capacity is crucial in moderating the relationship between digital leadership and digital capability. Digital leadership fosters an environment in which employees are encouraged to adopt new technologies and processes; however, without strong absorptive capacity, organizations may struggle to fully realize the benefits of these innovations. Absorptive capacity ensures that the external knowledge introduced through digital leadership is effectively integrated into the organization, enhancing digital capability. The more absorptive capacity an organization has, the more it can leverage the guidance of digital leadership to improve digital capabilities. Digital leaders establish effective external collaboration networks to obtain the latest technology and market information (Pagani & Pardo, 2017). Once absorbed, this external knowledge is transformed into in-ternal capabilities, enhancing the organization's digital capacity.

Absorptive capacity facilitates the assimilation and transformation of knowledge. Enterprises must convert external knowledge into practical operational capabilities and skills through internal learning (García-Sánchez et al., 2018). According to social cognitive theory (Bandura, 1986), digital leadership models the use of new technologies and practices, but absorptive capacity determines how well these models are internalized by the organization. Employees and teams with strong absorptive capacity are better able to observe and replicate the behaviors and practices modeled by digital leaders, leading to enhanced digital capabilities.

Absorptive capacity also enhances one's ability to utilize knowledge. Through effective knowledge management, organizations can apply absorbed knowledge to create new value (Bierly III et al., 2009). Digital leaders promote knowledge-sharing and collaboration, ensuring that knowledge flows and is effectively applied within the organization. Enterprises with a high absorptive capacity can quickly respond to market changes and technological advancements and maintain a competitive edge. By enhancing their ability to acquire, assimilate, transform, and utilize knowledge, IT enterprises can improve their digital capabilities, foster innovation, and achieve sustainable development.

Based on the above theory, the following hypothesis is proposed:

H8. : Absorptive capacity moderates the impact of digital leadership on digital capability.

3.9. Moderating role of absorptive capacity in the mediating effect of digital capability between digital leadership and organizational sustainability

Absorptive capacity, as a dynamic capability, not only influences the formation and development of digital capability but also determines the effectiveness of digital capa-bility in promoting organizational sustainability. The absorptive capacity theory (Cohen & Levinthal, 1990) argues that absorptive capacity mediates the mediating role of digital capabilities by enabling organizations to better absorb and utilize the knowledge and technologies of digital leadership. Digital capabilities developed through leadership programs are more effective in promoting sustainable development when organizations have high absorptive capacity. Absorptive capacity strengthens the connection between digital leadership and capabilities, enabling them to be used effectively for long-term sustainable development. IT companies with high absorptive capacity can quickly ac-quire and digest advanced external technologies and knowledge, thereby enhancing the digital capabilities of the company (Xie et al., 2018). Digital leaders improve their employees' technical skills and innovation abilities by promoting the absorption of external knowledge. Organizations with a high absorptive capacity can more effectively apply digital capabilities to business operations and promote sustainability (Pagani & Pardo, 2017).

Absorptive capacity enhances resource allocation and process management, facili-tating the full utilization of digital capabilities. They also affect organizational innovation by helping organizations identify and leverage external innovation opportunities and drive internal practices (Flor et al., 2018). The sustainable development theory (Brundtland, 1987) emphasizes that organizations with high absorptive capacity are better able to adapt to market changes and technological advancements, ensuring long-term sustainability. Under the guidance of digital leadership, organizations can continuously enhance their digital capabilities through ongoing learning and innovation, ultimately achieving development goals.

Based on the above theory, the following hypothesis is proposed:

H9. : Absorptive capacity moderates the mediating effect of digital capability between digital leadership and organizational sustainability.

3.10. Moderating role of innovation atmosphere in the impact of digital organizational culture on organizational sustainability

An innovative atmosphere significantly enhances IT enterprises' sustainability by stimulating employee creativity, promoting knowledge sharing, and strengthening team collaboration (Ye et al., 2022). The creative climate theory (Ekvall, 1996) suggests that an innovation

atmosphere creates a creative climate that stimulates employees to think outside the box, take risks, and pursue new approaches. In a digital organizational culture that promotes openness and digital transformation, the innovation atmosphere moderates the relationship by encouraging employees to explore innovative solutions that contribute to sustainability. This theory shows how a creative environment amplifies the effects of organizational culture on sustainability outcomes, in which employees are more willing to innovate and collaborate (West, 2003). Digital organizational culture fosters innovation by promoting collaboration and proactivity and enhancing employees' ability to think creatively (Auernhammer & Hall, 2014). An innovative atmosphere also promotes knowledge-sharing and teamwork, further boosting organizational in-novation capacity and competitiveness (Ye et al., 2022).

According to the resource-based view (Barney, 1991), an innovation atmosphere is a valuable resource that strengthens an enterprise's adaptability and flexibility. This al-lows organizations to leverage their digital culture more effectively, improving their ability to respond quickly to external changes and technological advancements. This adaptability enables employees to stay updated on their latest technological knowledge and market insights, positioning them to tackle challenges and seize new opportunities. Additionally, in an innovation-driven environment, employees are more likely to pro-pose solutions that contribute to social and environmental sustainability, thus promoting the organization's overall sustainability (Trushkina et al., 2020).

Based on the above theory, the following hypothesis is proposed:

H10. : Innovation atmosphere moderates the impact of digital organizational culture on organizational sustainability.

Despite the growing body of research on digital leadership and organizational sustainability, significant gaps remain in understanding the underlying mechanisms through which digital leadership influences sustainability outcomes. Previous studies have primarily focused on the direct effects of digital leadership, with limited attention to the mediating roles of digital capabilities and digital organizational culture, as well as the moderating roles of absorptive capacity and innovation atmosphere. This study aims to address these gaps by proposing a comprehensive moderated mediation model that examines how digital leadership enhances organizational sustainability through digital capabilities and digital organizational culture, while considering the moderating effects of absorptive capacity and innovation atmosphere. By integrating these variables, this study provides a more nuanced understanding of the pathways through which digital leadership drives sustainability, offering valuable insights for both academic research and practical applications in the context of SMEs.

Based on the above theories and hypotheses, this study proposes a research model (Fig. 1).

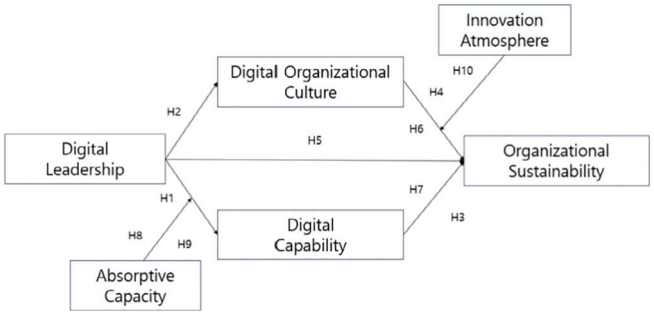

Fig. 1. Research model.

4. Research methodology

4.1. Sample and data

This study collected data from small- and medium-sized IT enterprises in China in 2024. To ensure a representative sample, we employed a random sampling method by selecting participants from a list of employees provided by human resource managers. Specifically, we contacted HR managers from various companies, explained the purpose of the study, and requested access to a list of employees. From these lists, participants were randomly selected to ensure that the sample was unbiased and representative of the target population.

4.1.1. Questionnaire translation and pilot study

To ensure the accuracy of the questionnaire, we employed a back-translation method. The original English questionnaire was first translated into Chinese by a bilingual expert. Subsequently, another independent bilingual translator translated the Chinese version back into English. The two English versions were then compared to identify and resolve any discrepancies, ensuring that the Chinese version conveyed the same meaning as the original English questionnaire. Additionally, a pilot study was conducted with 30 participants to test the clarity and reliability of the questionnaire. Based on the feedback, minor adjustments were made to improve the wording and structure of the questions.

4.1.2. Data collection and cleaning

Data were primarily collected through electronic questionnaires distributed and collected via an online survey platform. To ensure the quality of the responses, we implemented a data cleaning process. Questionnaires completed in an unreasonably short time (<5 min) were excluded from the analysis. This threshold was determined based on the average time required to thoughtfully complete the questionnaire, as observed during the pilot study. Additionally, we checked for contradictory responses and incomplete questionnaires, further ensuring the reliability of the data. After excluding invalid responses, 552 valid questionnaires were obtained.

4.1.3. Response rate

A total of 700 questionnaires were distributed, and 552 valid responses were obtained, resulting in a response rate of 78.9 %. This relatively high response rate can be attributed to the support of HR managers, who facilitated the distribution of the questionnaire and encouraged employee participation. The high response rate also indicates that the topic of digital leadership and organizational sustainability is of significant interest to the respondents.

4.1.4. Demographic Information

Among the survey sample, 50.36 % were male and 49.64 % were female respondents. Regarding age, 6.34 % were under 25 years, 23.91 % were between 26 and 30 years, 30.43 % were between 31 and 35 years, 17.93 % were between 36 and 40 years, 13.41 % were between 41 and 50 years, and 7.97 % were over 50 years. In terms of education, 15.76 % had a high school education or lower, 29.53 % had a college education, 41.49 % had a bachelor's degree, 8.15 % had a master's degree, and 5.07 % had a doctoral degree or higher. Regarding work experience, 34.42 % had 1–5 years, 32.07 % had 6–10 years, 14.49 % had 11–15 years, 10.33 % had 16–20 years, and 8.7 % had >20 years. Regarding the time spent working with their leader, 12.68 % had six months or less; 25.36 % had more than six months but less than a year; 19.38 % had more than one year but less than a year and a half; 19.02 % had more than a year and a half but less than two years; and 23.55 % had two or fewer years of experience. In terms of position level, 38.95 % were employees, 34.06 % were junior managers, 24.09 % were middle managers, and 2.9 % were senior managers. Regarding company size, 0.72 % had 50 or fewer employees, 32.79 % had 51–100 employees, 25.91 % had 101–150 employees, 10.87 % had 151–200 employees, and

4.71 % had >201 employees.

4.1.5. Control variables

The first part of the questionnaire included the respondents' demographic information. Previous studies have indicated that individual variables can influence employees' work behaviors and attitudes to some extent. Therefore, this study selected individual variables as control variables, including sex, age, educational level, work experience, job level, time spent working with the leader, and company size.

4.2. Measurement

Digital leadership was used the measurement tool by Hoang et al. (2024)) based on the measurement tool of Borah et al. (2022), which consists of 6 items (1 = strongly disagree; 7 = strongly agree). Sample items include: "Digital leaders raise employees' awareness of information technology risks" and "Digital leaders raise awareness of technologies that help improve organizational processes." This scale assesses leaders' ability to guide digital transformation by integrating digital technologies and platforms to enhance team electronic engagement and communication efficiency. The Cronbach's alpha for this scale is 0.919.

Digital capability was measured using a scale from Annarelli et al. (2021) and Khin and Ho (2019), which includes 5 items (1 = strongly disagree; 7 = strongly agree). Sample items include: "Our company can access key digital technologies" and "Our company can identify opportunities related to new digital technologies." This scale measures the ability of enterprises to flexibly use digital tools and technologies to innovate products, services, and business models, thereby improving productivity and operational efficiency in the digital era. The Cronbach's alpha for this scale is 0.896.

Absorptive capacity was measured using a scale from Jansen et al. (2005) and Pavlou and El Sawy (2006), which consists of 7 items (1 = strongly disagree; 7 = strongly agree). Sample items include: "Our company uses formal processes (e.g., meetings with customers or third parties) to acquire new knowledge" and "Our company can effectively transform existing information into new knowledge." This scale assesses the ability of enterprises to identify, evaluate, acquire, assimilate, transform, and apply external knowledge. The Cronbach's alpha for this scale is 0.922.

Digital organizational culture was measured using a scale from Martínez-Caro et al. (2020), which consists of 4 items (1 = strongly disagree; 7 = strongly agree). Sample items include: "Our organizational teams collaborate functionally on innovation and digital transformation plans" and "There is a clear direction for digital technology transformation in our organizational culture." This scale measures the set of shared values and beliefs formed within the context of digitalization. The Cronbach's alpha for this scale is 0.867.

Innovation atmosphere was measured using a scale from Koo Moon and Kwon Choi (2014), which consists of 5 items (1 = strongly disagree; 7 = strongly agree). Sample items include: "Our company encourages me to take risks by trying new things" and "Our company encourages me to develop my own ideas." This scale measures the degree to which the organization encourages innovative activities and supports innovative behaviors. The Cronbach's alpha for this scale is 0.899.

Organizational sustainability was measured using a scale from Huang et al. (2011), which consists of 6 items (1 = strongly disagree; 7 = strongly agree). Sample items include: "Our company places a high emphasis on environmental protection" and "Our company strives to promote environmental protection." This scale measures the ability of enterprises to achieve long-term operations across economic, social, and environmental dimensions. The Cronbach's alpha for this scale is 0.913.

5. Results

5.1. Confirmatory Factor Analysis (CFA)

The model's suitability can be confirmed through Confirmatory Factor Analysis (CFA) (Presson et al., 1997). The results of the CFA are as follows. The absolute fit indices are: $X^2(p) = 606.247$ (0.000), $X^2/df = 1.263$, RMSEA = 0.022. Secondly, the incremental fit indices are IFI = 0.989 and CFI = 0.989. Thirdly, the parsimonious fit indices are PGFI = 0.802 and PNFI = 0.863.

This study analyzed the Average Variance Extracted (AVE) and Composite Reliability (CR) values. For AVE, the values were: digital leadership at 0.653, digital capability at 0.633, absorptive capacity at 0.627, organizational sustainability at 0.635, digital organizational culture at 0.620, and innovation atmosphere at 0.642; all of which are >0.5. For the value of CR, digital leadership at 0.802, digital capability at 0.755, absorptive capacity at 0.811, organizational sustainability at 0.795, digital organizational culture at 0.711, and innovation atmosphere at 0.761. When the AVE value is >0.5 and the CR value is >0.7, the measurement demonstrates significant validity. In addition, all of the t-value showed $p < .001$.

The value of *t*-value showed that digital leadership was from 20.631 to 22.010, digital capabilities was from 19.493 to 21. 291, absorptive capacity was from 20.182 to 20.902, organizational sustainability was from 19.521 to 20.476, organizational digital culture was from 18.428 to 20.772, and innovation atmosphere was from 19.341 to 20.670. In addition, all of the values of significance were under 0.001. Thus, these results showed that all of values were significant.

In addition, the reliability analysis is performed. The results of Cronbach's alpha values were digital leadership at 0.919, digital capability at 0.896, absorptive capacity at 0.922, organizational sustainability at 0.913, digital organizational culture at 0.867, and innovation atmosphere at 0.899. Reliability analysis indicates that when Cronbach's alpha is >0.7, the reliability analysis has significant validity. The results are presented in Table 1. (See Table 2.)

5.2. Discriminant validity test

According to Table 1, Each diagonal element (bolded) is the AVE value, and the other elements are the correlation squares between variables. The results presented that all variables of AVE are greater than correlation squares between variables, which means that the correlation between the variables is low and there are obvious differences. It can be confirmed that the variables in this study have good discriminant validity, and the latent variables can be clearly distinguished during measurement, avoiding overlap and confusion between latent variables.

Table 3 presents the descriptive statistics and correlation analysis. Descriptive statistics include mean values and standard deviations (SD). The mean values for digital leadership, absorptive capacity, digital capability, digital organizational culture, innovation atmosphere, and organizational sustainability are 4.431, 4.391, 4.44, 4.478, 4.46, and 4.43, respectively. Additionally, the standard deviations for digital leadership, absorptive capacity, digital capability, digital organizational culture, innovation atmosphere, and organizational sustainability are 1.409, 1.369, 1.405, 1.379, 1.416, and 1.37, respectively.

To verify the correlations between the variables, a correlation analysis was conducted, and the results are summarized as follows: Digital leadership is positively correlated with absorptive capacity ($r = 0.407, p < .01$), digital capability ($r = 0.392$, $p < .01$), digital organizational culture ($r = 0.369, p < .01$), innovation atmosphere ($r = 0.419, p < .01$), and organizational sustainability ($r = 0.444$, $p < .01$). Absorptive capacity is positively correlated with digital capability ($r = 0.459, p < .01$), digital organizational culture ($r = 0.409$, $p < .01$), innovation atmosphere ($r = 0.403, p < .01$), and organizational sustainability ($r = 0.449$, $p < .01$). Digital capability is positively correlated with digital organizational culture ($r = 0.409, p < .01$), innovation atmosphere ($r = 0.388$,

Table 1
The result of confirmatory factor analysis and reliability analysis.

Variables		Estimate	S.E.	t-value	*p*	Standardized Regression Weights	AVE	CR	Cronbach's alpha
Digital Leadership (A)	A1	1.000	–	–	–	0.807	0.653	0.802	0.919
	A2	1.041	0.048	21.893	0.000	0.820			
	A3	1.025	0.047	21.578	0.000	0.811			
	A4	1.054	0.048	22.010	0.000	0.823			
	A5	0.993	0.048	20.631	0.000	0.785			
	A6	1.011	0.047	21.291	0.000	0.803			
Digital Capabilities (B)	B1	1.000	–	–	–	0.795	0.633	0.755	0.896
	B2	0.966	0.050	19.493	0.000	0.775			
	B3	1.020	0.050	20.351	0.000	0.803			
	B4	0.985	0.048	20.412	0.000	0.805			
	B5	1.002	0.050	20.209	0.000	0.798			
Absorptive Capacity (C)	C1	1.000	–	–	–	0.796	0.627	0.811	0.922
	C2	0.953	0.047	20.182	0.000	0.780			
	C3	1.005	0.049	20.608	0.000	0.793			
	C4	1.010	0.049	20.549	0.000	0.791			
	C5	1.020	0.049	20.902	0.000	0.802			
	C6	1.005	0.048	20.787	0.000	0.798			
	C7	0.992	0.049	20.244	0.000	0.782			
Organizational Sustainability (D)	D1	1.000	–	–	–	0.782	0.635	0.795	0.913
	D2	0.987	0.051	19.521	0.000	0.778			
	D3	1.020	0.051	20.173	0.000	0.799			
	D4	1.033	0.052	20.026	0.000	0.794			
	D5	1.029	0.050	20.476	0.000	0.809			
	D6	1.054	0.051	20.772	0.000	0.818			
Organizational digital culture (E)	E1	1.000	–	–	–	0.786	0.620	0.711	0.867
	E2	0.975	0.053	18.428	0.000	0.771			
	E3	1.010	0.054	18.837	0.000	0.786			
	E4	1.040	0.054	19.341	0.000	0.806			
Innovation atmosphere (F)	F1	1.000	–	–	–	0.809	0.642	0.761	0.899
	F2	0.991	0.048	20.670	0.000	0.797			
	F3	0.958	0.047	20.324	0.000	0.786			
	F4	0.961	0.047	20.243	0.000	0.784			
	F5	1.011	0.046	21.746	0.000	0.828			
Model Fit Index	$X^2(p) = 606.247(0.000)$, $X^2/df = 1.263$, RMSEA = 0.022, IFI = 0.989, CFI = 0.989, TLI = 0.988, PGFI = 0.802, PNFI = 0.863								

Table 2
Discriminant validity test.

	Digital Leadership	Absorptive Capacity	Digital Capabilities	Organizational Digital Culture	Innovation Atmosphere	Organizational Sustainability
Digital Leadership	(0.653)					
Absorptive Capacity	0.166	(0.627)				
Digital Capabilities	0.154	0.211	(0.633)			
Organizational Digital Culture	0.136	0.167	0.167	(0.620)		
Innovation Atmosphere	0.176	0.162	0.151	0.111	(0.642)	
Organizational Sustainability	0.197	0.202	0.162	0.197	0.150	(0.635)

Each diagonal element (bolded) is the AVE value, and the other elements are the correlation squares between variables.

Table 3
The results of descriptive statistics and correlation analysis.*

	Mean	Standard deviation	Digital Leadership	Absorptive Capacity	Digital Capabilities	Organizational Digital Culture	Innovation Atmosphere	Organizational Sustainability
Digital Leadership	4.431	1.409	–					
Absorptive Capacity	4.391	1.369	0.407**	–				
Digital Capabilities	4.44	1.405	0.392**	0.459**	–			
Organizational Digital Culture	4.478	1.379	0.369**	0.409**	0.409**	–		
Innovation Atmosphere	4.46	1.416	0.419**	0.403**	0.388**	0.333**	–	
Organizational Sustainability	4.43	1.37	0.444**	0.449**	0.402**	0.444**	0.387**	–

* $p < .05$.
** $p < .01$.

$p < .01$), and organizational sustainability ($r = 0.402$, $p < .01$). Digital organizational culture is positively correlated with innovation atmosphere ($r = 0.333$, $p < .01$) and organizational sustainability ($r = 0.444$, $p < .01$). Innovation atmosphere is positively correlated with organizational sustainability ($r = 0.387$, $p < .01$).

We tested the measures of model fit separately using AMOS. After

testing, as shown in Table 4.1, the model fit is good, $X^2(p) = 100.661$ (0.491), $X^2/df = 0.997$, GFI = 0.978, AGFI = 0.97, PGFI = 0.726, NFI = 0.982, RFI = 0.978, PNFI = 0.826, PCFI = 0.842. This indicates that there is a good fit between the model and the data. As shown in Table 3.2, the model fit is good, $X^2(p) = 152.249(0.013)$, $X^2/df = 1.312$, GFI = 0.969, AGFI = 0.959, PGFI = 0.735, NFI = 0.975, RFI = 0.970, PNFI = 0.831, PCFI = 0.848. This indicates a good fit between the model and the data.

Based on the above main effects, in order to test the mediating effects of organizational digital culture and digital capabilities, this study constructed two models and used the Bootstrap method of AMOS 24.0 for parameter estimation. Table 4.1 and Table 4.2 show the mediating effects.

The mediating effect of digital organizational culture was analyzed using SEM. The results showed that digital leadership had a positive impact on organizational sustainability (Estimate = 0.323, $p < .001$) and digital organizational culture (Estimate = 0.346, $p < .001$). Additionally, the results showed that digital organizational culture significantly affected organizational sustainability (Estimate = 0.412, $p < .001$). Therefore, Hypotheses 2, 4, and 5 were supported.

The indirect path, digital leadership → organizational digital culture → organizational sustainability, is significant with an effect value = 0.149, $p = .000 < 0.01$, and a 95 % bootstrap confidence interval excluding zero. This shows that Organizational digital culture plays a significant mediating role between digital leadership and organizational sustainability. H6 was verified.

The mediating effect of digital capabilities was analyzed using SEM. The results showed that digital leadership had a positive impact on organizational sustainability (Estimate = 0.347, $p < .001$) and digital capabilities (Estimate = 0.432, $p < .001$). In addition, the results also showed that digital capabilities significantly affected organizational sustainability (Estimate = 0.276, $p < .001$). Therefore, Hypotheses 1 and 3 were supported.

The indirect path, digital leadership → digital capabilities → organizational sustainability, is significant with an effect value = 0.124, $p = .000 < 0.01$, and a 95 % bootstrap confidence interval excluding zero. This shows that Digital Capabilities plays a significant mediating role between Digital Leadership and Organizational Sustainability. H7 was verified.

Hypothesis 8 tests the moderating effect of absorptive capacity. To avoid multicollinearity, the independent variable (digital leadership) and the moderating variable (absorptive capacity) were centered, and then a product term was created and included in the regression equation. As shown in Table 5.1, the independent variable digital leadership in Model 1 was positively correlated with the dependent variable digital capability (β = 0.392, $p < .001$), and the independent variable absorptive capacity in Model 2 was positively correlated with the dependent variable digital capability (β = 0.359, $p < .001$). The product term of the independent variable digital leadership and absorptive capacity was significantly positively correlated with the dependent variable digital capability (β = 0.183, p < .001). The results show that absorptive capacity has a marginal moderating effect on the relationship between digital leadership and digital capability. Therefore, Hypothesis 8 is supported.

Hypothesis 10 tests the moderating effect of innovation atmosphere. To prevent multicollinearity, the independent variable (digital organizational culture) and the moderating variable (innovation atmosphere) are centered, and then a product term is created and included in the regression equation. As shown in Table 5.2, the independent variable organizational digital culture in Model 1 is positively correlated with the dependent variable organizational sustainability (β = 0.444, $p < .001$), and the independent variable innovation atmosphere in Model 2 is positively correlated with the dependent variable organizational sustainability (β = 0.269, $p < .001$). The product term of the independent variable digital organizational culture and innovation atmosphere is significantly positively correlated with the dependent variable organizational sustainability (β = 0.243, p < .001). The results show that innovation atmosphere has a marginal moderating effect on the relationship between digital organizational culture and organizational sustainability. Therefore, Hypothesis 10 is supported.

To more vividly illustrate the moderating effect of absorptive capacity on the relationship between digital leadership and digital capability, this study used simple slope analysis to test and plot the moderating effect of absorptive capacity, as shown in Fig. 2. For employees with high levels of absorptive capacity, the positive effect of digital leadership on digital capability is significant; whereas for employees with low levels of absorptive capacity, the positive effect of digital leadership on digital capability is not significant. Thus, hypothesis 8 is further validated.

To more vividly illustrate the moderating effect of innovation atmosphere on the relationship between digital organizational culture and organizational sustainability, this study used simple slope analysis to test and plot the moderating effect of innovation atmosphere, as shown in Fig. 3. For organizations with a high level of innovation atmosphere, the positive effect of digital organizational culture on organizational sustainability is significant; whereas for organizations with a low level of innovation atmosphere, the positive effect of digital organizational culture on organizational sustainability is not significant. Thus, hypothesis 10 is further validated.

Table 6.1 shows the moderating effect of absorptive capacity. Hypothesis 9 proposed that absorptive capacity positively moderates the mediating effect of digital leadership on organizational sustainability through digital capability. The moderated mediation model was tested using SPSS Process Macro 3.4.1 Model 7, with a 95 % confidence interval and 5000 bootstrap samples. The conditional indirect effects of digital leadership on organizational sustainability through digital capability were evaluated by analyzing the index of moderation at three different levels (−1 SD, Mean (M), and + 1 SD).

Since the bootstrap lower limit confidence interval (Boot LLCI) and bootstrap upper limit confidence interval (Boot ULCI) do not include 0 at the levels of −1 SD, Mean (M), and + 1 SD, statistical significance is confirmed.

Additionally, the index of moderated mediation is 0.037, with Boot SE = 0.009, Boot LLCI = 0.0208, and Boot ULCI = 0.056. As the Boot LLCI and Boot ULCI do not include 0, the moderated mediation effect is significant. Therefore, hypothesis 9 is supported.

Table 4.1
The results of SEM.

Path			Estimate	SE	C.R	*P*
Digital Leadership	→	Organizational Sustainability	0.323	0.045	7.227	***
Digital Leadership	→	Organizational digital culture	0.412	0.048	8.653	***
Organizational digital culture	→	Organizational Sustainability	0.346	0.046	7.477	***
Mediation effect			Indirect effects	Lower limit		Upper limit
Digital Leadership → Organizational digital culture → Organizational Sustainability			0.149	0.113		0.186
Model fit			$X^2(p) = 100.661(0.491)$, $X^2/df = 0.997$, GFI = 0.978, AGFI = 0.97, PGFI = 0.726, NFI = 0.982, RFI = 0.978, PNFI = 0.826, PCFI = 0.842			

Table 4.2
The results of SEM.

Path			Estimate	SE	C.R	*P*
Digital Leadership	→	Organizational Sustainability	0.347	0.046	7.501	***
Digital Leadership	→	Digital Capabilities	0.432	0.047	9.129	***
Digital Capabilities	→	Organizational Sustainability	0.276	0.046	6.036	***
Mediation effect			Indirect effects	Lower limit		Upper limit
Digital Leadership → Digital Capabilities → Organizational Sustainability			0.124	0.089		0.164
Model fit			$X^2(p) = 152.249(0.013)$, $X^2/df = 1.312$, GFI = 0.969, AGFI = 0.959, PGFI = 0.735, NFI = 0.975, RFI = 0.970, PNFI = 0.831, PCFI = 0.848			

Table 5.1
The result of moderating effect of absorptive capacity.

	Model 1		Model 2		Model 3		
	β	*t*	*β*	*t*	*β*	*t*	VIF
Digital leadership (A)	0.392***	10.004	0.246***	6.133	0.212***	5.307	1.237
Absorptive Capacity (C)			0.359***	8.942	0.325***	8.127	1.237
Interaction					0.183***	4.850	1.108
R^2	0.154		0.262		0.292		
ΔR^2			0.108		0.030		
F	100.087***		79.957***		23.523***		

Table 5.2
The result of moderating effect of innovation atmosphere.

	Model 1		Model 2		Model 3		
	β	*t*	*β*	*t*	*β*	*t*	VIF
Organizational Digital Culture (E)	0.444***	11.636	0.355***	9.127	0.322***	8.558	1.143
Innovation Atmosphere (F)			0.269**	6.926	0.252***	6.729	1.130
Interaction					0.243***	6.787	1.030
R^2	0.198		0.262		0.319		
ΔR^2			0.064		0.057		
F	135.388***		47.964***		46.058***		

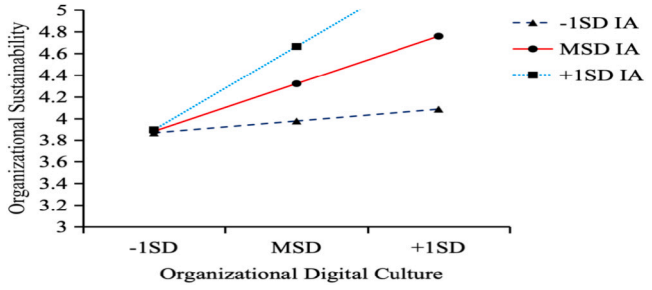

Fig. 2. Moderating effect of Innovation Atmosphere on the relationship between Organizational Digital Culture and Organizational Sustainability.

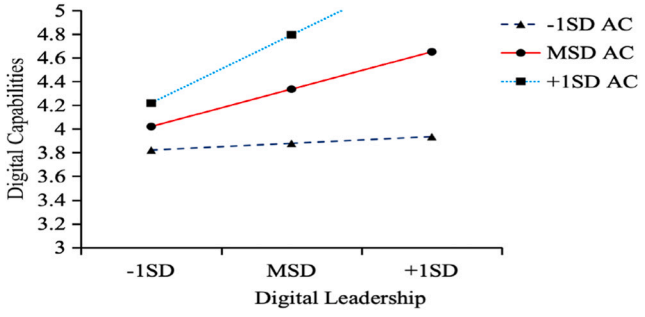

Fig. 3. Moderating effect of Absorptive Capacity on the relationship between Digital Leadership and Digital Capabilities.

6. Discussion

This study explores the impact of digital leadership, digital capability, digital organizational culture, innovation atmosphere, and absorptive capacity on the sustainability of IT SMEs in China. The findings indicate that digital leadership significantly enhances an organization's sustainability by improving its digital capabilities and culture. Digital leadership not only directly influences organizational sustainability but also in-directly promotes sustainability through the mediating roles of digital capability and digital organizational culture. Additionally, high absorptive capacity and an innovative atmosphere can further strengthen the impact of digital leadership on organizational sustainability.

The results support the hypothesis that digital leadership has a positive influence on digital capability (H1). This finding aligns with the Resource-Based View (RBV), which posits that digital leadership serves as a unique organizational resource that enhances digital capabilities. The findings confirm that digital leadership positively influences digital organizational culture (H2). This result is supported by the Organizational Culture Theory, which suggests that leadership plays a critical role in shaping organizational culture. Digital leaders, by promoting cross-departmental collaboration and continuous learning, foster a culture that values innovation and adaptability. The results indicate that digital capability positively impacts organizational sustainability (H3). This finding is consistent with the Dynamic Capabilities Theory, which

Table 6.1
The results moderated mediation test of absorptive capacity.

Dependent Variable: Organizational Sustainability					
Moderator	Level	Conditional Indirect Effect	Boot SE	Boot LLCI	Boot ULCI
Absorptive Capacity	−1 SD (−1.3688)	0.011	0.017	−0.023	0.043
	M	0.062	0.014	0.037	0.090
	+1 SD (1.3688)	0.113	0.020	0.077	0.153
Index of moderated mediation					
	Index		Boot SE	Boot LLCI	Boot ULCI
	0.037		0.009	0.0208	0.056

emphasizes the importance of organizational capabilities in adapting to changing environments. Digital capabilities enable organizations to leverage technological resources effectively, improving operational efficiency and innovation capacity, which are essential for long-term sustainability. The findings support the hypothesis that digital organizational culture positively influences organizational sustainability (H4). This result is consistent with the Organizational Learning Theory, which highlights the importance of a learning culture in achieving sustainability goals. A digital organizational culture promotes continuous learning, adaptability, and innovation, enabling organizations to respond effectively to technological and market changes. The results confirm that digital leadership has a direct positive influence on organizational sustainability (H5). This finding aligns with the Dynamic Capabilities Theory, which suggests that digital leaders possess the ability to manage uncertainty and adapt to technological changes, thereby promoting sustainability. The findings support the hypothesis that digital organizational culture mediates the relationship between digital leadership and organizational sustainability (H6). Digital leaders, by fostering a digital culture, create an environment that promotes innovation and continuous improvement, thereby enhancing sustainability. Practically, organizations should focus on cultivating a digital culture to maximize the impact of digital leadership on sustainability. The results confirm that digital capability mediates the relationship between digital leadership and organizational sustainability (H7). This finding aligns with the Resource-Based View (RBV), which posits that digital capability is a valuable organizational resource that enhances operational efficiency and innovation capacity. Practically, organizations should invest in developing digital capabilities to enhance the effectiveness of digital leadership in achieving sustainability goals. The findings support the hypothesis that absorptive capacity moderates the relationship between digital leadership and digital capability (H8). This result is consistent with the Absorptive Capacity Theory (Cohen & Levinthal, 1990), which suggests that absorptive capacity enhances an organization's ability to acquire and utilize external knowledge. Organizations with high absorptive capacity can more effectively leverage the guidance of digital leadership to improve digital capabilities. The results confirm that absorptive capacity moderates the mediating effect of digital capability between digital leadership and organizational sustainability (H9). This finding aligns with the Dynamic Capabilities Theory, which emphasizes the importance of dynamic capabilities in adapting to changing environments. Organizations with high absorptive capacity can more effectively apply digital capabilities to business operations, thereby enhancing sustainability. The findings support the hypothesis that innovation atmosphere moderates the relationship between digital organizational culture and organizational sustainability (H10). This result is consistent with the Creative Climate Theory (Ekvall, 1996), which suggests that an innovation atmosphere stimulates creativity and risk-taking behaviors. Organizations with a strong innovation atmosphere can more effectively leverage their digital culture to enhance sustainability.

6.1. Theoretical implications

This study is grounded in several theoretical frameworks, including the Resource-Based View (RBV), Dynamic Capabilities Theory, and Organizational Learning Theory. The findings provide strong support for these theories and extend their applicability in the context of digital leadership and organizational sustainability.

The results align with the RBV, which posits that digital leadership and digital capabilities are unique organizational resources that contribute to sustained competitive advantage. By leveraging these resources, organizations can enhance their digital transformation efforts and achieve long-term sustainability. The findings support the Dynamic Capabilities Theory, which emphasizes the importance of absorptive capacity and innovation atmosphere in enabling organizations to adapt to changing environments. These dynamic capabilities amplify the positive effects of digital leadership on organizational sustainability. The results also align with the Organizational Learning Theory, which highlights the role of digital organizational culture in fostering continuous learning and innovation. By promoting a culture of adaptability and knowledge sharing, digital organizational culture enhances the organization's ability to achieve sustainability goals.These theoretical insights not only deepen our understanding of the mechanisms through which digital leadership influences organizational sustainability but also provide a foundation for future research in this area.

Compared to previous studies that focused on the general impacts of digital lead-ership, this study specifically reveals the mediating roles of digital capability and digital organizational culture. Muniroh et al. (2022) studied the direct impact of digital lead-ership on organizational performance, whereas Cortellazzo et al. (2019) explored the performance of digital leadership in enterprises of different sizes. However, neither study delved into the internal mechanisms, such as how specific organizational factors, like digital capability and culture, influence the digital leadership-sustainability relationship. This study deepens the research by specifically analyzing the mediating roles of digital capability and organizational culture, providing a more detailed theoretical framework. In addition to these mediating factors, this study analyzed the moderating effects of absorptive capacity and innovation atmosphere, revealing differences in the impact mechanisms of digital leadership on organizational sustainability in different organizational environments. Unlike previous studies that focused on the role of absorptive capacity in organizational learning (Cohen & Levinthal, 1990; Zahra & George, 2002) and the impact of an innovation atmosphere on organizational innovation performance (Amabile et al., 1996), this study introduced these factors into the research framework of digital leadership, revealing their moderating roles in the digital transformation process, providing new directions and ideas for future research. This approach enables a more comprehensive understanding of how external organizational conditions influence the effectiveness of digital leadership, offering practical insights for businesses aiming to leverage leadership for digital success.

This study has made significant progress in both theoretical and empirical research in the field of digital leadership, deepening the understanding of how digital leadership affects organizational sustainability through the mediating roles of digital capability and organizational culture while revealing the moderating effects of absorptive capacity and innovation atmosphere. The exploration of these multidimensional effects not only bridges the gap between leadership theory and digital transformation but also creates a more nuanced understanding of how various organizational capabilities and cultural factors interact in this context. This study also provides new perspectives and valuable references for future academic research and enterprise practices. Compared to previous studies, the theoretical implications of this study lie in its integration of multiple dimensions, providing a more dynamic and interactive perspective that explains the mechanisms of

digital leadership in different contexts. This not only injects new content into existing theoretical research but also provides more detailed and effective guidance for enterprises in practice. By adopting an integrated view of digital leadership, this study contributes a holistic framework that can better inform scholars and practitioners.

6.2. Practical implications

The findings of this study offer several practical implications for organizations, particularly SMEs, seeking to enhance their sustainability through digital transformation. First, organizations should invest in developing digital leadership competencies by equipping leaders with technical skills and strategic foresight to integrate digital tools, foster innovation, and articulate a clear digital transformation vision. Second, organizations must enhance digital capabilities by providing regular training, investing in digital infrastructure, and encouraging experimentation with new technologies to improve operational efficiency and innovation capacity. Third, cultivating a digital organizational culture is essential, which can be achieved by promoting cross-departmental collaboration, encouraging continuous learning, and recognizing innovative contributions. Fourth, organizations should leverage absorptive capacity and innovation atmosphere by establishing knowledge management systems, fostering external collaborations, and creating an innovation-friendly environment to amplify the impact of digital leadership. Finally, adopting a holistic digital transformation strategy is critical, ensuring initiatives align with strategic goals, engage stakeholders at all levels, and are regularly monitored for continuous improvement. By implementing these recommendations, organizations can maximize the impact of digital leadership, digital capabilities, and digital culture on long-term sustainability.

This study provides a development plan for IT SMEs to formulate systematic digital leadership and cultivate leaders with digital thinking and technical capabilities to better guide digital transformation. In particular, it emphasizes the need for leaders to not only possess strong technical skills but also strategic foresight, equipping them to navigate the complex digital landscape while aligning technological initiatives with organizational goals. Compared to previous studies (Kane et al., 2015; Mithas et al., 2011) that discussed general strategies for digital transformation, this study offers more specific practical guidance. Mithas et al. (2011) emphasized the role of IT capability in organizational performance but did not delve into leader cultivation. Kane et al. (2015) pointed out the necessity of digital transformation but lacked specific leadership development plans. By focusing on leadership as a critical driver of digital transformation, this study bridges the gap, identifying the competencies leaders need and offering detailed pathways for their development. This study fills the research gap by providing detailed leadership training plans and strategies to enhance employees' digital capabilities.

Enterprises should focus on cultivating leaders by implementing systematic training programs to ensure that they have a forward-looking digital vision and innovative capabilities. Such programs must go beyond basic digital literacy, incorporating elements of strategic decision-making, change management, and innovation leadership. These training programs should cover the latest digital technology applications, data analysis skills, and digital strategy formulation, enabling leaders to effectively utilize digital tools and data-driven decision-making to enhance an organization's competitive advantage. Moreover, training programs should emphasize agility, preparing leaders to respond rapidly to technological advancements and market shifts. Previous research (Garud et al., 2011) indicated that leaders' digital thinking is crucial for successful digital transformation but lacks specific training methods and content. This study contributes by outlining a structured approach to leadership development that combines theoretical knowledge with hands-on practice, ensuring that leaders are not only technologically proficient but also strategically oriented. This study provides a comprehensive training program that offers practical guidance; enterprises should continuously invest in digital capability training for all employees. Digital leadership is not confined to the top level of management; thus, fostering a culture where all employees are empowered to think digitally is critical for sustained success. By introducing the latest technological tools and methods and regularly organizing internal training and external learning opportunities, enterprises can improve employees' digital literacy and technical application abilities. Potemkin and Rasskazova (2020) emphasized the importance of employees' digital skills but lacked systematic training strategies.

This study provides practical guidance in this area through specific training plans and implementation methods. This not only enhances employees' work efficiency and innovation capabilities but also improves the overall digital level of the organization, enabling it to better adapt to rapidly changing market environments. By aligning digital skills training with broader organizational objectives, enterprises can create a workforce that is both technically adept and strategically aligned, driving innovation across all levels. Enterprises should strive to create an open and collaborative organizational atmosphere. Enterprises can stimulate employees' innovation potential by establishing cross-departmental collaboration mechanisms and promoting knowledge sharing and collaborative innovation among departments. This cross-functional collaboration is essential for fostering innovation, as it brings together diverse perspectives and skills, enabling the development of more creative solutions to complex problems. Unlike Teece's (2007) dynamic capability theory, this study emphasizes practical collaboration and innovation mechanisms. An open organizational atmosphere encourages employees to propose innovative ideas and drives continuous organizational change and development. In particular, fostering psychological safety within teams can encourage employees to take calculated risks and pursue innovative initiatives without the fear of failure. Enterprises need to establish effective knowledge management systems to facilitate the acquisition of external knowledge and integration of internal knowledge. By building knowledge-sharing platforms and databases, enterprises can ensure efficient knowledge flow within the organization, encouraging continuous learning and self-improvement among employees. Nonaka (Ikujirō), and Takeuchi, H. (1995) emphasized the spiral model of knowledge creation; however, this study further proposes specific knowledge management implementation plans. These include structured systems for capturing tacit knowledge from experienced employees and tools that facilitate the exchange of insights across departments, thus ensuring that valuable knowledge is not shared within individual teams. Supported by a knowledge management system, enterprises can acquire advanced external technologies and market information, adjust their development strategies in a timely manner, and maintain a competitive advantage. A well-implemented knowledge-management system also enhances organizational agility, allowing enterprises to respond more effectively to market disruptions and technological advances.

Therefore, enterprises should focus on fostering an innovative atmosphere. By es-tablishing innovation incentive mechanisms, encouraging employees to actively participate in innovation activities, and providing necessary resources and support, enter-prises can ensure the smooth progress of innovation projects. This could include offering financial rewards, career advancement opportunities, or public recognition for innovative contributions, thereby creating a culture that celebrates and encourages innovation. This study offers specific innovation incentive measures and resource support strategies compared with Damanpour's (2018) innovation management theory. Fostering an innovative atmosphere helps enhance enterprises' adaptability and innovation capacity, enabling them to stand out in fierce market competition and achieve long-term sustainable development. By creating a work environment that values creativity and continuous improvement, enterprises can sustain innovation in the long term, ensuring their ability to thrive in an increasingly digital world.

6.3. Limitations and future research

Despite the contributions of this study, it has several limitations. The data come primarily from IT SMEs in China, which may limit the generalizability of the results owing to geographic and industrial constraints. Future research could broaden the sample scope to include more industries and regions to verify the applicability of the findings. For instance, expanding the sample to large enterprises, other tech or non-tech industries could help compare the differences in digital leadership and sustainability across various types of enterprises. Additionally, this study relies mainly on static data analysis and does not adequately consider the impact of the time dimension on digital leadership and organizational sustainability. Future research could adopt a longitudinal design to track changes in enterprises over different time points, thereby providing a better understanding of the dynamic relationship between digital leadership and organizational sustainability. This approach helps reveal the long-term effects and trends of the digital transformation process.

Furthermore, this study does not fully consider other variables that might influence the relationship between digital leadership and organizational sustainability, such as corporate culture, market environment, and policy regulations. Corporate culture may significantly affect the effectiveness of leadership styles, whereas market conditions and policy regulations may influence digital transformation strategies and sustainability goals. Future research should explore the roles and effects of these factors to provide more comprehensive insights. Additionally, variables such as employees' digital literacy, technological infrastructure, and innovation capacity could act as key mediators or moderators between digital leadership and organizational sustainability. Since the data may have common method bias, the relationship between variables may be overestimated or underestimated. Although we took control measures such as anonymous surveys in the research design, we still cannot completely eliminate this bias. Future research can further reduce the impact of common method bias through multi-source data or time lag design.

To address these limitations, future research should adopt the following measures. First, future research may expand the sample to include companies of various sizes and industries beyond IT SMEs to enhance the generalizability of the results.

Second, future research may employ a longitudinal design to track changes in companies over time, offering a better understanding of the dynamic relationship be-tween digital leadership and organizational sustainability.

Third, this study is an empirical study that focused on a new digital leadership research topic. In addition, it measures organizational sustainability via digital-related variables that are currently receiving much new attention. In addition, we argue that our research also has limitation, which is problem of common method bias. According to the Harman single factor test method was used to conduct principal component analysis on the sample. However, the total factor explanation rate was 70.492 %, and the explanation rate of the first factor was 36.046 %. Although the first factor explained a large proportion of the variance, although it exceeded 50 % of the total factor explanation rate. The result is considered as a limitation of this study. In future studies, more rigorous and appropriate methods should be utilized for research methods. In particular, when measuring items, both supervisors and subordinates should be involved to eliminate the problem common method bias through more accurate measurement.

Finally, future research should consider additional potential moderating and mediating variables, such as corporate culture, market competition intensity, and policy environment, to build a more comprehensive research model. These improvements provide detailed and in-depth insights into how digital leadership affects corporate sustainability under different contexts and conditions. By overcoming these limitations, future research could more comprehensively reveal the mechanisms by which digital leadership affects the sustainability of IT SMEs. This provides a stronger theoretical foundation and practical guidance for the digital transformation and sustainability of enterprises. Fundamentally, it will not only enhance the depth and breadth of theoretical research but also offer valuable references for business management practices, thereby helping enterprises achieve sustainability goals in an increasingly digital business environment.

7. Conclusion

In conclusion, this study provides valuable insights into the mechanisms through which digital leadership influences organizational sustainability. By integrating multiple theoretical perspectives and examining the mediating and moderating roles of digital capabilities, digital organizational culture, absorptive capacity, and innovation atmosphere, the study offers a holistic framework for understanding digital transformation in SMEs. The findings not only contribute to the academic literature on digital leadership and organizational sustainability but also provide practical guidance for organizations seeking to leverage digital transformation for long-term success.

CRediT authorship contribution statement

Zian Cheng: Writing – original draft, Software, Resources, Data curation, Conceptualization. **Xiu Jin:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Formal analysis. **Won Jun Kwak:** Writing – review & editing, Validation, Supervision, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

The authors declare no conflict of interest.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

References

Afsar, B., & Umrani, W. A. (2020). Transformational leadership and innovative work behavior: The role of motivation to learn, task complexity, and innovation climate. *European Journal of Innovation Management, 23*(3), 402–428. https://doi.org/10.1108/EJIM-12-2018-0257

Agostini, L., Galati, F., & Gastaldi, L. (2020). The digitalization of the innovation process: Challenges and opportunities from a management perspective. *European Journal of Innovation Management, 23*(1), 1–12. https://doi.org/10.1108/EJIM-11-2019-0330

AlNuaimi, B. K., Singh, S. K., Ren, S., Budhwar, P., & Vorobyev, D. (2022). Mastering digital transformation: The nexus be-tween leadership agility and digital strategy. *Journal of Business Research, 145*, 636–648. https://doi.org/10.1016/j.jbusres.2022.03.038

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal, 39*(5), 1154–1184. https://doi.org/10.2307/256995

Annarelli, A., Battistella, C., Nonino, F., Parida, V., & Pessot, E. (2021). Literature review on digitalization capabilities: Co-citation analysis of antecedents, conceptualization and consequences. *Technological Forecasting and Social Change, 166*, Article 120635. https://doi.org/10.1016/j.techfore.2021.120635

Anning-Dorson, T. (2021). Organizational culture and leadership as antecedents to organizational flexibility: Implications for SME competitiveness. *Journal of Entrepreneurship in Emerging Economies, 13*(5), 1309–1325. https://doi.org/10.1108/JEEE-08-2020-0288

Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2021). Associations between traditional and digital lead-ership in academic environment: During the COVID-19 pandemic. *Emerging Science Journal, 5*(4), 405–428. https://doi.org/10.28991/esj-2021-01286

Argyris, C., & Schön, D. A. (1997). Organizational learning: A theory of action perspective. Addison-Wesley. *Reis, 77/78*, 345–348. https://doi.org/10.2307/40183951

Artüz, S. D., & Bayraktar, O. (2021a). The effect of relation between digital leadership practice and learning organization on the perception of individual performance. *İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi, 20*(40), 97–120. https://doi.org/10.46928/iticusbe.761479

Artüz, S. D., & Bayraktar, O. (2021b). The effect of relation between digital leadership practice and learning organization on the perception of individual performance. *İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi, 20*(40), 97–120.

Asif, M., Yang, L., & Hashim, M. (2024). The role of digital transformation, corporate culture, and leadership in enhancing corporate sustainable performance in the manufacturing sector of China. *Sustainability, 16*(7), 2651. https://doi.org/10.3390/su16072651

Auernhammer, J., & Hall, H. (2014). Organizational culture in knowledge creation, creativity and innovation: Towards the Freiraum model. *Journal of Information Science, 40*(2), 154–166. https://doi.org/10.1177/0165551513508356

Awedyk, M., & Niezgoda, A. (2018). Resilience planning as an opportunity for future sustainable development in tourism. *Op-erations Research and Decisions, 28*.

Bandura, A. (1986). Social foundations of thought and action. *Englewood Cliffs, NJ, 1986* (23–28), 2.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Basu, R. (2024). The role of digital leadership in fostering organizational commitment. *International Journal of Indian Psy-chology, 12*(3), 2875–2880. https://doi.org/10.25215/1203.278

Baumgartner, R. J., & Rauter, R. (2017). Strategic perspectives of corporate sustainability management to develop a sustainable organization. *Journal of Cleaner Production, 140*, 81–92. https://doi.org/10.1016/j.jclepro.2016.04.146

Beckerman, W. (1995). Economic growth and the environment: Whose growth? Whose environment?. In *Growth, the environ-ment and the distribution of incomes* (pp. 275–290). Edward Elgar Publishing. https://doi.org/10.4337/9781035334865.00025.

Benitez, J., Arenas, A., Castillo, A., & Esteves, J. (2022). Impact of digital leadership capability on innovation performance: The role of platform digitization capability. *Information & Management, 59*(2), Article 103590. https://doi.org/10.1016/j.im.2022.103590

Bierly, P. E., III, Damanpour, F., & Santoro, M. D. (2009). The application of external knowledge: Organizational conditions for exploration and exploitation. *Journal of Management Studies, 46*(3), 481–509. https://doi.org/10.1111/j.1467-6486.2009.00829.x

Borah, P. S., Iqbal, S., & Akhtar, S. (2022). Linking social media usage and SME'S sustainable performance: The role of digital leadership and innovation capabilities. *Technology in Society, 68*, Article 101900. https://doi.org/10.1016/j.techsoc.2022.101900

Broman, G. I., & Robèrt, K. H. (2017). A framework for strategic sustainable development. *Journal of Cleaner Production, 140*, 17–31. https://doi.org/10.1016/j.jclepro.2015.10.121

Brundtland, G. H. (1987). Selected speeches on the commission and its report by HE Mrs. Gro Harlem Brundtland, prime min-ister of Norway and chairman of the world commission on environment and development. WCED archive collection*; v.* 42, doc. 1-36.

Carcary, M., Doherty, E., & Conway, G. (2016, September). A dynamic capability approach to digital transformation: A focus on key foundational themes. In *the European conference on information systems management* (p. 20). Academic conferences in-ternational.

Cetindamar, D., Abedin, B., & Shirahada, K. (2021). The role of employees in digital transformation: A preliminary study on how employees' digital literacy impacts use of digital technologies. *IEEE Transactions on Engineering Management*. https://doi.org/10.1109/TEM.2021.3087724

Chen, C. L., Lin, Y. C., Chen, W. H., Chao, C. F., & Pandia, H. (2021). Role of government to enhance digital transformation in small service business. *Sustainability, 13*(3), 1028. https://doi.org/10.3390/su13031028

Chen, L., Luo, F., Zhu, X., Huang, X., & Liu, Y. (2020). Inclusive leadership promotes challenge-oriented organizational citi-zenship behavior through the mediation of work engagement and moderation of organizational innovative atmosphere. *Frontiers in Psychology, 11*, Article 560594. https://doi.org/10.3389/fpsyg.2020.560594

Chen, Y. S., Chang, C. H., & Lin, Y. H. (2014). Green transformational leadership and green performance: The mediation effects of green mindfulness and green self-efficacy. *Sustainability, 6*(10), 6604–6621. https://doi.org/10.3390/su6106604

Chirumalla, K. (2021). Building digitally-enabled process innovation in the process industries: A dynamic capabilities approach. *Technovation, 105*, Article 102256. https://doi.org/10.1016/j.technovation.2021.102256

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152. https://doi.org/10.2307/2393553

Cortellazzo, L., Bruni, E., & Zampieri, R. (2019). The role of leadership in a digitalized world: A review. *Frontiers in Psychol-ogy, 10*, Article 456340. https://doi.org/10.3389/fpsyg.2019.01938

Damanpour, F. (2018). Organizational innovation: A meta-analysis of effects of determinants and moderators. In *Organizational innovation* (pp. 127–162). Routledge.

de Araujo, L. M., Priadana, S., Paramarta, V., & Sunarsi, D. (2021). Digital leadership in business organizations. *International Journal of Educational Administration, Management, and Leadership, 45-56*. https://doi.org/10.51629/ijeamal.v2i1.18

De Waal, A., & Heijtel, I. (2016). Searching for effective change interventions for the transformation into a high performance organization. *Management Research Review, 39*(9), 1080–1104. https://doi.org/10.1108/MRR-04-2015-0094

Dragičević, Z., & Bošnjak, S. (2019). Digital transformation in the mining enterprise: The empirical study. *Mining and Metal-lurgy Engineering Bor, 1-2*, 73–90. https://doi.org/10.5937/mmeb1902073D

Duerr, S., Holotiuk, F., Wagner, H. T., Beimborn, D., & Weitzel, T. (2018). What is digital organizational culture? *Insights from exploratory case studies.*. https://doi.org/10.24251/HICSS.2018.640

Eberl, J. K., & Drews, P. (2021a). Digital Leadership–Mountain or molehill? A literature review. Innovation through information systems: Volume III: A collection of latest research on management issues, 223-237. https://doi.org/10.1007/978-3-030-86800-0_17.

Eberl, J. K., & Drews, P. (2021b). Digital Leadership–Mountain or molehill? A literature review. In Ahlemann, F., Schütte, R., & Stieglitz, S. (Eds), innovation through information systems. Wi 2021. Lecture notes in information systems and organization (48th ed., pp. 223-237).

Ekvall, G. (1996). Organizational climate for creativity and innovation. *European journal of work and organizational psycholo-gy, 5*(1), 105–123. https://doi.org/10.1080/13594329608414845

El Sawy, O. A., Kræmmergaard, P., Amsinck, H., & Vinther, A. L. (2020). How LEGO built the foundations and enterprise ca-pabilities for digital leadership. In *Strategic information management* (pp. 174–201). Routledge. https://doi.org/10.4324/9780429286797-8.

Erhan, T., Uzunbacak, H. H., & Aydin, E. (2022). From conventional to digital leadership: Exploring digitalization of leadership and innovative work behavior. *Management Research Review, 45*(11), 1524–1543. https://doi.org/10.1108/MRR-05-2021-0338

Erkutlu, H. (2012). The impact of organizational culture on the relationship between shared leadership and team proactivity. *Team Performance Management: An International Journal, 18*(1/2), 102–119. https://doi.org/10.1108/13527591211207734

Fachrurazi, F. (2023). The role of leadership and collaboration in enhancing the digital skills of young entrepreneurs in the era of the Covid-19 pandemic. *GEMILANG: Jurnal Manajemen dan Akuntansi, 3*(2), 15–29. https://doi.org/10.56910/gemilang.v3i2.420

Fang, L. (2023). Examining the effects of digital leadership strategies on enhancing organizational innovation Perfor-mance. *Journal of Logistics, Informatics and Service Science, 10*(4), 318–335. https://doi.org/10.33168/JLISS.2023.0422

Ferreira, J., Coelho, A., & Moutinho, L. (2020). Dynamic capabilities, creativity and innovation capability and their impact on competitive advantage and firm performance: The moderating role of entrepreneurial orientation. *Technovation, 92*, Article 102061. https://doi.org/10.1016/j.technovation.2018.11.004

Fischer, B. D., & Montalbano, N. (2014). Continuous innovation from all employees: An underutilized font of organizational improvement. *American Journal of Management, 14*(3), 40.

FitzGerald, M., Kruschwitz, N., Bonnet, D., & Welch, M. (2014). Embracing digital technology: A new strategic imperative. *MIT Sloan Management Review, 55*(2), 1.

Flor, M. L., Cooper, S. Y., & Oltra, M. J. (2018). External knowledge search, absorptive capacity and radical innovation in high-technology firms. *European Management Journal, 36*(2), 183–194. https://doi.org/10.1016/j.emj.2017.08.003

Flyverbom, M., Deibert, R., & Matten, D. (2019). The governance of digital technology, big data, and the internet: New roles and responsibilities for business. *Business & Society, 58*(1), 3–19. https://doi.org/10.1177/0007650317727540

García-Sánchez, E., García-Morales, V. J., & Martín-Rojas, R. (2018). Influence of technological assets on organizational per-formance through absorptive capacity, organizational innovation and internal labour flexibility. *Sustainability, 10*(3), 770. https://doi.org/10.3390/su10030770

Garud, R., Gehman, J., & Kumaraswamy, A. (2011). Complexity arrangements for sustained innovation: Lessons from 3M Cor-poration. *Organization Studies, 32*(6), 737–767. https://doi.org/10.1177/0170840611410810

Gimpel, H., Hosseini, S., Huber, R., Probst, L., Röglinger, M., & Faisst, U. (2018). Structuring digital transformation: A frame-work of action fields and its application at ZEISS. *Journal of Information Technology Theory and Application (JITTA), 19*(1), 3.

GRANT, R. M.. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge Integra-tion. *Organization Science, 7*, 375–387. https://doi.org/10.1287/orsc.7.4.375

Han, G. R., & Lee, J. E. (2024). The moderating effect of ESG level in the relationship between digital transformation capability and financial performance: Evidence from foreign subsidiaries of Korean firms. *Sustainability, 16*(9), 3764. https://doi.org/10.3390/su16093764

Heredia, J., Castillo-Vergara, M., Geldes, C., Gamarra, F. M. C., Flores, A., & Heredia, W. (2022). How do digital capabilities affect firm performance? The mediating role of technological capabilities in the "new normal". *Journal of Innovation & Knowledge, 7*(2), Article 100171. https://doi.org/10.1016/j.jik.2022.100171

Hoang, D., Minh, T., Toan, N., & Mai, V. (2024). Digital capabilities and innovation capabilities in Vietnamese SMEs. *International Journal of Data and Network Science, 8*(2), 1073–1084. https://doi.org/10.5267/j.ijdns.2023.12.001

Huang, J., Chen, Y., & Zhai, H. M. (2011). The influence of corporate environmental ethics on sustainable development perfor-mance: The mediation role of proactive environmental management. *Econ Manag J, 104*(3), 361–370. https://doi.org/10.1007/s10551-011-0914-x

Hussain, F. (2024). The impact of technology on modern business management. *Journal for Business Research Review, 2*(1), 72–84.

Hussein, H., Albadry, O. M., Mathew, V., Al-Romeedy, B. S., Alsetoohy, O., Abou Kamar, M., & Khairy, H. A. (2024). Digital leadership and sustainable competitive advantage: Leveraging green absorptive capability and eco-innovation in tourism and hospitality businesses. *Sustainability, 16*(13), 5371. https://doi.org/10.3390/su16135371

Işık, M. (2024). The mediating role of firm innovatıon performance in the impact of digital leadership on employee performance: Evidence from startups. *Kahramanmaraş Sütçü İmam Üniversitesi Sosyal Bilimler Dergisi, 21*(3), 1534–1549.
Jansen, J. J. P., van den Bosch, F. A. J., & Volberda, H. W. (2005). Managing potential and realized absorptive capacity: How do organizational antecedents matter? *Academy of Management Journal, 48*(6), 999–1015. https://doi.org/10.5465/amj.2005.19573106
Kane, G. C., Palmer, D., Phillips, A. N., & Kiron, D. (2015). Is your business ready for a digital future? *MIT Sloan Management Review, 56*(4), *37*.
Karafakioglu, E., & Afacan Findikli, M. (2024). The mediating role of work engagement in the relationship between digital leadership and innovative behavior and organizational agility. *International Journal of Organizational Leadership, 13*(1), 1–21.
Karakose, T., & Tülübaş, T. (2023). Digital leadership and sustainable school improvement—A conceptual analysis and impli-cations for future research. *Educational Process: International Journal, 12*(1), 7–18. https://doi.org/10.22521/edupij.2023.121.1
Khalil, S. I., Farhan, O. M., & Hamad, H. A. (2022). The role of digital leadership in achieving organizational excellence an ap-plied study at the university of Tikrit. *World Economics and Finance Bulletin, 12*, 85–94.
Khani, N., Nor, K. M., Hakimpoor, H., Bahrami, M., & Salavati, S. (2011). IS/IT capability and strategic information system planning (SISP) success. *International Journal of Managing Information Technology (IJMIT), 3*. https://doi.org/10.5121/ijmit.2011.3303
Khawaja, N., & Hamdan, A. (2023). The moderation effect of digital leadership on the relationship between artificial Intel-ligence and accounting profession: A review. *Emerging Trends and Innovation in Business and Finance, 803-818*. https://doi.org/10.1007/978-981-99-6101-6_60
Khin, S., & Ho, T. C. (2019). Digital technology, digital capability and organizational performance: A mediating role of digital innovation. *International Journal of Innovation Science, 11*(2), 177–195. https://doi.org/10.1108/IJIS-08-2018-0083
Kiron, D., Kane, G. C., Palmer, D., Phillips, A. N., & Buckley, N. (2016). Aligning the organization for its digital future. *MIT Sloan Management Review, 58*(1).
Kıyak, A., & Bozkurt, G. (2020). A general overview to digital leadership concept. *Uluslararası Sosyal ve Ekonomik Çalışmalar Dergisi, 1*(1), 84–95. https://dergipark.org.tr/tr/pub/gsijses/issue/82367/1412761.
Klein, V. B., & Todesco, J. L. (2021). COVID-19 crisis and SMEs responses: The role of digital transformation. *Knowledge and Process Management, 28*(2), 117–133. https://doi.org/10.1002/kpm.1660
Koo Moon, H., & Kwon Choi, B. (2014). How an organization's ethical climate contributes to customer satisfaction and finan-cial performance: Perceived organizational innovation perspective. *European Journal of Innovation Management, 17*(1), 85–106. https://doi.org/10.1108/EJIM-03-2013-0020
Kostopoulos, K., Papalexandris, A., Papachroni, M., & Ioannou, G. (2011). Absorptive capacity, innovation, and financial per-formance. *Journal of Business Research, 64*(12), 1335–1343. https://doi.org/10.1016/j.jbusres.2010.12.005
Leal-Rodríguez, A. L., Sanchís-Pedregosa, C., Moreno-Moreno, A. M., & Leal-Millán, A. G. (2023). Digitalization beyond technology: Proposing an explanatory and predictive model for digital culture in organizations. *Journal of Innovation & Knowledge, 8*(3), Article 100409. https://doi.org/10.1016/j.jik.2023.100409
Lebrata, L., Isramilda, I., Rumengan, A. E., & Satriawan, B. (2024). The digital leadership, teamwork, work environment, competencies and employee performance: Assessing the superior Facility in Manufacturing Context. *Jurnal Minds: Manajemen Ide dan Inspirasi, 11*(2), 237–258.
Li, Z., Yang, C., Yang, Z., & Zhao, Y. (2024). The impact of middle managers' digital leadership on employee work engagement. *Frontiers in Psychology, 15*, Article 1368442.
Liao, J., Kickul, J. R., & Ma, H. (2009). Organizational dynamic capability and innovation: An empirical examination of inter-net firms. *Journal of Small Business Management, 47*(3), 263–286. https://doi.org/10.1111/j.1540-627X.2009.00271.x
Lin, H. E., & McDonough, E. F., III (2011). Investigating the role of leadership and organizational culture in fostering innovation ambidexterity. *IEEE Transactions on Engineering Management, 58*(3), 497–509. https://doi.org/10.1109/TEM.2010.2092781
Liu, W., Hu, M., & Chen, W. (2022). Identifying the service capability of long-term care facilities in China: An e-Delphi study. *Frontiers in Public Health, 10*, Article 884514. https://doi.org/10.3389/fpubh.2022.884514
Lloréns Montes, F. J., Ruiz Moreno, A., Fernández, M. M., & L.. (2004). Assessing the organizational climate and con-tractual relationship for perceptions of support for innovation. *International Journal of Manpower, 25*(2), 167–180. https://doi.org/10.1108/01437720410535972
Malakyan, G. P. (2019). Digital leader-followership for the digital age: A north American perspective. In *In digital leadership-A new leadership style for the 21st century* (pp. 1–24). https://doi.org/10.5772/intechopen.89820
Martín-de Castro, G. (2015). Knowledge management and innovation in knowledge-based and high-tech industrial markets: The role of openness and absorptive capacity. *Industrial Marketing Management, 47*, 143–146. https://doi.org/10.1016/j.indmarman.2015.02.032
Martínez-Caro, E., Cegarra-Navarro, J. G., & Alfonso-Ruiz, F. J. (2020). Digital technologies and firm performance: The role of digital organisational culture. *Technological Forecasting and Social Change, 154*, Article 119962. https://doi.org/10.1016/j.techfore.2020.119962
Matyushok, V., Vera Krasavina, V., Berezin, A., & Sendra García, J. (2021). The global economy in technological transfor-mation conditions: A review of modern trends. *Economic Research-Ekonomska Istraživanja, 34*(1), 1471–1497. https://doi.org/10.1080/1331677X.2020.1844030
McCarthy, C. (2024). *Future-fit leadership: A guidebook to thrive in today's dynamic*. Digital Environment: Austin Ma-cauley Publishers.
Mithas, S., Ramasubbu, N., & Sambamurthy, V. (2011). How information management capability influences firm performance. *MIS Quarterly, 237-256*. https://doi.org/10.2307/23043496
Mollah, M. A., Choi, J.-H., Hwang, S.-J., & Shin, J.-K. (2023). Exploring a pathway to sustainable organizational performance of South Korea in the digital age: The effect of digital leadership on IT capabilities and organizational learning. *Sustainability, 15*(10), 1–18. https://doi.org/10.3390/su15107875
Mollah, M. A., Ibrahim, Masud, A. A., & Chowdhury, M. S. (2024). How does digital leadership boost competitive performance? The role of digital culture, affective commitment, and strategic agility. *Heliyon, 10*(23), Article 1–14. https://doi.org/10.1016/j.heliyon.2024.e40839
Mollah, M. A., Amin, M. B., Debnath, G. C., Hosain, M. S., Rahaman, M. A., & Abdullah, M. (2024). Nexus among digital leadership, digital transformation, and digital innovation for sustainable financial performance: Revealing the influence of environmental dynamism. *Sustainability, 16*(18), 8023. https://doi.org/10.3390/su16188023
Moore, S. B., & Manring, S. L. (2009). Strategy development in small and medium sized enterprises for sustainability and in-creased value creation. *Journal of Cleaner Production, 17*(2), 276–282. https://doi.org/10.1016/j.jclepro.2008.06.004
Muniroh, M., Hamidah, H., & Abdullah, T. (2022). Managerial implications on the relation of digital leadership, digital culture, organizational learning, and innovation of the employee performance (case study of PT. Telkom digital and next business de-partment). *Management and Entrepreneurship: Trends of Development, 1*(19), 58–75. https://doi.org/10.26661/2522-1566/2022-1/19-05
Mwita, M. M., & Joanthan, J. (2019). Digital leadership for digital transformation. *Electronic Scientific Journal, 10*(4), 2082–2677.
Niu, S., Park, B. I., & Jung, J. S. (2022). The effects of digital leadership and ESG management on organizational innovation and sustainability. *Sustainability, 14*(23), Article 15639. https://doi.org/10.3390/su142315639
Noblet, J. P., Simon, E., & Parent, R. (2011). Absorptive capacity: A proposed operationalization. *Knowledge Management Re-search & Practice, 9*(4), 367–377. https://doi.org/10.1057/kmrp.2011.26
Nonaka (Ikujirō), & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. Oxford university press. https://doi.org/10.1093/oso/9780195092691.001.0001.
Nylén, D. (2015). *Digital innovation and changing identities: Investigating organizational implications of digitalization* (Doc-toral dissertation,. Umeå Universitet.
Oberer, B., & Erkollar, A. (2018). Leadership 4.0: Digital leaders in the age of industry 4.0. *International journal of Organiza-tional. Leadership, 7*(4), 404–412. https://doi.org/10.33844/ijol.2018.60332
Orieno, O. H., Udeh, C. A., Oriekhoe, O. I., Odonkor, B., & Ndubuisi, N. L. (2024). Innovative management strategies in con-temporary organizations: A review: Analyzing the evolution and impact of modern management practices, with an emphasis on leadership, organizational culture, and change management. *International Journal of Management & Entrepreneurship Re-search, 6*(1), 167–190. https://doi.org/10.51594/ijmer.v6i1.727
Pagani, M., & Pardo, C. (2017). The impact of digital technology on relationships in a business network. *Industrial Marketing Management, 67*, 185–192. https://doi.org/10.1016/j.indmarman.2017.08.009
Paiola, M., & Gebauer, H. (2020). Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. *Industrial Marketing Management, 89*, 245–264. https://doi.org/10.1016/j.indmarman.2020.03.009
Parris, T. M., & Kates, R. W. (2003). Characterizing and measuring sustainable development. *Annual Review of Environment and Resources, 28*(1), 559–586. https://doi.org/10.1146/annurev.energy.28.050302.105551
Pavlou, P. A., & El Sawy, O. A. (2006). From IT leveraging competence to competitive advantage in turbulent environments: The case of new product development. *Information Systems Research, 17*(3), 198–227. https://doi.org/10.1287/isre.1060.0094
Potemkin, V., & Rasskazova, O. (2020, September). Digital competence of employees and the value of human resources in the development strategy of enterprises. In IOP conference series: Materials science and engineering (Vol. Vol. 940, No. 1, p. 012098). IOP Publishing. https://doi.org/10.1088/1757-899X/940/1/012098.
Presson, P. K., Clark, S. C., & Benassi, V. A. (1997). The Levenson locus of control scales: Confirmatory factor analyses and evaluation. *Social Behavior and Personality: An International Journal, 25*(1), 93–103. https://doi.org/10.2224/sbp.1997.25.1.93
Rafique, M., Hameed, S., & Agha, M. H. (2018). Impact of knowledge sharing, learning adaptability, and organizational com-mitment on absorptive capacity in pharmaceutical firms based in Pakistan. *Journal of Knowledge Management, 22*(1), 44–56. https://doi.org/10.1108/JKM-04-2017-0132
Ravasi, D., & Schultz, M. (2006). Responding to organizational identity threats: Exploring the role of organizational culture. *Academy of Management Journal, 49*(3), 433–458. https://doi.org/10.5465/amj.2006.21794663
Salamzadeh, Y., Farzad, F. S., Salamzadeh, A., & Palalić, R. (2021). Digital leadership and organizational capabilities in manu-facturing industry: A study in Malaysian context. *Periodicals of Engineering and Natural Sciences (PEN), 10*(1), 195–211. https://doi.org/10.21533/pen.v10i1.2237
Schiuma, G., Schettini, E., Santarsiero, F., & Carlucci, D. (2022). The transformative leadership compass: Six competencies for digital transformation entrepreneurship. *International Journal of Entrepreneurial Behavior & Research, 28*(5), 1273–1291. https://doi.org/10.1108/IJEBR-01-2021-0087
Schwarzmüller, T., Brosi, P., Duman, D., & Welpe, I. M. (2018). How does the digital transformation affect organizations? Key themes of change in work design and

leadership. *Management Revue, 29*(2), 114–138. https://doi.org/10.5771/0935-9915-2018-2-114
Sheninger, E. (2014a). Digital leadership: Changing paradigms for changing times. *Corwin Press.*. https://doi.org/10.21125/inted.2019.2528
Sheninger, E. (2014b). *Digital leadership: Changing paradigms for changing times*. Corwin Press.
Shin, J., Mollah, A., & Choi, J. (2023). Sustainability and organizational performance in South Korea: The effect of digital leadership on digital culture and employees' digital capabilities. Sustainability, 15, 1–15. doi:doi.org/https://doi.org/10.3390/su15032027.
Strøm-Andersen, N. (2020). Innovation and by-product valorization: A comparative analysis of the absorptive capacity of food processing firms. *Journal of Cleaner Production, 253*, Article 119943. https://doi.org/10.1016/j.jclepro.2019.119943
Ta, V. A., & Lin, C. Y. (2023). Exploring the determinants of digital transformation adoption for SMEs in an emerging econo-my. *Sustainability, 15*(9), 7093. https://doi.org/10.3390/su15097093
Tang, S., Liao, S., Wang, L., Chen, W., & Guo, Z. (2022). A configurational analysis of small and medium-sized enterprises' radical innovations: The perspective of dynamic capabilities. *Frontiers in Psychology, 12*, Article 784738. https://doi.org/10.3389/fpsyg.2021.784738
Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise perfor-mance. *Strategic Management Journal, 28*(13), 1319–1350. https://doi.org/10.1002/smj.640
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z
Topcuoglu, E., Oktaysoy, O., Uygungil-Erdogan, S., Kaygin, E., & Karafakioglu, E. (2023). The mediating role of job security in the impact of digital leadership on job satisfaction and life satisfaction. *Marketing and Management of Innovations, 1*, 122–132.
Trushkina, N., Abazov, R., Rynkevych, N., & Bakhautdinova, G. (2020). Digital transformation of organizational culture under conditions of the information economy. *Virtual Economics, 3*(1), 7–38. https://doi.org/10.34021/ve.2020.03.01(1)
Tülübaş, T. K. T. (2023). *Digital leadership and sustainable school improvement—A conceptual analysis and implications for future research*.
Türk, A. (2023). Digital leadership role in developing business strategy suitable for digital transformation. *Frontiers in Psy-chology, 13*, Article 1066180. https://doi.org/10.3389/fpsyg.2022.1066180
Van Deursen, A. J., & Van Dijk, J. A. (2014). *Digital skills: Unlocking the information society*. Springer.
Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & De Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior, 72*, 577–588. https://doi.org/10.1016/j.chb.2017.03.010
Vaska, S., Massaro, M., Bagarotto, E. M., & Dal Mas, F. (2021). The digital transformation of business model innovation: A structured literature review. *Frontiers in Psychology, 11*, Article 539363. https://doi.org/10.3389/fpsyg.2020.539363
Velyako, V., & Musa, S. (2024). The relationship between digital organizational culture, digital capability, digital innovation, organizational resilience, and competitive advantage. *Journal of the Knowledge Economy, 15*(3), 11956–11975. https://doi.org/10.1007/s13132-023-01575-4
Wang, T., Lin, X., & Sheng, F. (2022). Digital leadership and exploratory innovation: From the dual perspectives of strategic orientation and organizational culture. *Frontiers in Psychology, 13*, Article 902693. https://doi.org/10.3389/fpsyg.2022.902693
Watson, R. T., Boudreau, M. C., & Chen, A. J. (2010). Information systems and environmentally sustainable development: En-ergy informatics and new directions for the IS community. *MIS Quarterly, 23-38*. https://doi.org/10.2307/20721413
West, M. A. (2003). Innovation implementation in work teams. *Group Creativity: Innovation Through Collaboration, 245-276*. https://doi.org/10.1093/acprof:oso/9780195147308.003.0012
Xie, X., Wu, Y., & Zeng, S. (2016). A theory of multi-dimensional organizational innovation cultures and innovation perfor-mance in transitional economies: The role of team cohesion. *Chinese Management Studies, 10*(3), 458–479. https://doi.org/10.1108/CMS-01-2016-0023
Xie, X., Zou, H., & Qi, G. (2018). Knowledge absorptive capacity and innovation performance in high-tech companies: A Mul-ti-mediating analysis. *Journal of Business Research, 88*, 289–297. https://doi.org/10.1016/j.jbusres.2018.01.019
Yao, Q., Tang, H., Liu, Y., & Boadu, F. (2024). The penetration effect of digital leadership on digital transformation: The role of digital strategy consensus and diversity types. *Journal of Enterprise Information Management, 37*(3), 903–927.
Ye, P., Liu, L., & Tan, J. (2022). Creative leadership, innovation climate and innovation behaviour: The moderating role of knowledge sharing in management. *European Journal of Innovation Management, 25*(4), 1092–1114. https://doi.org/10.1108/EJIM-05-2020-0199
Yeh-Yun Lin, C., & Liu, F. C. (2012). A cross-level analysis of organizational creativity climate and perceived innovation: The mediating effect of work motivation. *European Journal of Innovation Management, 15*(1), 55–76. https://doi.org/10.1108/14601061211192834
Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203. https://doi.org/10.2307/4134351
Zhang, F., Yang, B., & Zhu, L. (2023). Digital technology usage, strategic flexibility, and business model innovation in tradi-tional manufacturing firms: The moderating role of the institutional environment. *Technological Forecasting and Social Change, 194*, Article 122726. https://doi.org/10.1016/j.techfore.2023.122726
Zoppelletto, A., Orlandi, L. B., Zardini, A., Rossignoli, C., & Kraus, S. (2023). Organizational roles in the context of digital transformation: A micro-level perspective. *Journal of Business Research, 157*, Article 113563. https://doi.org/10.1016/j.jbusres.2022.113563

Further Reading

Imran, F., Shahzad, K., Butt, A., & Kantola, J. (2021). Digital transformation of industrial organizations: Toward an integrated framework. *Journal of Change Management, 21*(4), 451–479. https://doi.org/10.1080/14697017.2021.1929406
Quinn, R. E., & Rohrbaugh, J. (1983). A spatial model of effectiveness criteria: Towards a competing values approach to organ-izational analysis. *Management Science, 29*(3), 363–377. https://doi.org/10.1287/mnsc.29.3.363
Xu, Z., Wang, H., & Suntrayuth, S. (2022). Organizational climate, innovation orientation, and innovative work behavior: The mediating role of psychological safety and intrinsic motivation. *Discrete Dynamics in Nature and Society, 2022*(1), Article 9067136. https://doi.org/10.1155/2022/9067136