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# Effects of digital orientation on organizational resilience: a dynamic capabilities perspective

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## Abstract

**Purpose** - This study aims to investigate the impact of digital orientation (*DO*) on organizational resilience (*OR*) and explore the contingency effects of human resource slack and nature of enterprise ownership.

**Design/methodology/approach** - The model hypotheses were tested using fixed effects regression on panel data collected from Chinese A-share listed manufacturing firms spanning from 2007 to 2020.

**Findings** - *DO* has a positive effect on *OR*. Human resource slack positively moderates the relationship between *DO* and *OR*. Additionally, *DO* enhances *OR* more effectively in non-state-owned firms than in state-owned firms.

**Research limitations/implications** - This study relies on data from a single industry from a single country.

**Practical implications** - The study supports that firms facing uncertainty, risk and pressure should promptly develop their *DO* strategy. Firms can derive greater resilience from implementing a *DO* strategy when they have a high-level human resource pool. State-owned enterprises will benefit from a *DO* strategy if they make some adaptive changes in leadership, structure, culture and mindset aspects.

**Originality/value** - This study is the first to examine the relationship between *DO* and *OR*, contributing to the existing literature on digital transformation and organizational resilience. It offers valuable insights for practitioners and policymakers seeking to adapt their organizations for the digital era and foster predictive, defensive and growth responses strategies in a dynamic business environment.

**Keywords:** Digitalization, digital orientation, organizational resilience, human resource slack, nature of enterprise ownership, dynamic capabilities theory

## 1. Quick value overview

**Interesting because:** Manufacturing firms must be resilient to deal with a volatile, uncertain, complex and ambiguous environment. Organizational resilience is an organization's ability to absorb stress, respond positively, maintain stability, and even thrive when subjected to internal and external shocks or disruptions. Studies on organizational resilience have predominantly focused on internal factors within companies and the traits and characteristics of executives. With the widespread use of digital technologies research has started to explore the external effect of specific technologies on organizational resilience. However, the relationship between digital orientation and organizational resilience has not been studied and this paper addresses this gap in the literature.

**Theoretical value:** The study shows that digital orientation helps firms mitigate fluctuations in financial performance. Two factors moderate this relationship: slack in human resources and the nature of the enterprise ownership. The higher the slack in human resources the more impact the digital orientation has on financial performance. While nonstate-owned enterprises are better able to increase their resilience by implementing digital orientation strategy than state-owned enterprises.

**Practical value:** Firms that face uncertainty, risk, and pressure should craft a digital orientation strategy. Such a strategy cultivates the capabilities to sense, absorb, and integrate, which is vital for anticipating and responding to adversity. Firms should also boast a high-level human resource pool because this empowers these firms to amplify dynamic capabilities, thereby fortifying their resilience. The implementation of digital orientation in state-owned enterprises can be facilitated by building a digital strategy leadership team, developing a digital organization structure and standardization system, and cultivating digital culture and digital mindset. Furthermore, policymakers should reduce their intervention in enterprises, raise managers' awareness of risk-taking, and foster entrepreneurship.

## 2. Introduction

The present corporate environment is becoming increasingly volatile, uncertain, complex, and ambiguous (Bennett and Lemoine, 2014). Issues such as production and technical reliability (Linnenluecke, 2017), corporate scandals (Kahn et al., 2018), and social media chaos (Williams et al., 2017) occur from time to time. Global events, such as pandemics and regional wars, also threaten corporate survival and development (Hamidu et al., 2023). These issues and events adversely affect business operations, particularly in manufacturing, because manufacturing firms derive value mainly from improved products and sales, have more stakeholders, and face more environmental threats (Hamidu et al., 2023). They must be resilient to effectively anticipate, avoid, and respond to risks and even surpass themselves (Kahn et al., 2018; Ortiz-de-Mandojana and Bansal, 2016). Organizational resilience (*OR*) refers to an organization's ability to absorb stress, respond positively, maintain stability, and even thrive when subjected to internal and external shocks or disruptions (Duchek, 2020; Hillmann and Guenther, 2020). Enhancing *OR* will be a priority for organizational survival and growth (Hillmann and Guenther, 2020).

Previous studies on organizational resilience have predominantly focused on internal factors within companies such as organizational resources, structure, and capabilities (Iftikhar et al., 2021;

**Linnenluecke, 2017; Williams and Shepherd, 2016**) and the traits and characteristics of executives, such as their individual cognition, emotion, behaviors, and social relationships (**Ortiz-de-Mandojana and Bansal, 2016; Williams et al., 2017**). Nevertheless, scholars call for more research on the processes and mechanisms of *OR* formation (**Iftikhar et al., 2021; Linnenluecke, 2017**). With the widespread use of digital technologies, the role of digital factors in *OR* cannot be overlooked. Several studies mainly explored the effect of specific digital technologies or digital capabilities on *OR* in the context of the Covid-19 crisis, often focusing on one aspect, such as defensive responses (**Ciasullo et al., 2022; Isensee et al., 2023; Robertson et al., 2022**). One critical knowledge gap concerns the role that digital orientation (*DO*) strategy plays in an organization's predictive, defensive, and growth response to general adversities, and when this role may differ.

Unlike general digital factors, *DO* refers to a company's strategic positioning in harnessing the opportunities presented by digital technologies, which includes support for generating and leveraging market insights, proactive innovation, and openness to new ideas and behaviors (**Kindermann et al., 2021; Quinton et al., 2018**). *DO* steers the awareness, adoption, and application of digital technologies in a firm's business processes (**Kindermann et al., 2021**). It determines which digital activities the firm will undertake, how individual digital activities will be configured, and how these activities interrelate with each other, thus profoundly influencing the firm's digital capabilities (**Proksch et al., 2021**). Nevertheless, the relationship between *DO* and *OR* remains unexplored. Therefore, our research questions are:

*RQ1.* What is the impact of *DO* on *OR*?

*RQ2.* What are the moderating effects on the relationship between *DO* and *OR*?

To answer above questions, this study develops a conceptual model based on dynamic capabilities (*DC*) theory to explore how a firm's *DO* impacts *OR*. *DC* theory posits that firms navigating dynamic and evolving markets must develop their *DC* to sense opportunities and threats, seize opportunities, and reconfigure assets and capabilities to achieve sustained competitive advantage (**Teece et al., 1997**). As adopting digital technologies can enhance digital dynamic capability (**Shen et al., 2021**), in our study, *DO* shapes *OR* by strengthening organizational dynamic capabilities. In addition, to validate the action mechanism between *DO* and *OR*, we have incorporated potential moderating factors. As **Linnenluecke (2017)** suggested, specific structural and organizing principles (e.g. redundancy, flexibility and/or buffer capacity) and the firm's nature need to be considered when establishing *OR*. Superior organizational performance depends on the alignment between strategic orientation and resources (**Slater et al., 2006**). **Mahmood and Mubarik (2020)** demonstrated the positive role of human capital in digital transformation change. With these insights in mind, we have identified two critical moderators: human resource (*HR*) slack and the nature of enterprise ownership (*NEO*).

This study aims to explore the impact of *DO* on *OR* and the contingent conditions between them. We employed text analytic techniques to quantify the keywords related to digital orientation in the "Company Profile" and "Management Discussion and Analysis" sections of the annual reports. We then matched this data with pertinent information from Chinese A-share listed manufacturing firms spanning 2007 to 2020. Subsequently, we tested our hypotheses with the fixed effects regression method.

Next, we will introduce the literature review and theoretical background and framework, hypotheses, methodology, results, and finally, the discussion of this paper.

### **3. Literature review and theoretical Framework**

#### *3.1 Organizational resilience*

Organizational resilience is a vital trait for organizations to counter crises or adversities, showcasing their ability to withstand challenges and navigate uncertainty (**Williams et al., 2017**). Existing literature mainly focused on three aspects of *OR*: predictive response, defensive response, and growth response. Predictive response involves identifying potential risks and taking proactive measures to avoid escalating crises (**Ortiz-de-Mandojana and Bansal, 2016**). Defensive response pertains to restoring normalcy post adverse events or disruptions (**Martín-Rojas et al., 2023; Salanova et al., 2012**). Growth response refers to learning from adversity and making positive adjustments to elevate the organization beyond its initial state (**Demmer et al., 2011**).

Recent studies suggest that *OR* encompasses multiple composite attributes, such as anticipation, adjustment, adaptation, thriving, and configuration, collectively enabling effective responses to adverse event shocks (**Demmer et al., 2011; Duchek, 2020; Hillmann and Guenther, 2020**). Therefore, drawing from extant literature (**Duchek, 2020; Kahn et al., 2018; Ortiz-de-Mandojana and Bansal, 2016**), we define *OR* as an organization's ability to anticipate, avoid, and carry shocks, as well as maintain, adapt, and improve operations amidst adversity. From a process perspective, resilient organizations exhibit anticipation, response, adaptation, and growth prior to, during, and following adversity, respectively (**Duchek, 2020; Williams et al., 2017**).

Within the relevant literature, most existing studies have primarily explored the impact of specific digital technologies or capabilities on *OR*, particularly in the context of the Covid-19 crisis. These studies often concentrate on one aspect, such as defensive responses (**Ciasullo et al., 2022; Isensee et al., 2023; Robertson et al., 2022**). However, few studies have explored the effects of digital or strategic factors on *OR* (see **Table 1**). These studies have neglected the contingency conditions between digital factors and *OR*. Furthermore, firms do not naturally possess resilience, but rather shaped by adversity during the process of growth and development. Therefore, it is more suitable to measure organizational resilience using multiyear observation data. Given these research gaps, this study aims to investigate the influence of digital orientation on generalizable *OR* while considering key contingency factors through longitudinal panel data.

#### *3.2 Digital orientation*

Strategic orientation refers to a firm's overall direction in conducting its business, guiding its activities towards achieving sustained superior performance (**Gatignon and Xuereb, 1997**). It aims to create an internal environment that encourages, supports, and implements the desired behaviors and actions (**Ardito et al., 2021**). Amid the rising digital economy, digital technologies are increasingly utilized to improve business operations or transform business models (**Vial, 2019**). These technologies are regarded as valuable strategic assets for achieving organizational differentiation (**Ciasullo et al., 2022**). Hence, the argument arises that digitalization should hold a strategic status within organizations, giving rise to the concept of digital orientation (**Quinton et al., 2018**).

Regarding the *DO* concept, current research primarily emphasizes that firms actively apply digital technologies to enhance collaboration efficiency, service levels, and competitive advantage (**Garcia de Lomana et al., 2019; Khin and Ho, 2019; Kindermann et al., 2021**). However, inconsistencies persist in defining *DO*. Furthermore, unclear terminology (challenge 1), conflation between the concept and its impacts (challenge 2), and lack of parsimony (challenge 3) sacrifice conceptual clarity (see column 3 of **Table 2**). To address these issues, drawing from established definition rules and guidelines (**Suddaby, 2010; Wacker, 2004**), we define *DO* as an organization's strategic guiding principle that encourages and supports the broad application of a combination of information, computing, communication, and connectivity technologies to improve its practices, routines, and processes. This definition comprises (1) the strategic subject, referring to an organization capable of action — here, the incumbent enterprise; (2) the strategic means, encompassing widespread application of basic and advanced information, computing, communication, and connectivity technologies, along with their combinations, manifesting in three dimensions: digital infrastructure, advanced digital technologies, and digital technology applications; and (3) the strategic objective, aiming to refine the enterprise's practices, routines, and processes. *DO* signifies organizations' commitment to digital technology adoption (**Yang et al., 2021**). This signal encourages proactive and open attitudes and behaviors toward digital technologies across all organizational levels and departments (**Ardito et al., 2021; Quinton et al., 2018**).

In the *DO* research landscape, existing studies have focused on the impact of *DO* on diverse facets of firm performance, such as financial performance (**Khin and Ho, 2019; Kindermann et al., 2021**), innovation performance (**Ardito et al., 2021; Arias-Pérez and Velez-Jaramillo, 2022**), and environmental performance (**Bendig et al., 2023**). However, the relationship between *DO* and *OR* remains unclear. On the one hand, *DO* provides a guiding direction for implementing corporate digitalization and accelerates overall organizational change (**Arias-Perez and Velez-Jaramillo, 2022; Khin and Ho, 2019**). It is vital in environment monitoring, operations control, and innovation, and potentially enhancing *OR*. For example, the big data analytics and digital media technologies laid out by *DO* can help small or medium-sized enterprises (*SMEs*) cope with the pandemic crisis (**Ciasullo et al., 2022; Martin-Rojas et al., 2023**). On the other hand, as *DO* deepens, applying digital technology can also pose challenges and difficulties for companies. For instance, digital technologies tend to expedite corporate change, resulting in increased volatility, complexity, and uncertainty in the business environment (**Warner and Wager, 2019**). Data security issues, such as information leakage, can significantly damage a company's reputation (**Williams et al., 2017**). In addition, implementing digital technologies may demand substantial resources, potentially depleting a company's financial reserves for managing external risks or shocks. Prior research has also demonstrated that *DO* doesn't ensure financial success for a company (**Nasiri et al., 2022**). Therefore, it is essential to investigate whether *DO* influences organizational sustained and long-term resilience.

**Table 1.** Comparison of current study with extant literature focusing on both digital factors and *OR*

Source	Method/sample	Context	Focus on OR	Strategic drivers of OR?	Contingency factors?	Main findings
<a href="#">Al-Omouh et al. (2023)</a>	Survey; 233 telecommunication firms, Jordan	Covid-19 crisis	Defensive	N	N	Digital corporate social responsibility has a positive impact on OR
<a href="#">Ciasullo et al. (2022)</a>	Survey; 192 SMEs, Europe	Covid-19 crisis	Defensive	N	N	Big data analytics capability (DBAC) and co-innovation (CI) positively affect OR. CI mediates BDAC and OR
<a href="#">Forliano et al. (2023)</a>	Survey; 186 firms, Germany and Italy	Covid-19 crisis	Defensive	Y	N	Digital maturity plays a fully mediating role between technology orientation and organizational resilience
<a href="#">Isensee et al. (2023)</a>	Case; 12 SMEs and start-ups, Germany	Post-Covid-19 crisis	Defensive	N	N	Sustainable digital entrepreneurs play essential roles in OR
<a href="#">Martín-Rojas et al. (2023)</a>	Survey; 259 SMEs, Spanish	Post-Covid-19 crisis	Defensive	N	N	Social media indirectly affects OR through self-renewal
<a href="#">Robertson et al. (2022)</a>	Mixed-method, 79 SME retailers, South Africa	COVID-19 crisis	Defensive	N	N	Digital maturity significantly improves OR
Current study	Longitudinal second data; 1965 manufacturing firms, China	General adversities	Predictive, defensive and growth	Y	Y	Digital orientation positively influences OR. HR slack and the nature of enterprise ownership positively and negatively moderate the first two relationships, respectively

**Note(s):** Y = Yes; N = No **Source(s):** Authors' work

**Table 2.** Definitions of digital orientation

Authors (year)	Definition	Conceptual clarity challenge(s)
Quinton <i>et al.</i> (2018)	A deliberate strategic positioning of an SME to take advantage of the opportunities presented by digital technologies (p. 4)	Challenge 1: “digital technologies.” Challenge 2
Khin and Ho (2019)	A firm’s commitment toward application of digital technology to deliver innovative products, services and solutions (p. 181)	Challenge 1: “digital technology.” Challenge 2
Garcia de Lomana <i>et al.</i> (2019)	A firm’s strategic orientation to foster the enablement and usage of digital technologies in products and services for the customer and to digitalize the firm’s internal and inter-firm processes and infrastructure to an effort to achieve competitive advantage (p. 4)	Challenge 1: “strategic orientation” and “digital technologies.” Challenge 2. Challenge 3
Kindermann <i>et al.</i> (2021)	An organization’s guiding principle to pursue digital technology enabled opportunities to achieve competitive advantage (p. 649)	Challenge 1: “digital technology.” Challenge 2
Arias-Pérez and Vélez-Jaramillo (2022)	A deliberate strategic positioning of a firm to take advantage of the opportunities presented by those emerging digital technologies, which involve the capture, transformation and application of knowledge to create value from digital technologies (p. 3)	Challenge 1: “digital technologies”. Challenge 3

*Source(s):* Authors’ work

### 3.3 A framework based on dynamic capabilities theory

In this section, we construct a conceptual model for this study rooted in dynamic capabilities theory (*DCT*) (**Figure 1**). *DCT* builds on the resource-based view (**Barney, 1991**), asserting that a firm’s competitive advantage relies not only on its valuable, rare, inimitable, and nonsubstitutable resources but also on integrating, adapting, and creating new resource reserves in a changing environment (**Teece et al., 1997**). Dynamic capabilities are organizational abilities to renew and reconfigure available resources, enabling quick responses to market changes and technological opportunities. Dynamic capabilities include three critical subcapabilities: sensing, seizing, and reconfiguring (**Teece, 2007**). Considering the concept’s observability and clarity, this study uses absorptive capability as a proxy for seizing capability, consistent with the existing literature (**Wilhelm et al., 2015**).

Specifically, sensing capability refers to a firm’s ability to identify, interpret, and gain insight into environmental opportunities and threats through scanning and searching the near/near-end technology and market environments (**Pavlou and El Sawy, 2011; Roberts et al., 2016; Teece, 2007**). Absorptive capability focuses on capturing, utilizing, and exploring knowledge and skills, and it relates to the acquisition, assimilation, transformation, and exploitation activities (**Pavlou and El Sawy, 2011; Wilhelm et al., 2015; Zahra and George, 2002**). Reconfiguring capability involves a firm’s ability to coordinate and deploy tasks, resources, and routines to maintain evolutionary fitness, encompassing integration, orchestration, and reorganization activities (**Pavlou and El Sawy, 2011; Teece, 2007**).

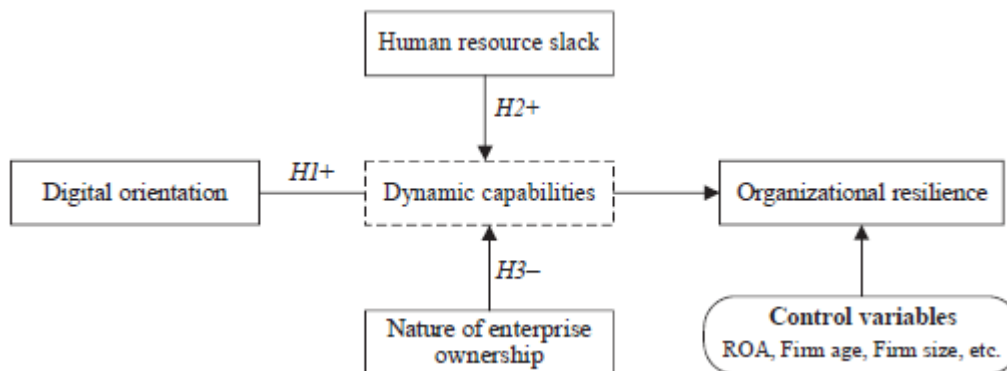
*DO* grants organizations greater access to digital technology resources (**Kindermann et al., 2021**). It empowers firms to sustain vigilance, agility, and ongoing exploration and learning, which fosters adaptation and resource reconfiguration in ever-changing business environments (**Lenka et al., 2017; Warner and Wäger, 2019**), greatly enhancing dynamic capabilities (**Bresciani et al., 2021**). In turn, dynamic capabilities enable organizations to achieve resilience (**Kurtz and Varvakis, 2016**). Dynamic

capabilities stem from an organization’s micro-foundations, encompassing human and technological resources, and are influenced by organizational management and structure (Liu and Zhao, 2021; Teece, 2007). Enriched human capital allows companies to acquire enhanced digital-related capabilities, leading to higher performance (Mahmood and Mubarik, 2020). Furthermore, differences in enterprise ownership result in different organizational structures, management styles, and work climates (Wang et al., 2019), likely influencing the extent to which organizations employ a digital strategy to enhance dynamic capabilities. Hence, we argue that the role of *DO* on *OR* can be affected by *HR* slack and *NEO*.

#### 4. Hypotheses development

##### 4.1 Digital orientation and organizational resilience

Based on *DCT*, we posit that *DO* can enhance *OR*, which is elucidated through three functional mechanisms. First, *DO* facilitates organizational seizing capability, enhancing predictive responses. Digital-oriented firms tend to adopt a proactive and open approach, quickly embrace digital initiatives, and commit to understanding and using digital technologies (Khin and Ho, 2019). They configure digital hardware components, connect digital products and stakeholders, and collect and analyze critical information (Lenka et al., 2017). For example, tools such as social media, applets, and mobile devices allow real-time collection of customer and product feedback (Roberts et al., 2016); big data analytics integrate and process vast information (Gupta and George, 2016); and digital tools offer varied information sharing mechanisms (Williams et al., 2017).



Source(s): Figure by authors

Figure 1. The conceptual model

Thus, implementing *DO* enhances the organizational seizing capability to scan, search, and interpret market intelligence. This enhanced capability deepens a firm’s understanding of customer needs, partner and competitor behavior, and industry trends (Gupta and George, 2016; Liu et al., 2023; Roberts et al., 2016). In turn, helps the organization anticipate crises, identify risks (Wilhelm et al., 2015), adjust resources in advance to address volatile situations (Kurtz and Varvakis, 2016).

Second, *DO* facilitates organizational absorptive capability, enabling defensive responses. Digital-oriented firms are willing to integrate digital technologies with other strategic elements to adapt and enhance existing resources and practices (Kindermann et al., 2021). Firms incorporate digital components into products, enabling real-time customer interaction and access to critical information resources (Vial, 2019). Some digital technologies also connect business units and management

modules, improving communication, collaboration, and knowledge sharing (Bresciani et al., 2021). Digital design tools accelerate knowledge creation and experimentation in new product development (Marion and Fixson, 2020). Therefore, DO enhances the organizational absorptive capability to capture, utilize, and explore (Day and Schoemaker, 2016; Kastelli et al., 2022). In turn, absorptive capability expands knowledge breadth and depth and enhances strategic flexibility, enabling firms to withstand disruptions through diverse solutions (Duchek, 2020). When companies encounter operational difficulties or changes in customer needs, absorptive capability becomes especially important. It improves supply chain responsiveness and stability, offering timely and differentiated digital solutions, co-creating value efficiently (Lenka et al., 2017; Shen et al., 2021), and mitigating unethical behavior by increasing transparency in supplier relationships (Zhang et al., 2022b). Additionally, it assists firms in establishing appropriate decision rules, processes, and business models (Ciasullo et al., 2022). During COVID-19, firms were able to promptly conduct online training, repurposed manufacturing capabilities for essentials like masks, and collaborated across industries (Chiarini et al., 2023).

Third, DO enhances organizational reconfiguring capability, bolstering growth responses. Digital-oriented firms value fostering a culture embracing digital technologies and an applied mindset (Proksch et al., 2021). They continuously increase digital maturity and intensity (Nasiri et al., 2022; Warner and Wäger, 2019), which enables the decoupling and liquefaction of existing resources, thereby allowing for flexible combinations of modular units (Fehrer et al., 2020; Goduscheit and Faullant, 2018). Moreover, highly digital organizations trigger broader changes in technology, architecture, processes, and business models (Rachinger et al., 2019). These changes include fostering an agile and entrepreneurial mindset, developing new products and processes, designing and implementing viable new business models (Teece, 2007), and expanding network and shaping ecosystems (Day and Schoemaker, 2016). Thus, a digital-oriented strategy dramatically enhances the organization's ability to integrate and restructure both internal and external resources (Warner and Wäger, 2019). In turn, reconfiguration capability enables firms to reflect, learn, and improve quickly in adversity, thereby gaining evolving resilience (Zhang et al., 2022a). Firms experiencing adversity explore diverse application contexts, diversify product and service innovations (Heinonen and Strandvik, 2020), and redesign team-based structures to enhance internal adaptability (Warner and Wäger, 2019). During the pandemic, some firms expanded their online presence and collaborated with digital partners to mitigate operational difficulties and centralized losses (Ciasullo et al., 2022; Nasiri et al., 2022), while others adapted value propositions, optimized operations, and expanded social network capital via platform business models, nurturing long-term ecosystem resilience (Floetgen et al., 2021). Therefore, we propose the following hypothesis:

*H1. DO has a positive impact on OR.*

## *4.2 Moderating effects*

### *4.2.1 The moderating role of human resource slack*

Human resources encompass the collective human capital of individuals employed directly by the firm, including their knowledge, skills, and abilities (Wright et al., 1994). HR slack refers to surplus human resources beyond the firm's current business needs (Wang et al., 2016), essential for sustaining operations and developing new capabilities to address unforeseen challenges (Bentley and Kehoe, 2020). Organizational practices related to digital technologies rely on individuals' knowledge, experience, and skills, which are vital components of digital dynamic capabilities (Kindermann et al.,

**2021**). Research indicates that human capital positively influences organizational dynamic capabilities (**Nguyen et al., 2023**). Therefore, we assert that HR slack will enable *DO* to improve *OR*.

First, *HR* slack means that firms have broader social capital, allowing them to access valuable information and knowledge via external employee networks (**Schenkel and Teigland, 2016**). This facilitates a better understanding of customers' and competitors' digital technology adoption, thereby enabling accurate market change assessments. Second, internal members create, retain, and transfer explicit and implicit organizational knowledge. Ample human capital contributes to enriching the knowledge base, supporting ongoing learning, and thereby forming absorptive capability in digitalization (**Kastelli et al., 2022**). Improved absorptive capability heightens a firm's environmental responsiveness. Third, *HR* slack empowers firms to flexibly integrate and orchestrate internal and external resources. Digital transformation poses challenges such as allocating resources, maintaining ongoing operations, and achieving new market growth (**Bentley and Kehoe, 2020**). *HR* slack aids by reallocating surplus workforce for digital innovation initiatives (**Adomako and Nguyen, 2020**). Sufficient skilled employees and specific routines, developed by the organizational human capital, facilitate firms to understand and integrate new knowledge related to digital technologies. This integration drives the development of new products, processes, or other innovative transformations (**Kastelli et al., 2022**). Ultimately, firms acquire the ability to navigate future adversities. Thus, we propose the following hypothesis:

*H2. HR slack positively moderates the relationship between DO and OR.*

#### 4.2.2 The moderating role of the nature of enterprise ownership

There are two types of enterprises in China: state-owned enterprises (*SOEs*) and non-state-owned enterprises (*NSOEs*). *SOEs* are deeply influenced by traditional Chinese culture and social ideology, characterized by hierarchical respect, group harmony, and strict government bureaucratic control (**Ngo et al., 2008**). These factors dictate that *SOEs* differ from *NSOEs* in organizational structure, decision-making processes, and resource allocation and utilization (**Wang et al., 2019**). Ultimately, the impact of *DO* on *OR* may vary based on the ownership nature.

On the one hand, compared to *NSOEs*, *SOEs* exhibit distinct bureaucratic characteristics (**Ngo et al., 2008**), including formalized and hierarchical organizational environments, standardized functions division and jurisdictions, and limited horizontal/upward communication (**Olsen, 2006**). These characteristics may lead to organization rigidity, obstruct information flow, and pose challenges in integrating digital resources across departments. Consequently, firms face difficulties in scanning and analyzing external changes, assimilating and utilizing knowledge and resources, and effectively predicting and responding to environmental risks. Moreover, these bureaucratic structures harm digital innovation. The pyramidal structure of *SOEs* inhibits senior executives from accessing insights of lower-level members (**Wellman et al., 2020**) and slows innovation decision-making (**Teece, 2007**). Less decentralization also restricts opportunities for digital experimentation. Consequently, *SOEs* struggle to restructure internal resources to enhance dynamic capabilities through digital initiatives, ultimately weakening *OR*.

On the other hand, *SOEs* lack robust incentives and effective supervision. Their managers often have to achieve political and social goals, not only market profit goals (**Zhou et al., 2016**). Moreover, when experiencing adversity, *SOEs* often receive governmental resource support (**Wang et al., 2019**). As a result, they make insufficient efforts to improve the reconfiguring capability through digital technologies. Thus, *SOEs* may miss chances for self-improvement during challenges. In contrast,

*NSOEs* are not subject to government or multinational bureaucracies (Xia and Walker, 2015). They emphasize market and entrepreneurial orientation and possess well-structured monitoring and incentive mechanisms, crucial for survival and success (Wang et al., 2019). *NSOEs* actively invest in technologies to search, process, and communicate customer needs across the value chain (Chen et al., 2017). They embrace open innovation, and develop integration and coordination capabilities, thereby enhancing their resilience. Therefore, we assume that:

*H3. NEO* negatively moderates the relationship between *DO* and *OR*. *NSOEs* are more likely to leverage *DO* to enhance *OR* than *SOEs*.

## 5. Methodology

### 5.1 Sample and procedure

Given the widespread adoption of digital technology and the strategic significance of resilience in ensuring production and operations continuity (Shen et al., 2021; Yang et al., 2021), the manufacturing sector is an appropriate context to explore the link between *DO* and *OR*. Specifically, manufacturing industries in emerging economies such as China are undergoing extensive digital transformation (Chen et al., 2017). To empirically test our conceptual model, we collected text and financial data from Chinese A-share-listed manufacturing firms during 2007-2020. Corporate annual reports, financial data, nature of enterprise ownership, and corporate governance data are sourced from the China Stock Market and Accounting Research (*CSMAR*) database. The *CSMAR* database, renowned for its comprehensiveness, has been widely utilized in previous management research (e.g. Huang et al., 2020). Outliers and missing samples were excluded from the analysis. Continuous variables were winsorized at 1 and 99%. We obtained 11,208 observations finally, containing 1,875 companies.

### 5.2 Measurement

The specific operationalization of each variable is presented in **Table 3**.

**Dependent variable.** Organizational resilience is measured by financial volatility (Ortiz-de-Mandojana and Bansal, 2016). Resilient organizations are demonstrated by maintaining low financial volatility (Ortiz-de-Mandojana and Bansal, 2016). Using financial volatility to measure *OR* is more objective and precise than the perceptual scales employed in prior studies (Martin-Rojas et al., 2023; Salanova et al., 2012).

**Independent variable.** We developed a digital orientation measure by utilizing text analytic techniques and drawing from the literature on digital transformation (Paschou et al., 2020). Text analysis techniques have recently been widely applied to conceptual measurement (Kindermann et al., 2021; Nasiri et al., 2022). Following methodologies outlined by Kindermann et al. (2021) and Loughran and McDonald (2016), we applied Python 3.9 software to count the frequency of the 269 characteristic words in digital infrastructure (e.g. computer software, computer system, network communication, communication equipment, and IT system), advanced digital technologies (e.g. artificial intelligence, machine learning, big data, cloud computing, cloud platform, blockchain, and Internet of things), and digital technology applications (e.g. digitalization, industrial Internet, Internet business model, app, ERP, industrial intelligence, digital system, and smart manufacturing) from corporate annual reports and calculated the degree of *DO*.

**Table 3.** Variable measurement

Variable	Abbreviation	Operationalization
Organizational resilience	OR	$Financial\ volatility_{it} = \ln \left[ \sqrt{\frac{1}{N} \sum_{t=1}^T \left( r_{it} - \frac{1}{T} \sum_{t=1}^T r_{ijt} \right)^2} \right]$ , where $r_{ijt}$ is the stock returns rate of firm $i$ in month $j$ within year $t$ , and $T$ is the total number of months in each fiscal year
Digital orientation	DO	$DO_{i,t} = \frac{W_{it}}{\sum_t W_{it}}$ , where $W_{it}$ is the total keyword word frequency of firm $i$ in year $t$ , and $\sum_t W_{it}$ is the total keyword word Frequency in the annual report of the whole sample in year $t$
Human resource slack	HR slack	$HR\ slack = \frac{Firm\ employees}{Firm\ sales} - \frac{Industry\ employees}{Industrysales}$
Nature of enterprise ownership	NEO	State-owned enterprises are assigned a value of 1, and others are 0
Return on assets	ROA	Net profit divided by the average balance of total assets
Financial leverage	Lev	Total liabilities divided by total assets
Cash flow	Cash	Net cash flow from operating activities divided by total assets
Total asset turnover	ATO	Operating income divided by average total assets
R&D intensity	RDI	R&D expenditures divided by total sales
Innovation efficiency	IE	Patent number/ $\ln(1 + R\&D\ expenditures)$
Competitive intensity	CI	The total number of firms in the industry
Firm age	Age	Focus year minus initial start year
Firm size	Size	$\ln(\text{total number of active employees})$

Source(s): Authors' work

Moderator variables. We measure HR slack by the number of employees over sales adjusted relative to industry norms (Mishina et al., 2004). NEO is a dummy variable indicating whether a firm is state-owned.

Control variables. Referring to previous resilience studies (DesJardine et al., 2019; Marsat et al., 2022), we controlled for several variables in firm finance (return on assets, financial leverage, cash flow, and total asset turnover), firm characteristics (age and size), innovation (R&D intensity and innovation efficiency) and market environment (competitive intensity). These factors potentially influence organizational resilience.

### 5.3 Model estimation

In this section, we conduct baseline regressions to identify the relationship between digital orientation and organizational resilience. Since our dataset is longitudinal panel data, we use the Hausman test ( $p < 0.001$ ) to choose the model for regression analyses. The result suggests that we should employ fixed effects regression models to test our hypothesis. Fixed effects models can mitigate the endogeneity problem caused by time invariance (Pereira et al., 2018). We construct four multiple regression models: Model 1 includes the independent variable and the controls, Models 2 and 3 add moderating variables, and Model 4 represents the full model. Our model incorporates industry, year, and firm-fixed effects.

$$OR = \beta_0 + \beta_1 DO_{it} + \beta_2 Control_{it} + \sum Industry + \sum Year + \sum Firm + \varepsilon_{it} \quad (1)$$

$$OR = \beta_0 + \beta_1 DO_{it} + \beta_2 HR\_slack_{it} + \beta_3 DO_{it} * HR\_slack_{it} + \beta_4 Control_{it} + \sum Industry + \sum Year + \sum Firm + \varepsilon_{it} \quad (2)$$

$$OR = \beta_0 + \beta_1 DO_{it} + \beta_2 NEO_{it} + \beta_3 DO_{it} * NEO_{it} + \beta_4 Control_{it} + \sum Industry + \sum Year + \sum Firm + \varepsilon_{it} \quad (3)$$

$$OR = \beta_0 + \beta_1 DO_{it} + \beta_2 HR\_slack_{it} + \beta_3 NEO_{it} + \beta_4 DO_{it} * HR\_slack_{it} + \beta_5 DO_{it} * NEO_{it} + \beta_6 Control_{it} + \sum Industry + \sum Year + \sum Firm + \varepsilon_{it} \quad (4)$$

In the equations above, the dependent variable, *OR* is organizational resilience, represented by firms' financial volatility. The independent variable, *DO* is digital orientation. *HR\_slack* and *NEO* are moderating variables. Control represents a series of control variables. Industry, Year, and Firm, represent industry, industry, year, and firm dummies, respectively.  $\varepsilon$  is the random error term.

## 6. Results

### 6.1 Basic analysis

**Table 4** presents the descriptive statistics for all the variables involved in the model. The variables' mean, standard deviation, maximum and minimum values fall within reasonable ranges. All paired correlation coefficients between our variables were below |0.45|. We also calculated the variance inflation factor (*VIF*). The results showed that all *VIFs* were below the threshold of 2.50 (**Johnston et al, 2018**), demonstrating that our model does not suffer from multicollinearity.

### 6.2 Hypothesis testing

We provide our regression analysis results in **Table 5**. From models 1 ( $\beta = -17.631, p < 0.01$ ), it is clear that *DO* has a significant negative impact on financial volatility, i.e. it helps firms mitigate fluctuations in financial performance, thus supporting **H1**. The result of Model 2 shows a significant negative interaction ( $\beta = -226.706; p < 0.01$ ), indicating *HR* slack strengthens the negative relationship between *DO* and financial volatility, i.e. a higher level of *HR* slack further enhances the positive impact of *DO* on *OR*, supporting **H2**. The result of Model 3 shows a significant positive interaction ( $\beta = 19.549; p < 0.01$ ), suggesting that *NEO* weakens the negative relationship between *DO* and financial volatility, i.e. *NSOEs* are better able to increase their resilience by implementing *DO* strategy than *SOEs*, supporting **H3**. **Figure 2** further illustrates the moderating effect of *DO* on *OR* under different levels of *HR* slack, and **Figure 3**. Further shows that the impact of *DO* on *OR* is more pronounced in *SOEs*. Thus, these results support **H2** and **H3**.

### 6.3 Robustness tests

To further reduce the endogeneity problem, we lagged the dependent variable by one year. The results (as shown in **Table 6**) remain robust and our hypotheses are again supported.

## 7. Discussion

We make contributions to theory in several areas. First, this study provides an updated *DO* definition, addressing the ambiguity limiting its research development. This paper defines *DO* as an organization's strategic guiding principle that encourages and supports the broad application of a combination of information, computing, communication, and connectivity technologies to improve its practices, routines, and processes. Unlike prior *DO* definitions (**Arias-Pérez and Vélez-Jaramillo, 2022; Garcia de Lomana et al, 2019; Khin and Ho, 2019; Kindermann et al, 2021; Quinton et al, 2018**), this definition clarifies the subject, means, and objectives of *DO*, providing a solid foundation for future research streams in digital transformation.

**Table 4.** Descriptive statistics and correlations of variables

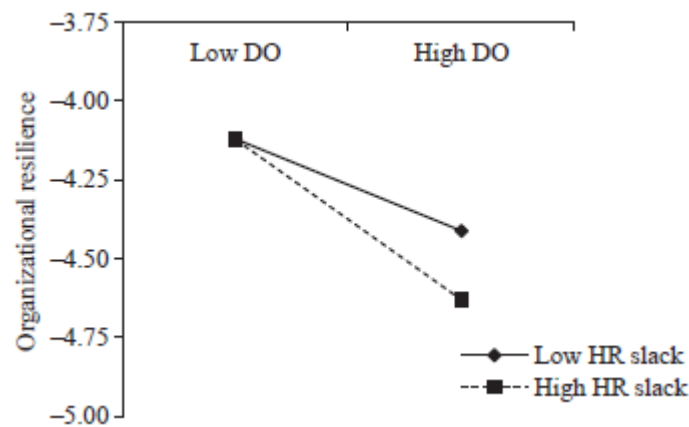
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. OR	1												
2. DO	-0.051***	1											
3. HR slack	-0.037***	-0.082***	1										
4. NEO	0.002	-0.070***	-0.153***	1									
5. ROA	-0.059***	0.088***	-0.089***	-0.162***	1								
6. Lev	0.038***	-0.091***	-0.118***	0.343***	-0.436***	1							
7. ATO	-0.032***	0.006	-0.260***	0.153***	0.185***	0.204***	1						
8. Cash	0.008	0.018*	-0.120***	-0.021**	0.391***	-0.132***	0.169***	1					
9. RDI	0.000	-0.037***	0.104***	-0.052***	-0.064***	-0.044***	-0.197***	-0.038***	1				
10. IE	-0.012	-0.021**	0.102***	0.082***	0.019**	0.162***	0.045***	0.014	0.032***	1			
11. CI	0.016*	-0.163***	0.159***	-0.063***	-0.011	-0.079***	-0.152***	-0.043***	0.108***	0.140***	1		
12. Age	0.037***	-0.092***	0.215***	0.150***	-0.148***	0.199***	-0.027***	0.055***	0.087***	0.096***	0.049***	1	
13. Size	-0.035***	0.001	-0.128***	0.191***	0.044***	0.227***	0.295***	0.090***	-0.148***	0.126***	-0.141***	-0.121***	1
Mean	-2.153	0.003	-0.015	0.339	0.046	0.402	0.691	0.043	0.010	0.156	92.460	2.705	7.014
SD	1.068	0.008	0.030	0.473	0.060	0.200	0.392	0.066	0.033	0.082	55.290	0.388	1.489

**Note(s):** \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ ;  $N = 511,208$  **Source(s):** Authors' work

**Table 5.** Results of regression for organizational resilience

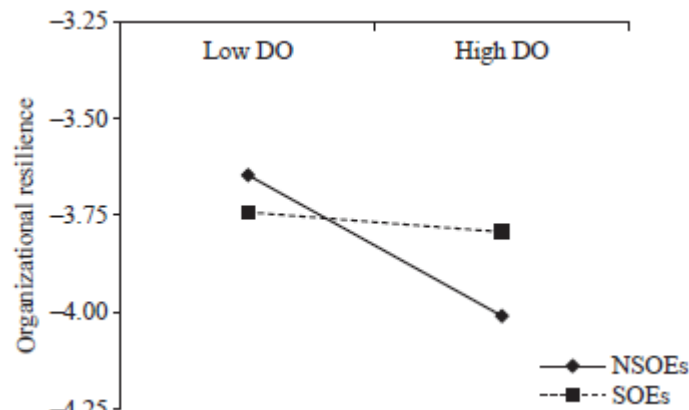
	Model 1	Model 2	Model 3	Model 4
DO	-17.631*** (2.160)	-28.395*** (2.748)	-22.735*** (2.467)	-30.971*** (2.877)
DO × HR slack		-226.706*** (35.927)		-203.444*** (36.737)
DO × NEO			19.549*** (4.586)	14.087*** (4.684)
HR slack		-1.157 (1.719)		-1.135 (1.718)
NEO			0.002 (0.084)	-0.003 (0.084)
ROA	0.051 (0.272)	0.040 (0.272)	0.054 (0.272)	0.043 (0.272)
Lev	0.608*** (0.119)	0.606*** (0.120)	0.622*** (0.120)	0.615*** (0.120)
ATO	-0.072 (0.063)	-0.082 (0.065)	-0.079 (0.063)	-0.086 (0.065)
Cash	0.212 (0.202)	0.220 (0.205)	0.226 (0.202)	0.227 (0.205)
RDI	0.718 (0.516)	0.721 (0.515)	0.720 (0.516)	0.722 (0.515)
IE	0.193 (0.219)	0.182 (0.219)	0.200 (0.219)	0.188 (0.219)
CI	0.001** (0.001)	0.001** (0.001)	0.002** (0.001)	0.001** (0.001)
Age	0.769*** (0.140)	0.767*** (0.140)	0.754*** (0.140)	0.757*** (0.140)
Size	-0.001 (0.012)	0.000 (0.013)	-0.001 (0.012)	0.000 (0.013)
Constant	-3.775*** (0.374)	-3.783*** (0.385)	-3.760*** (0.385)	-3.775*** (0.385)
Industry-, year- and firm-fixed effects	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.101	0.105	0.103	0.106
Observations	11,208	11,208	11,208	11,208
Number of firms	1,875	1,875	1,875	1,875

**Note(s):** Standard errors in parentheses; \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$  **Source(s):** Authors' work



**Source(s):** Authors' work

**Figure 2.** Moderating effect of HR slack on the relationship between DO and OR



Source(s): Authors' work

Figure 3. Moderating effect of NEO on the relationship between DO and OR

Table 6. Results of robustness tests

	Model 5	Model 6	Model 7	Model 8
DO	-17.171*** (3.308)	-30.926*** (4.202)	-23.001*** (3.916)	-32.837*** (4.432)
DO × HR slack		-260.527*** (49.734)		-240.641*** (51.922)
DO × NEO			18.022*** (6.509)	9.075 (6.785)
HR slack		-4.539** (2.248)		-4.524** (2.248)
NEO			-0.018 (0.101)	-0.026 (0.101)
ROA	0.263 (0.327)	0.214 (0.327)	0.264 (0.327)	0.214 (0.327)
Lev	0.645*** (0.152)	0.623*** (0.152)	0.656*** (0.152)	0.629*** (0.152)
ATO	0.110 (0.082)	0.069 (0.084)	0.105 (0.082)	0.067 (0.084)
Cash	0.160 (0.251)	0.091 (0.254)	0.181 (0.251)	0.100 (0.254)
RDI	0.864 (0.599)	0.877 (0.598)	0.872 (0.599)	0.885 (0.598)
IE	0.449 (0.279)	0.462* (0.278)	0.466* (0.279)	0.470* (0.278)
CI	0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
Age	0.815*** (0.212)	0.803*** (0.211)	0.801*** (0.212)	0.797*** (0.212)
Size	0.003 (0.015)	0.007 (0.015)	0.002 (0.015)	0.007 (0.015)
Constant	-5.080*** (0.712)	-4.994*** (0.711)	-5.029*** (0.712)	-4.978*** (0.711)
Industry-, year- and firm-fixed effects	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.069	0.073	0.070	0.073
Observations	8,801	8,801	8,801	8,801
Number of firms	1,660	1,660	1,660	1,660

Note(s): Standard errors in parentheses; \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$  Source(s): Authors' work

Second, this study contributes to organizational resilience literature by establishing *DO* as a pivotal antecedent of *OR*. Previous research on *OR* has predominantly focused on factors such as organizational resources, structure, and capabilities (Iftikhar et al., 2021; Linnenluecke, 2017; Williams and Shepherd, 2016), along with individual cognition, emotion, behaviors, and social relationships (Ortiz-de-Mandojana and Bansal, 2016; Williams et al., 2017). Our research substantiates that *DO*, a strategic factor of the organization, positively affects *OR*. Although certain studies have explored the repercussions of specific digital technologies on *OR*, such as social media tools and big data analytics technologies (Ciasullo et al., 2022; Martín-Rojas et al., 2023), we argue that a higher-level digital strategy empowers firms to effectively amalgamate and harmonize diverse digital endeavors spanning production, R&D, and marketing, mitigates the potential drawbacks of isolated technological applications and tackles challenges across various departments or projects, thereby fostering sustained and fortified long-term resilience. Significantly, in contrast to the findings of Forliano et al. (2023), our empirical study unveils that *DO*, rather than technological orientation, directly engenders a positive impact on *OR*. *DO* offers a comprehensive compass for firms' digital transformation, triggering profound effects on organizational leadership, structure, and culture (Kindermann et al., 2021), thereby amplifying overall resilience. While technology orientation focuses only on new product development at the technical level (Gatignon and Xuereb, 1997), it might not directly and fundamentally enhance *OR*.

Third, this study contributes to the corporate digitalization and strategy management literature by expanding the outcomes research of *DO*. While existing *DO* studies have primarily centered on its impact on firm's financial performance (Khin and Ho, 2019; Kindermann et al., 2021), innovation performance (Ardito et al., 2021; Arias-Pérez and Vélez-Jaramillo, 2022), and environmental performance (Bendig et al., 2023), there remains a research gap concerning organizational resilience. Moreover, existing findings are inconsistent, with some literature suggesting that digitization promotes financial and innovative performance (Ardito et al., 2021; Kindermann et al., 2021), while others demonstrate that digitization negatively affects performance (Cappa et al., 2020). Taken together, we posit that while digitization might not yield immediate advantages to organizations, it holds the potential to fortify long-term risk resilience. This is important because digitization strategy are principles and beliefs that organizations uphold over time (Kindermann et al., 2021), and the resultant *OR* is a fundamental assurance for achieving organizational stable operations and performance growth (Ortiz-de-Mandojana and Bansal, 2016; Zhang et al., 2022a). Our perspective is affirmed by analyzing panel data from Chinese-listed manufacturing firms.

Finally, this study enriches the dynamic capabilities literature by elucidating how a manufacturing firm's *DO* can enhance digital-based dynamic capabilities, thereby augmenting organizational resilience. Specifically, this study pinpoints how the directional guidance and change-accelerating advantages conferred by *DO* improve a firm's organizational sensing, seizing, and reconfiguring capabilities - the core argument of *DCT* (Teece, 2007; Teece et al., 1997), meanwhile validating this mechanism by considering the moderating roles of HR slack and the nature of enterprise ownership, expanding *DCT*'s scope to encompass the digital orientation domain. Despite previous researches demonstrate *DO*'s positive impact on business performance (Khin and Ho, 2019; Kindermann et al., 2021), many digital transformation initiatives do not achieve the desired goals (Gebauer et al., 2020; Tabrizi et al., 2019), which may be attributed to neglecting the contingencies of implementing digital strategy. In summary, this study makes a significant theoretical contribution by bridging the *DCT* literature to the forefront of the globally emerging digital transformation in manufacturing (Rachinger et al., 2019).

## 8. Conclusion

### 8.1 Practical implications

The results of this study emphasize the priority of implementing digital orientation and enhancing manufacturing firms' organizational resilience. This study offers valuable insights for managers and policymakers seeking to navigate and benefit from digital transformation. First, we pinpoint that firms facing uncertainty, risk, and pressure should promptly craft their *DO* strategy. Such a strategy cultivates the capabilities to sense, absorb, and integrate, which is vital for anticipating and responding to adversity. The absence of a strategy frequently underlies digital transformation failures due to the challenge of internal personnel comprehending and effectively capitalizing on digitalization's impact (**Kane et al., 2016; Tabrizi et al., 2019**). Hence, for sustained and stable growth, senior executives must elucidate the direction, means, and vision for digital initiative implementation. They stand to gain by establishing a robust digital infrastructure, embracing advanced digital technologies, and aligning them with business processes and models.

Second, our study underscores the advantages of implementing a *DO* strategy for firms boasting a high-level human resource pool. Harnessing their intellectual capital empowers these firms to amplify dynamic capabilities, thereby fortifying their resilience. In a dynamic environment, digital technology alone does not guarantee long-term and stable growth; it's only effective when leveraged and adapted by the organization's personnel. Thus, reserving a certain human resources level is crucial in volatile internal and external environments. Moreover, we offer a different perspective: for companies grappling with adversity and possessing a certain workforce size, seeking to ensure survival through layoffs isn't always the optimal path. Although layoffs can reduce short-term costs, they harm relationships and hinder the collective effort needed to enhance the company's dynamic capabilities in crisis response (**Schenkel and Teigland, 2016**). Instead, it is wise to allocate some idle employees to digital activities and prioritize improving the workforce's digital competence through training and other measures prior to crises. Given the growing scarcity of human resources with advanced digital technology expertise, prioritizing their recruitment becomes essential.

Third, our empirical findings reveal that implementing *DO* improves *OR* in non-state enterprises more effectively than in state-owned enterprises. We offer the following suggestions to *SOE* managers and policymakers for augmenting their digital strategy: (1) Building a digital strategy leadership team. Assemble a dedicated team to steer the *DO* strategy, overseeing organizational, process, and business changes, along with nurturing shifts in employees' mindsets and optimizing management; (2) Developing a digital organization structure and digital standardization system. Prioritize creating a flat or matrix structure, internal digital dictionaries, and a unified data standard system to facilitate seamless resource movement, communication, and collaboration; (3) Cultivating digital culture and digital mindset. Firms should provide digital competence training for employees, embed the digital priority concept into the corporate culture and systems, and encourage employees to embrace and utilize digital tools; and (4) Policymakers should reduce their intervention in enterprises, raise managers' awareness of risk-taking, and foster entrepreneurship. Moreover, top leaders should exhibit a spirit of self-reflection and innovation, break away from established paths, and reshape their perceptions of business development and survival.

### 8.2 Limitations and future research

Our study has limitations that offer insights for future research. First, our sample was sourced from listed manufacturing companies in China. Given potential variations in the impact of *DO* on *OR* across

countries, industries, and firm types, future investigations could extend and validate the conclusions of this study by conducting research in other countries and industries, as well as exploring *SMEs* or family-owned businesses. Second, we identified two contingency factors between *DO* and *OR*. However, the pivotal role of senior executives in *DO* development warrants consideration. The moderating effect of other strategic orientations can be detrimental to organizational outcomes (Ardito et al., 2021), so balancing different strategic orientations is crucial for company development. Thus, analyzing other boundary conditions (e.g. top management team functional diversity and stability, entrepreneurial orientation, and customer orientation) may extend our understanding of the *DO – OR* relationship. Third, our measurement of *DO* relies on machine learning-based text analytics techniques. However, it provides little details of specific sentences associated with digitized words. Future research could develop a multidimensional *DO* scale to enhance the validity of our findings. Lastly, there's a significant lack of research on the *DO*'s antecedents. Future studies could investigate the factors (e.g. external digital signals and internal adaptive culture) that promote or hinder *DO*.

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