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Impact of information technology capabilities on organizational resilience: the mediating role of social capital

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Organizational resilience is becoming a priority for enterprises' survival in volatile, uncertain, complex, and ambiguous (VUCA) contexts. However, few studies have investigated how information technology (IT) capabilities promote organizational resilience. To fill this gap, we draw on the IT capabilities literature and social capital theory to build a theoretical model to investigate the impact of IT capabilities on organizational resilience. The concept of social capital is introduced as a mediating mechanism in the relationship between IT capabilities (i.e., infrastructure capability, human capability, and business spanning capability) and organizational resilience (i.e., reactive and proactive resilience). The model is tested based on 369 Chinese manufacturing enterprises that survived the COVID-19 pandemic. This study confirms the key role of IT capabilities in building organizational resilience and the critical mediating role that social capital exhibits between IT capabilities and organizational resilience. This study has both theoretical and managerial implications for enterprise digital resilience.

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Introduction

In volatile, uncertain, complex, and ambiguous (VUCA) contexts, enterprises worldwide face a variety of dilemmas that have adverse effects on their performance and survival (González-Cabañas et al. 2021). These "black swan" events, such as the COVID-19 pandemic, have made enterprise survival even more difficult (Al-Omoush et al. 2020; Williams et al. 2017). During the pandemic, many ordinary enterprises struggled to survive, and even industry-leading enterprises suffered losses (Rodrigues et al. 2021). For instance, the well-known airline Avianca filed for bankruptcy protection in May 2020 as a result of the pandemic. The British Institute reported that 86% of supply chain suppliers were affected by the pandemic (Yang et al. 2022). In 2020, Apple announced that the company was expecting a worldwide iPhone supply shortage, as the coronavirus outbreak impacted its production and sales in China. These events highlight the need for enterprises to prepare for and develop the capability to respond to uncertain external environments (Lian et al. 2022).

Recently, IT has greatly facilitated enterprise transformation and development (Li and Jia, 2018). At present, IT permeates enterprises in terms of both internal functions and external business. Researchers have indicated that digital technologies (e.g., big data) and other new forms of IT enable enterprises to withstand external shocks more effectively. As enterprises and governments increasingly rely on IT-based infrastructure, IT has become the foundation for organizations' crisis response and recovery capabilities. This study argues that to survive and thrive in adverse contexts, enterprises must possess IT capabilities (Aslam et al. 2022; Buyl et al. 2019).

Existing studies have identified several key antecedents of organizational resilience, including organizational networks (Xie et al. 2022), organizational resources (Bhaskara and Filimonau, 2021; Prayag et al. 2024), resource management capabilities (Do et al. 2022), contingency planning (Ager et al. 2015), and management processes (Brinkerhoff and Bossert, 2014). Additionally, some studies have investigated the role of IT and digital technology on organizational resilience (He et al. 2023; Marcucci et al. 2022; Trieu et al. 2023). These studies primarily focus on the direct impacts of IT infrastructure and IT skills on organizational resilience. However, few studies have examined IT capabilities from a comprehensive perspective or investigated the mechanisms of how IT capabilities affect organizational resilience. Given the gaps in prior research, this paper conceptualizes organizational resilience in terms of both proactive and reactive aspects and divides IT capabilities into IT infrastructure capability (ITIC), IT human capability (ITHC), and IT business spanning capability (ITBSC). Our study aims to answer the question of how IT capabilities affect organizational resilience.

This paper proposes a research framework of "IT capabilities-social capital (SC)-organizational resilience" to address our research question. We use SC as a key intermediary for two reasons. First, SC not only plays a significant role in ensuring organizational survival (Monteil et al. 2020), but also helps organizations recover from disasters. According to SC theory, businesses can establish connections with other organizations to acquire resources that can enhance organizational resilience (Aldrich, 2012). Therefore, SC is suitable for investigating how IT influences organizational resilience. Second, detailed investigations of the factors that influence SC have revealed that IT is a vital factor that can increase SC (Aral et al. 2013). IT capabilities can facilitate social interactions, trust, and shared goals. Therefore, this study analyzes how IT capabilities affect organizational resilience through SC.

This study defines IT capabilities as comprising ITIC (the technological foundation), ITHC (the skilled personnel), and ITBSC (the business-IT strategic partnership). These three dimensions provide a comprehensive framework for understanding and leveraging IT capabilities to enhance organizational resilience. Research data were collected from 369 middle managers of Chinese manufacturing enterprises that survived the COVID-19 pandemic. These survey data are used to examine the links among IT capabilities, SC, and organizational resilience. The findings reveal that all three dimensions of IT capabilities can affect the two aspects of organizational resilience through SC.

This paper makes two primary theoretical contributions. First, we contribute to the organizational resilience literature by clarifying how IT capabilities affect organizational resilience in VUCA contexts. By proposing a theoretical framework of "IT capabilities-SC-organizational resilience", our research opens the black box of how IT capabilities affect organizational resilience through SC. Second, although recent research has explored the influence of IT capabilities and digital transformation on organizational resilience, it frequently concentrates on individual aspects of IT capabilities without providing a holistic understanding. This study fills this gap by categorizing IT capabilities into three distinct types and offering a multidimensional perspective on how these IT capabilities enhance organizational resilience.

The rest of our paper is structured as follows. In Section "Theoretical framework and hypothesis development", we review related literature on organizational resilience, IT capabilities, and SC, and we propose our research framework along with the corresponding hypotheses. Section "Methodology" outlines the methodology used in our study. In Section "Findings", we present the results of the data analysis. Section "Discussion and implications" discusses the theoretical and managerial implications of our findings. Finally, the paper concludes with a discussion of the research's limitations and suggestions for future research directions.

Theoretical framework and hypothesis development

This study is based on the perspective that the use of IT capabilities can influence SC, which in turn influences organizational resilience. This relationship flow is illustrated in Fig. 1.

Enterprises utilize various information and communications technologies, such as enterprise resource planning (ERP) and knowledge management systems (KMS), to establish communication channels and exchange supply and demand information with their partners. Nahapiet and Ghoshal (1998) indicate that these connections, alongside the tangible and intangible resources that they offer, constitute what is known as SC. SC equips enterprises with critical resources, such as vital information essential for their survival, thereby strengthening organizational resilience (Gölgeci and Kuivalainen, 2020).

Organizational resilience. Resilience, originally from the field of ecology, refers to the ability to absorb and develop under changing conditions (Holling, 1973). In management studies, this concept is generally associated with an organization's capability to endure and recover from adverse events (Annarelli and Nonino, 2016; Hall et al. 2017; Kahn et al. 2018). It is characterized as an organization's evolving ability to predict and adapt to its surroundings (Ortiz-de-Mandojana and Bansal, 2016). Building on

Fig. 1 Relationship flow.

Table 1 Definition and antecedents of organizational resilience.

Literature	Antecedent	Method	Organizational resilience	Findings
Jia et al. (2020)	Social capital	Survey ($n = 138$)	Defined as outcome	Structural capital influences proactive organizational resilience, whereas relational capital influences reactive organizational resilience
Prayag et al. (2024)	Resilient leadership	Survey ($n = 458$)	Defined as outcome	Resilient leadership behaviors can promote organizational resilience
Xie et al. (2022)	Network breadth and depth	Survey ($n = 409$)	Defined as process	Network depth and breadth impact organizational resilience capacity
Prayag et al. (2020)	Employee resilience	Survey ($n = 84$)	Defined as outcome	Employee resilience can influence organizational resilience
DesJardine et al. (2019)	Social and environmental practices	Survey ($n = 963$)	Defined as outcome	Strategically structured emergency preparedness plans can help enterprises recover from crisis
Do et al. (2022)	Resource-based management initiatives	Survey ($n = 188$)	Defined as process	Resource-based management activities indirectly impact organizational resilience
Marcucci et al. (2022)	Key IT-related technologies related to Industry 4.0	Survey ($n = 160$)	Defined as capability	Information technologies have positive influences on organizational resilience capabilities
Trieu et al. (2023)	IT capability and government support	Survey ($n = 247$)	Defined as outcome	Both IT capabilities and government support are essential in fostering organizational resilience
He et al. (2023)	Digital transformation	Survey ($n = 474$)	Defined as capability	Digital investments enable organizations to survive during crises
Duchek (2020)	Organization's knowledge base	Review	Defined as process	The knowledge base can promote organizational resilience
Su and Junge (2023)	Diversification and organizational ambidexterity	Review	Defined as process	Organizational ambidexterity and diversification can improve enterprise resilience
Ndiege et al. (2023)	Information technology	Interviews ($n = 20$)	Defined as capability	IT-enabled coping strategies help enterprises increase their resilience
Ngoc Su et al. (2021)	Human resource practices	Interviews ($n = 20$)	Defined as process	Human resource practices affect organizational resilience
Yuan et al. (2022)	Absorptive capacity	Case study ($n = 1$)	Defined as process	Absorptive capacity facilitates organizational resilience

previous research, we divide organizational resilience into two dimensions: reactive (passive) resilience and proactive (active) resilience (Jia et al. 2020; Sajko et al. 2021).

Proactive organizational resilience (POR) is defined as the active preparation for potential crises in advance (Williams et al. 2017). This preparation includes anticipating possible threats and implementing strategies to strengthen the organization's capacity to withstand risks. POR consists of four key organizational activities: potential risk prediction, self-assessment, self-improvement, and planning and preparation measures for crises (Jia et al. 2020). However, external factors such as social interactions and trust among organizational partners can either facilitate or impede the process of these activities. Reactive organizational resilience (ROR) consists of five activities performed in response to crises: quick response, information gathering and relevance analysis, rapid response measures, rapid organization of response teams, and successful crisis handling (Jia et al. 2020). Additionally, adaptability (Ritchie and Jiang, 2019) and information collection ability (Hervas-Oliver et al. 2021; Ray et al. 2005) are vital aspects that contribute to the enhancement of ROR.

We conduct a literature review on organizational resilience research focusing on two aspects: definition and antecedents (see Table 1). First, previous research has primarily defined organizational resilience from three key perspectives: as an outcome, as a capability, and as a process. Organizational resilience as an outcome refers to the tangible results and achievements demonstrated by an organization in response to a disruption (DesJardine et al. 2019; Jia et al. 2020; Prayag et al. 2024; Prayag et al. 2020; Trieu et al. 2023). Organizational resilience as a capability refers to an organization's inherent ability to prepare for and respond to adverse events (He et al. 2023; Hepfer and Lawrence, 2022; Marcucci et al. 2022; Ndiege et al. 2023). However, the outcome or capability view is questioned by Yuan et al. (2022). They argue that resilience is dynamic and propose that organizational resilience is the result of long-term development. This study defines organizational resilience as an outcome and empirically examines its determinants.

Second, we review the existing studies on the antecedents of organizational resilience. The antecedents include SC, resilient leadership, network breadth and depth, employee resilience, social and environmental practices, resource management measures, and human resource practices. For example, Prayag et al. (2020) argue that employee resilience has a positive influence on organizational resilience, whereas Ngoc Su et al. (2021) propose that human resource practices enable enterprises to foster organizational resilience. Recently, Ndiege et al. (2023) suggest that IT is crucial in enhancing enterprise organizational resilience. However, few empirical studies have investigated how IT capabilities can help enterprises develop organizational resilience to cope with and recover from major crises.

IT capabilities. IT capabilities have become essential for an organization's survival (Benitez et al. 2018; Li et al. 2013). It refers to the ability to the ability to leverage IT resources to support business strategies and processes (Ross et al. 1996). Drawing from prior research, we conceptualize IT capabilities in three dimensions: ITIC, ITHC, and ITBSC (Bharadwaj, 2000; Cheng and Wang, 2022; Liu et al. 2013; Shehzad et al. 2022).

ITIC refers to "a firm's capability that captures the extent to which the firm is good at managing data management services and architectures, network communication services, and application portfolio and services" (Lu and Ramamurthy, 2011, pp. 933-934). ITHC refers to the technical and managerial IT skills needed by an organization's employees (Mao et al. 2016). ITBSC describes an enterprise's ability to effectively use IT resources to support its business goals (Lu and Ramamurthy, 2011). This capability involves making a clear IT strategy, aligning IT planning with business planning, and helping management recognize the value of IT investments.

Social capital. SC helps enterprises survive disasters (Gölgeci and Kuivalainen, 2020; Ozanne et al. 2022) because it provides them with key access to resources and information that could aid them in disaster recovery (Gölgeci and Kuivalainen, 2020; Stolze et al. 2015). This study adopts a perspective that focuses on societal structure and defines SC in terms of structural, relational, and cognitive capital (Halushka and Inna, 2020; Woolcock, 1998).

Structural capital is defined as the arrangement of connections among individuals within and across enterprises; it describes enterprises' interactions and considers with whom and how they interact (Aslam et al. 2022; Jia et al. 2020). The social relationships that are established through interactions can offer organizations valuable resources and information (Du et al. 2014). Relational capital is defined as the strength of these relationships, that is, the level of reciprocity, trust, and respect between firms and partners (Aslam et al. 2022; Johnson et al. 2013; Polyviou et al. 2020). As these relationships strengthen, opportunistic behaviors that might occur in the cooperation can be reduced (Jia et al. 2020). Cognitive capital is defined as resources that promote the shared representations, understandings, and systems of meaning shared among various participants (Nahapiet and Ghoshal, 1998). Cognitive capital will increase when organizations hold similar aspirations, interests, objectives, and visions with their partners (Aslam et al. 2022; Jia et al. 2020; Polyviou et al. 2020). A shared vision can promote mutual understanding among members and support their work to achieve similar goals (Robert Jr et al. 2008). Moreover, cognitive capital can stimulate the emergence of a common language and collective ideology (Ali-Hassan et al. 2015; Roden and Lawson, 2014).

This study considers SC as a higher-level construct underlying its three dimensions: structural, relational, and cognitive capital (Jia et al. 2020). The concept captures the commonalities of all three of these dimensions. In addition, SC characterizes relationships that are created through exchange and thus provides enterprises with access to resources (Jia et al. 2020). Such capital reflects the extent to which enterprises are adept at obtaining resources from the relationships that are established through such exchange. For example, enterprises acquire valuable resources through interaction or trust and establish common goals in cooperation to promote success. Therefore, we propose that enterprises' SC serves as a key mediator that can explain the relationship between IT capabilities and organizational resilience.

IT capabilities and organizational resilience. Enterprises with high ITIC can set shareable information systems (e.g., ERP and data warehouses) that integrate data and business processes. This capability plays a critical role in enhancing enterprises' crisis prevention. Shareable information systems can provide real-time data monitoring and analytics, which enables enterprises to detect potential threats (Gu et al. 2021; Trieu et al. 2023). Besides, ITIC can facilitate enterprises in responding to crises and remaining resilient (Bustinza et al. 2019). When a crisis strikes, enterprises need to quickly determine the affected business processes and develop solutions. A well-developed IT infrastructure is very helpful in gaining timely access to critical information. By analyzing this information, enterprises can streamline their business processes and make quick decisions.

Hypothesis 1a: ITIC is positively associated with an enterprise's POR.

Hypothesis 1b: ITIC is positively associated with an enterprise's ROR.

Enterprises with high ITHC have a strong team of professionals who possess IT knowledge and expertise. Such skilled IT professionals can design and implement technology solutions to enhance an enterprise's capacity to react to potential disruptions. Their IT personal abilities allow quick detection and response to emerging threats (Bharadwaj, 2000; Selig, 2016). Additionally, IT professionals can develop contingency plans and maintain critical systems during disruptions to ensure business continuity. By leveraging their expertise, organizations can build a resilient infrastructure that is capable of adapting to and overcoming crises (Selig, 2016).

Hypothesis 2a: ITHC is positively associated with an enterprise's POR.

Hypothesis 2b: ITHC is positively associated with an enterprise's ROR.

Enterprises with ITBSC can improve risk prevention and response because they can effectively use IT resources to support their business goals. By integrating IT and business planning, enterprises can better anticipate and prepare for risks (Chen et al. 2014). In addition, management that understands the value of IT investments allocates resources to enhance security measures (Wang et al. 2019). This strategic approach ensures that IT systems are designed to quickly detect and respond to threats; this allows enterprises to effectively prevent risks and promptly respond to incidents. Moreover, enterprises with IT business-spanning capabilities can promote cross-departmental collaboration (Strese et al. 2016). Such collaboration allows different departments to work together to address potential risks.

Hypothesis 3a: ITBSC is positively associated with an enterprise's POR.

Hypothesis 3b: ITBSC is positively associated with an enterprise's ROR.

The mediating role of social capital. Enterprises with high IT capabilities can engage in frequent interactions with their partners via IT infrastructure (e.g., email, chat rooms, video conferences, and discussion boards). Through frequent social interactions, enterprises can enhance their relationships, trust, and shared vision with their partners (Han and Hovav, 2013; Jia et al. 2020; Nahapiet and Ghoshal, 1998). Enterprises with high SC can acquire more accurate and reliable information (Villena et al. 2011), thereby helping them predict potential crises (Koronis and Ponis, 2018). Typically, before a crisis, both upstream and downstream partners in an enterprise's supply chain may exhibit early signals, such as inventory backlogs at upstream enterprises, reduced orders, or poor sales performance at downstream enterprises. By engaging in social interactions, enterprises can proactively establish preventive measures to cope with such crises (Tanner et al. 2022). Moreover, many enterprises can share critical information with their trusted partners through information systems (Pfefferbaum et al. 2017; Zheng et al. 2022). For instance, enterprises can establish monitoring systems to collaboratively anticipate future risks and develop crisis response strategies (Jia et al. 2020).

Hypothesis 4a: SC mediates the relationship between ITIC and POR.

Hypothesis 4b: SC mediates the relationship between ITHC and POR.

Hypothesis 4c: SC mediates the relationship between ITBSC and POR.

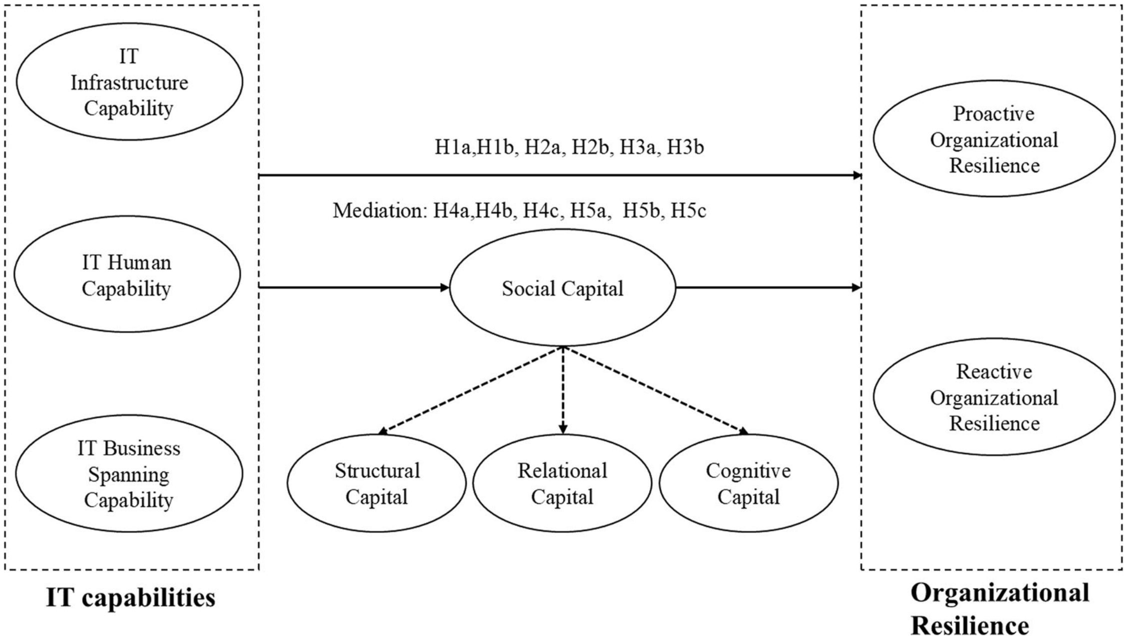

Fig. 2 Conceptual framework and hypotheses.

IT personnel are important in supporting the use of technology and resolving issues that occur in the context of enterprise collaboration (Shehzad et al. 2022). They can help enhance information accessibility for partners, thereby fostering transparency—an indispensable element in trust-building (Kim and Lee, 2018; Yang et al. 2022). In addition, enterprises with higher levels of ITBSC can clearly understand how IT contributes to enterprise management (Lu and Ramamurthy, 2011; Porter and Kramer, 2018). Enterprises with high SC can access quality information and resources for crisis management. When enterprises obtain pertinent information, they can expedite situational assessments and optimize crisis coping strategies, thereby fostering ROR. Enterprises can also establish supply chain networks with both upstream and downstream partners. The established networks offer more opportunities for enterprises to acquire needed resources. These enterprises possess the ability to transition to alternative networks and reduce losses caused by crises. (König et al. 2019). Moreover, the extant literature indicates that organizational resilience needs a shared understanding (Robert Jr et al. 2008). By establishing mutual understanding, enterprises can obtain key information to reduce uncertainties. Thus, we propose:

Hypothesis 5a: SC mediates the relationship between ITIC and ROR.

Hypothesis 5b: SC mediates the relationship between ITHC and ROR.

Hypothesis 5c: SC mediates the relationship between ITBSC and ROR.

All the hypotheses proposed in our research are summarized in Fig. 2.

Methodology

Research context. COVID-19 occurred in 2019, and more than 760 million cumulative cases were observed worldwide (WHO, 2023). The pandemic caused significant disruptions to global business activities. In America, lockdown measures resulted in numerous business closures. Chinese enterprises also faced significant challenges during the COVID-19 pandemic, which caused restrictions on operational activities, tightened cash flows, disrupted supply chains, and decreased market demand. According to a survey of 500 manufacturing companies in China (Shanghai Oriental Newspaper Co., 2020), 48.18% of the surveyed enterprises experienced significant losses due to the outbreak of the pandemic, and 2.55% of enterprises experienced irreversible damage. Only 25.91% of the enterprises experienced only a small amount of loss.

Sampling and data collection. Research data were collected from middle managers of Chinese manufacturing enterprises that survived the pandemic. The manufacturing enterprises included in the survey were mainly located in three Chinese provinces (i.e., Shandong, Zhejiang, and Jiangsu). The reasons for choosing these three provinces are as follows. First, the manufacturing industry in these provinces serves as a key contributor to the national economy. This selection helps to ensure the representativeness of the research data. Second, our established research base and network resources in these regions facilitated more efficient data collection and helped ensure the quality and reliability of the data. The survey data were collected by Wenjuanxing (equivalent to Amazon Mechanical Turk), a famous online questionnaire platform in China. Based on our research requirements, the company could facilitate the precise selection of middle managers of manufacturing enterprises and deliver the questionnaire to the targeted audience. The data collection began on December 15, 2022, and ended on January 3, 2023. A total of 677 questionnaires were distributed. Overall, 538 responses were collected from middle managers of manufacturing enterprises, with a response rate of 79.46%. After removing 121 responses due to incomplete information and excluding 48 responses because the managers' industries and positions did not meet our research criteria, 369 valid questionnaires were retained for further analysis.

To assess nonresponse bias, a comparison was conducted between early and late respondents using the Mann-Whitney U test. The results showed no statistically significant differences between the two groups ($P > 0.05$). The results indicate that nonresponse bias was not a concern in this study.

Survey instrument. We used multi-item reflective indicators to operate all the constructs (see Appendix Table A1). They were assessed on a 7-point Likert scale ranging from "1 = strongly disagree" to "7 = strongly agree". A total of 13 items are used to assess IT capabilities (Bharadwaj, 2000; Bhatt and Grover, 2005). Specifically, ITIC is measured via 4 items (Weill et al. 2002). ITHC is measured via 5 items (Bhatt and Grover, 2005) and primarily assesses employees' IT skills, control and evaluation of IT projects, and the IT team's understanding of strategic business alignment with IT planning. The measurement of ITBSC includes 4 items (Bharadwaj, 2000). These items reflect the extent to which the enterprise integrates IT strategic planning with its business and values management.

SC is measured via 14 items (Kale et al. 2000; Tsai and Ghoshal, 1998). Structural capital is measured via 4 items (Tsai and Ghoshal, 1998). We use 5 items to measure relational capital (Villena et al. 2011). This concept captures the close friendships, interactions, reciprocity, trust, and respect between an enterprise and its partners. We use 5 items to measure cognitive capital (Tsai and Ghoshal, 1998). This concept assesses the degree of alignment between the enterprise and its partners in terms of shared visions, goals, and mutual interests.

This research considers organizational resilience in two dimensions. We use 4 items to measure POR (Macdonald and Corsi, 2013). These items focus on proactive preparation activities before a crisis, such as internal crisis awareness, potential crisis assessment, preventive capabilities, and emergency planning. ROR is measured via 5 items (Christopher and Peck, 2004; Pettit et al. 2013). These items examine the organization's response activities following a crisis, including rapidly understanding the crisis, formulating measures, and establishing formal response teams.

The first two authors, who have high levels of English proficiency, translated the initial questionnaire into Chinese. We then invited experts from the manufacturing field to discuss the questionnaire both before and after translation. We determined the content of the Chinese version of the questionnaire by accounting for the relevant vocabulary and expressions alongside Chinese cultural characteristics. We also recruited a professional transcriber to verify the translated version and back-translated the survey to confirm the equivalence of the translated and original versions (Brislin, 1970). All participants completed the Chinese version of the questionnaire.

We utilized a procedural design and conducted a post-analysis to evaluate common method bias (CMB). In terms of procedural design, established scales were used in previous studies. Second, the data were collected by a famous online questionnaire enterprise. All the respondents possessed relevant knowledge of the manufacturing industry. Finally, anonymity was maintained in the questionnaires. In the post-analysis, we employed Harman's one-factor test to analyze all 36 items. The results indicate none of the individual factors explained more than 39% of the observed variance. Therefore, this study does not exhibit significant common method bias.

Data analysis. Partial least squares structural equation modeling (PLS-SEM) is a nonparametric statistical method (Chowdhury et al. 2020). Limaj and Bernroider (2019) report that PLS-SEM is a suitable approach for formative measures analysis (Xu et al. 2022). We tested all the items in this research for normality via the Kolmogorov–Smirnov test as recommended by Vaithilingam et al. (2024), and the results indicated that the data were nonnormal. PLS is suitable for nonnormally distributed data, whereas AMOS software relies on the assumption of normality, and a violation of this assumption could compromise the estimation process and results. Moreover, PLS has advantages regarding multicollinearity issues and facilitates direct estimates of path coefficients, thus making the results more straightforward to interpret. Therefore, we used SmartPLS 3.2.9 software instead of AMOS for the data analysis. We adhered to the sample size guidelines proposed by Hair et al. (2011). The sample size of at least ten times the largest number of structural paths associated with a specific latent construct in the structural model (Hair et al. 2011). Based on this requirement, our sample size meets the requirements.

Table 2 Respondent profiles.

Nature of enterprise in terms of property rights	Frequency	Percentage
State-owned enterprises	55	14.91
Private enterprises	240	65.04
Foreign-funded enterprises	49	13.28
Collective enterprises	24	6.5
Other	1	0.27
TOTAL	369	100%
No. of years in business operation		
Less than 5	99	26.83
5 to 10	107	28.99
11 to 20	98	26.56
21 to 29	48	13.01
30 or more	17	4.61
TOTAL	369	100%
No. of employees		
Less than 20	4	1.08
20 to 299	177	47.97
300 to 999	123	33.33
1000 or more	65	17.62
TOTAL	369	100%
Total annual sales (in tens of thousands of RMB)		
Less than 300	15	4.07
300 to 1999	124	33.6
2000 to 39999	170	46.07
40000 or more	60	16.26
TOTAL	369	100%

Findings

Sample characteristics. Table 2 reveals that more than half of the surveyed enterprises are private (65.04%). Most surveyed enterprises have been in operation for less than 5 years (26.83%) or are established businesses that have been operating for more than 5 years but less than 10 years (28.99%). Nearly half of the enterprises employ between 20 and 299 employees (47.97%). Additionally, the average annual sales of the enterprises over the past two years range from more than 20 million to less than 400 million RMB (46.07%).

Outer model evaluation. The assessment of the outer model involves evaluating the reliability and validity of the measures, with a threshold of 0.7 established for item reliability (Chin, 2009). Composite reliability (CR) and Cronbach's alpha (α) are used to evaluate the internal consistency of the items (Hair et al. 2019). All CR and α values exceed 0.8 (see Table 3), thus indicating that each dimension meets the requirements.

First, we assess the convergent validity of the constructs. Convergent validity is confirmed when the Average Variance Extracted (AVE) for each construct exceeds 0.5 (Hair et al. 2019). As shown in Table 3, all constructs have AVE values greater than 0.6. Second, we assess the discriminant validity of the constructs. Table 4 shows two criteria to establish discriminant validity: Fornell and Larcker's criterion and the heterotrait–monotrait ratio (HTMT) of correlations (Hair et al. 2019). The square root of the AVE values for each latent construct should be greater than all construct correlation values (Maroufkhani et al. 2022).

Table 3 Scale validity and reliability.

Scales	Loading	Cronbach's α	CR	AVE
ITIC		0.875	0.914	0.727
ITIC1	0.886			
ITIC2	0.831			
ITIC3	0.849			
ITIC4	0.844			
ITHC		0.899	0.925	0.712
ITHC1	0.858			
ITHC2	0.818			
ITHC3	0.847			
ITHC4	0.862			
ITHC5	0.832			
ITBSC		0.877	0.915	0.729
ITBSC1	0.883			
ITBSC2	0.829			
ITBSC3	0.857			
ITBSC4	0.846			
Structural capital (Q^2 = 0.447)		0.880	0.917	0.735
SC1	0.859			
SC2	0.884			
SC3	0.825			
SC4	0.860			
Relational capital (Q^2 = 0.478)		0.912	0.934	0.741
RC1	0.877			
RC2	0.882			
RC3	0.875			
RC4	0.791			
RC5	0.875			
Cognitive capital (Q^2 = 0.497)		0.921	0.941	0.761
CC1	0.906			
CC2	0.864			
CC3	0.836			
CC4	0.873			
CC5	0.882			
POR (Q^2 = 0.410)		0.876	0.915	0.729
POR1	0.846			
POR2	0.850			
POR3	0.857			
POR4	0.862			
ROR (Q^2 = 0.3)		0.928	0.946	0.777
ROR1	0.909			
ROR2	0.863			
ROR3	0.887			
ROR4	0.878			
ROR5	0.870			
Second-order reflective construct				
SC (Q^2 = 0.195)		0.917	0.846	0.674
Structural capital				
Relational capital				
Cognitive capital				

Additionally, the HTMT values should not exceed 0.9 (Maroufkhani et al. 2022).

Structural model. Concerning the model, we adopt the variance inflation factor (VIF) to evaluate the multicollinearity issue. All VIF values are under 3, which confirms that multicollinearity is not a concern in our research (Hair et al. 2019).

Following the analysis of the outer model, we evaluate the internal model via two indicators in PLS. The R^2 and Q^2 values are used to indicate the explanatory power and predictive relevance of the research model, respectively (Hair et al. 2019). Our research model explains 38.6% and 56.7% of the variance in reactive and proactive resilience, respectively. 41.1% of the variance in SC is accounted for by ITIC, ITHC, and ITBSC.

Table 4 Fornell-Larcker criterion and HTMT ratio.

	ITHC	ITIC	ITBSC	SC	POR	ROR
ITHC	**0.844**	0.526	0.459	0.570	0.631	0.385
ITIC	0.472	**0.853**	0.583	0.580	0.625	0.507
ITBSC	0.412	0.514	**0.854**	0.564	0.621	0.505
SC	0.518	0.521	0.512	**0.804**	0.755	0.611
POR	0.565	0.551	0.549	0.678	**0.854**	0.650
ROR	0.356	0.461	0.461	0.567	0.588	**0.882**

Note: The square roots of the AVE values are denoted by bold numbers, the Fornell and Larcker criterion is presented on the lower half of the diagonal, and the HTMT ratio is presented on the upper half of the diagonal.

Path coefficients are computed via the bootstrapping method with 5000 subsamples(Hair et al. 2019). Table 5 presents our results: 11 of the proposed hypotheses are supported, while only one hypothesis is not validated. These hypotheses are also confirmed via bias-corrected and accelerated (BCa) confidence intervals. ITIC ($\beta = 0.153$, $p = 0.004$), ITHC ($\beta = 0.213$, $p < 0.001$), and ITBSC ($\beta = 0.177$, $p = 0.006$) all have significant impacts on POR. Therefore, the outcomes support H1a, H2a, and H3a. ITIC ($\beta = 0.174$, $p = 0.011$) and ITBSC ($\beta = 0.186$, $p = 0.007$) both have positive impacts on ROR. ITHC ($\beta = -0.0.5$, $p = 0.943$) has no impact on ROR. The results indicate support for H1b and H3b, while H2b is not supported.

For the mediation analysis, our findings suggest that ITIC ($\beta = 0.095$, $p = 0.001$), ITHC ($\beta = 0.112$, $p < 0.001$), and ITBSC ($\beta = 0.102$, $p < 0.001$) all have positive indirect effects on POR through SC. Moreover, ITIC ($\beta = 0.086$, $p = 0.001$), ITHC ($\beta = 0.102$, $p < 0.001$), and ITBSC ($\beta = 0.092$, $p = 0.001$) exhibit positive indirect effects on ROR. These results support H4a to H5c.

The proposed model included the variables of years, size, and sales as control variables. The year variable exhibits a positive effect on reactive resilience ($\beta = 0.153$, $p < 0.001$) but no significant effect on proactive resilience ($\beta = 0.037$, $p = 0.359$). Size exhibits a negative influence on reactive resilience ($\beta = -0.092$, $p = 0.038$) but no significant effect on proactive resilience ($\beta = -0.069$, $p = 0.121$). The effects of sales on reactive resilience ($\beta = 0.008$, $p = 0.886$) and proactive resilience ($\beta = 0.066$, $p = 0.204$) are nonsignificant.

We used the Gaussian copula approach to check for endogeneity and the Kolmogorov–Smirnov test to check for nonnormality (Sarstedt et al. 2022; Vaithilingam et al. 2024). The Kolmogorov–Smirnov test results indicated that all the constructs are nonnormally distributed ($P < 0.05$). Additionally, we conducted a robustness check using the Gaussian copula approach (Sarstedt et al. 2020). The findings show that all Gaussian copulas (i.e., SC, ROR, and POR) are nonsignificant. Therefore, these results confirm the robustness of our research findings (Hult et al. 2018).

Owing to the large proportion of private enterprises in our sample, we revalidated the hypothesis via these 240 private enterprises. Appendix Table A2 presents the related results. With respect to the direct effects, H1a, H1b, and H2a are supported, while H2b ($\beta = 0.131$, $p = 0.220$), H3a ($\beta = 0.107$, $p = 0.247$), and H3b ($\beta = 0.094$, $p = 0.327$) are not supported. For the mediating effect, H4a ($\beta = 0.081$, $p = 0.057$) and H5c ($\beta = 0.084$, $p = 0.056$) are not supported, whereas the remaining hypotheses receive support.

Table 5 Path coefficients and effect sizes.

Paths	Std. Path coeff. (β)	T- stats	P values	BCa Confidence intervals		Hypothesis supported?
				2.50%	97.50%	
Direct effect						
ITIC - > POR	0.153	2.916	0.004	0.045	0.253	H1a Yes
ITIC - > ROR	0.174	2.559	0.011	0.041	0.307	H1b Yes
ITHC - > POR	0.213	3.751	0.000	0.103	0.324	H2a Yes
ITHC - > ROR	−0.005	0.071	0.943	−0.146	0.141	H2b No
ITBSC - > POR	0.177	2.770	0.006	0.049	0.298	H3a Yes
ITBSC - > ROR	0.186	2.702	0.007	0.050	0.318	H3b Yes
Mediating effect						
ITIC - > SC - > POR	0.095	3.224	0.001	0.042	0.157	H4a Yes
ITHC - > SC - > POR	0.112	3.568	0.000	0.056	0.177	H4b Yes
ITBSC - > SC - > POR	0.102	3.648	0.000	0.052	0.159	H4c Yes
ITIC - > SC - > ROR	0.086	3.440	0.001	0.039	0.137	H5a Yes
ITHC - > SC - > ROR	0.102	4.021	0.000	0.055	0.155	H5b Yes
ITBSC - > SC - > ROR	0.092	3.406	0.001	0.046	0.151	H5c Yes

Notes: β indicates the path coefficient; t indicates two-tailed t-test values; p values represent the significance level; path significances: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

Discussion and implications

In our study, we develop a theoretical model of "IT capabilities-SC-organizational resilience" to examine how IT capabilities affect organizational resilience in dynamic environments. This study confirms the key role of three IT capabilities in the process of promoting proactive and ROR and the crucial mediating role of SC in the relationship between IT capabilities and organizational resilience. Our research is an important step toward understanding the mechanisms through which IT capabilities affect organizational resilience. All hypotheses are supported except for H2b. For H2b, ITHC does not exhibit a positive effect on ROR. In a crisis, enterprises may cut back on workers to reduce expenses. Enterprises' IT teams may not be able to control IT projects because of the departure of IT staff and key technical personnel. Therefore, enterprises cannot quickly organize crisis response teams to ensure the continuity of business operations.

The empirical results confirm that SC plays a significant mediating role in the link between IT capabilities and organizational resilience. These findings enrich previous related research (Chowdhury et al. 2019; He et al. 2023; Marcucci et al. 2022; Trieu et al. 2023). For instance, Chowdhury et al. (2019) use adaptive resilience as a mediating variable to study how SC affects enterprise performance. He et al. (2023) and Trieu et al. (2023) confirm the direct effect of digital technology capabilities on organizational resilience. Similarly, Marcucci et al. (2022) confirm the direct effect of IT-related key technologies on organizational resilience. However, those authors ignored how IT capabilities affect organizational resilience. We address the research gap by investigating the indirect relationship between IT capabilities and organizational resilience through the mediation of SC.

Our study also enriches the literature by examining the relationship between IT capabilities and SC (Ali-Hassan et al. 2015; Kim and Shim, 2017). Ali-Hassan et al. (2015) explore the effect of social media usage on individual-level SC. Kim and Shim (2017) find that IT facilitates communication and information sharing among employees. In contrast to their research, our research investigates the effect of IT capabilities on SC at the firm level rather than at the individual level. Jia et al. (2020) investigate the effects of structural capital, relational capital, and cognitive capital as first-order constructs on both POR and ROR. Their findings indicate that structural capital positively influences POR, while relational capital positively affects ROR. There are two reasons why our research results differ from theirs. The first reason is that the research data differ. Jia et al. (2020) studied enterprises that survived the earthquake, and our data were collected from manufacturing enterprises in Zhejiang, Jiangsu, and Shandong Provinces. The second reason is that SC differs among enterprises in different industries. Enterprises in these provinces are embedded in close cooperation networks and exhibit higher SC. This makes them more likely to leverage this SC effectively in response to crises.

Theoretical contributions. This research offers two key theoretical contributions to the field of organizational resilience research. First, this study contributes to the organizational resilience literature by clarifying how IT capabilities affect organizational resilience in the VUCA context. We develop a theoretical model of IT capabilities–SC–organizational resilience to investigate the relationships among IT capabilities, SC, and organizational resilience. This framework enhances our understanding of how IT capabilities affect organizational resilience through SC. The mechanisms through which IT capabilities affect organizational resilience have not been explored in previous research. For example, Reich and Kaarst-Brown (2003) indicated that the relationships between digital technologies and resilience and the underlying mechanisms require further exploration. In this study, we explore how IT capabilities affect organizational resilience by identifying SC as a mediating mechanism. Our findings reveal the critical role of SC as a bridge in this process, which can enhance organizational resilience research.

Second, our research enhances the understanding of the antecedents of organizational resilience by identifying and examining three dimensions of IT capabilities: ITIC (technological foundation), ITHC (skilled IT personnel), and ITBSC (business-IT strategic partnership). Prior research has investigated the antecedents of organizational resilience from the perspective of organizational networks and contingency planning (Ager et al. 2015; Xie et al. 2022). Recent research has investigated the impact of IT capabilities or digital transformation on organizational resilience (He et al. 2023; Trieu et al. 2023) but focused only on individual aspects of IT capabilities without offering a comprehensive framework. IT capabilities indicate a firm's proficiency in managing its IT resources to support and enhance its business strategies and activities (Bharadwaj, 2000; Lu and Ramamurthy, 2011). We demonstrate that this concept needs to be reflected in multiple dimensions. By categorizing IT capabilities into three distinct types, we provide a holistic understanding of how IT capabilities affect organizational resilience.

Managerial contributions. We also provide practical suggestions regarding how IT capabilities can be fostered to promote organizational resilience. First, our findings indicate that structural capital mediates the relationship between IT capabilities and organizational resilience. Therefore, enterprises should leverage IT capabilities to enhance interaction and collaboration with their partners. For example, enterprises can implement advanced collaboration platforms to enable seamless communication and project management across organizational boundaries. Additionally, enterprises can integrate enterprise resource planning systems with partners for supply chain management and visibility into order status. This integration helps align production schedules and reduces delays caused by miscommunication or data inconsistencies. By using IT capabilities to improve these collaborative processes, enterprises can respond in a more agile way to market changes and crises.

Second, this study demonstrates that relational capital mediates the relationship between IT capabilities and organizational resilience. Leveraging IT capabilities can significantly enhance trust with business partners by facilitating more transparent and efficient interactions. For example, implementing advanced IT systems such as real-time data-sharing platforms or collaborative project management tools allows partners to access up-to-date information and reduces uncertainties during crises. These systems can track progress and ensure that all parties are aligned with the agreed-upon objectives. By actively investing in such IT-enabled relationships, enterprises can build a robust support system that not only mitigates risks but also enhances their ability to adapt and recover from crises.

Third, this research reveals that cognitive capital serves as a mediator between IT capabilities and organizational resilience. Enterprises can utilize IT capabilities by implementing collaborative platforms and integrated communication tools to enhance understanding and establish a shared vision with partners. For example, enterprises can cultivate an environment of continuous learning by investing in KMS and collaborative tools that encourage the sharing of expertise and best practices. This approach helps employees quickly develop new skills and adapt to changing conditions. Additionally, encouraging open communication and forming cross-functional teams can harness diverse perspectives for quicker adaptation to crises.

Limitations. Although this research offers some contributions, it also has its limitations. First, the ability to generalize these results to other industries is restricted due to the sample characteristics. The sample was limited to manufacturing enterprises in China, whereas the influence of the COVID-19 pandemic was global. The generalizability of our findings to other industries is thus limited by sample characteristics. The IT capabilities of the education industry have become a hot topic in the organizational resilience literature. Future research could explore how IT capabilities foster the recovery of such enterprises after disasters. Second, the relationships on which our research focused are limited to one type of culture. Future research should develop cross-cultural models to obtain a deeper insight into the dynamics that characterize the relationships between IT capabilities and SC, as well as the corresponding effects on organizational resilience. Third, IT is only one aspect of how resilience is achieved during a crisis. From the social-technical perspective, future research can explore how other factors, such as personnel, funding, and culture, interact with or can be combined with IT to promote organizational resilience.

Data availability

The data used in this study has been made available as a supplementary file to this article. This ensures transparency and enables further analysis or replication of the results by interested researchers.

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Competing interests

The authors declare no competing interests.

Ethical approval

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Informed consent

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Additional information

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