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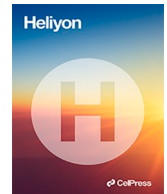
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Research article

Top of tide: Nexus between organization agility, digital capability and top management support in SME digital transformation

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ABSTRACT

In the swiftly evolving business landscape, digital transformation (DT) has emerged as a crucial strategy for firms to gain a competitive edge. Despite the abundance of literature on DT in firms, there remains a dearth of empirical research that defines and analyzes crucial antecedents of small and medium-sized enterprises' (SMEs) DT from an internal perspective. To fill this research gap, this study examines the correlation between organizational agility and digital capability in cultivating SMEs' DT while also evaluating top management support as a moderating variable through the lens of internal factors of SMEs. The results indicate that both organizational agility and digital capability have a positive impact on SMEs' DT, with organizational agility significantly influencing digital capability. Furthermore, the findings highlight that digital capability serves as a mediator between organizational agility and SMEs' DT. In addition, top management support plays a moderating role in these relationships to a certain extent. Additionally, we explicate the concept of digital capabilities from the perspective of dynamic capability. Our study contributes to an enhanced understanding of the effect of organizational agility and digital capability on SMEs' DT, as well as the role of top management support. We provide recommendations for managers to enhance organizational agility and suggest that SMEs should improve their digital thinking to better perceive digital technology changes, enhance digital operation capabilities, and better integrate digital resources.

1. Introduction

Digital technologies, such as artificial intelligence (AI), machine learning (ML), cloud computing, blockchain, and the Internet of Things (IoT), have already diffused across various fields and have significantly impacted enterprise competitiveness and development

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([1,2]; Steiber et al., 2021). On the one hand, these effects are positive, which include enhancing customer service efficiency and satisfaction [3,4], transforming business models [5,6], fostering innovation [7], and creating values [8,9], among others. On the other hand, rapid changes brought about by the development of digital technologies make the current business and operating surroundings full of uncertainty, such as dynamic changes in customer demand. As a result, in the competitive market, firms, especially SMEs which are naturally more flexible, are eager to leverage their strengths to make better use of digital technologies, so as to achieve digital transformation goals and gain competitive advantages [10].

However, research conducted by the Boston Consulting Group has revealed that a considerable 70 % of digital transformation initiatives fail to meet their intended objectives [11]. This finding suggests that the practical application of digital transformations is a daunting challenge. Furthermore, in comparison to larger enterprises, SMEs encounter more obstacles when it comes to implementing digital transformation, such as limited resources, concerns regarding data security, and significant opportunity costs [12,13]. To compound this issue, the intricate and multifaceted nature of digital transformation means that many SME managers may be rash or hesitant in their approach to implementation [14]. As a consequence, the ability to perceive and leverage digital technologies is a key factor for SMEs to ensure the success of their digital transformation [15]. Meanwhile, top management support for a coherent digital transformation strategy is essential.

How to achieve the goal of digital transformation has also aroused attention in the academic field. In recent decades, numerous valuable academic investigations have been conducted regarding the facilitators of DT. For instance, several scholars contend that DT is influenced by the interaction of various factors and have analyzed DT support factors such as connectivity, collaboration, enterprise digital infrastructure, security, culture, and management support [16,17]. Specifically, concerning SMEs, some literature highlights the significance of culture, trust, and management's optimism as crucial elements in driving DT [18]. Furthermore, other studies emphasize the role of digital platforms and information system capabilities in the DT of SMEs [19]. Additionally, Vial [20] asserts that digital capability enables enterprises to redefine people, objects, and processes, and promotes corporate value creation. Although previous research streams have provided a comprehensive categorization of antecedent factors contributing to DT, there is a dearth of research that defines and analyzes key factors of SMEs' DT from an internal perspective. For example, in much research on SMEs' DT, while digital capability is mentioned, their composition dimension is not deconstructed. Furthermore, research on the nexus between important antecedents is also lacking. To respond to the practice need and fill the gap in the literature, the current research addresses two questions: (1) From an internal perspective, what are the important factors affecting digital transformation in SMEs? (2) What is the correlation between these important factors?

Following this, the present study endeavors to investigate the internal factors that significantly impact the SMEs' DT. Firstly, the uncertainty of the business and operational environment associated with the rapid development of digital technologies requires organizations to be able to respond proactively to change [21]. According to Lu and Ramamurthy [22], organizational agility is a firm's ability to cope with rapid, relentless, and uncertain changes and thrive in a competitive environment of continually and unpredictably changing opportunities. In addition, many scholars reckon that organizational agility is vital to innovation and competition (e.g., Ref. [23]). Therefore, organizational agility is a crucial factor that enables enterprises to gain a competitive advantage in the digital age [24]. Secondly, in the rapidly changing digital economy environment, companies must possess dynamic capabilities to adapt. Dynamic capabilities are defined as "the firm's ability to integrate, build, and reconfigure internal and external competences to address a rapidly changing environment" [25]. The core components of dynamic capabilities include "sensing", "seizing" and "reorganizing". In the digital economy, digital capability represents the critical embodiment of dynamic capability and is a vital condition for the success of enterprise digital transformation [26]. Thus, we draw upon the core content of dynamic capabilities to conceptualize digital capabilities. Additionally, top management support is essential throughout the transformation process, as digital transformation strategies impact the entire company and their execution may result in resistance from different areas of the organization [17,27]. Moreover, this study aims to figure out the interactions between these three internal factors. Specifically, our objectives are as follows: (1) explore the connotation of digital capability from the perspective of dynamic capability; (2) determine the relationship between organizational agility and digital capabilities and their influence on DT; and (3) ascertain the moderating effect of top management support on the relationships between organizational agility, digital capability, and DT.

This scholarly article presents several significant contributions in both theoretical and practical domains. Initially, our investigation responds to the research gap identified by scholars, pertaining to the prosperous survival of SMEs in the ever-changing digital economy [19,21]. Our study delves into the internal factors that have a considerable influence on SMEs' digital transformation. We have developed a novel theoretical model called "organizational agility - digital capability - digital innovation performance" from the SMEs' perspective, which provides a fresh framework to understand the SMEs' DT under the digital economy's dynamic environment. Then we verified it by structural equation modeling. Moreover, we have explored the notion of digital capability through the lens of dynamic capability and proposed three dimensions of digital capability, namely digital perception capability, digital operation capability, and digital integration capability.

Our empirical results illustrate that both organizational agility and digital capability contribute to the successful DT of SMEs. Notably, organizational agility has a strong positive impact on digital capability, and digital capability mediates the relationship between organizational agility and SMEs' DT. Additionally, top management support plays a crucial moderating role in SMEs' DT. Based on our findings, this study offers recommendations to SME managers to enhance organizational agility and develop digital capability. Therefore, this research has valuable implications for both academia and practitioners to understand and improve SMEs' DT processes. The research logic is structured as follows (see Fig. 1).

2. Literature review and hypotheses

Digital transformation is a crucial mechanism that SMEs can employ to attain a competitive edge in the contemporary digital economy [28,29]. Therefore, it is imperative to investigate the factors that contribute to the promotion of SMEs' DT, especially since research on the impact of internal factors and their interrelationships is currently inadequate. This section undertakes a thorough analysis of several pivotal internal factors, namely organizational agility, digital capability, and top management support, while also discussing and proposing their interdependence.

2.1. Digital transformation

Research concerning digital transformation has garnered significant attention over the past few decades. Nevertheless, the discourse regarding the precise definition of DT and the effective implementation of DT by organizations remains inconclusive. Certain scholars posit that DT involves the utilization of novel digital technologies to facilitate advancements in a company's operations (e.g., Ref. [5]). Moreover, the proposition put forth by Matarazzo et al. [30] posits that DT is the means by which a company can apply digital

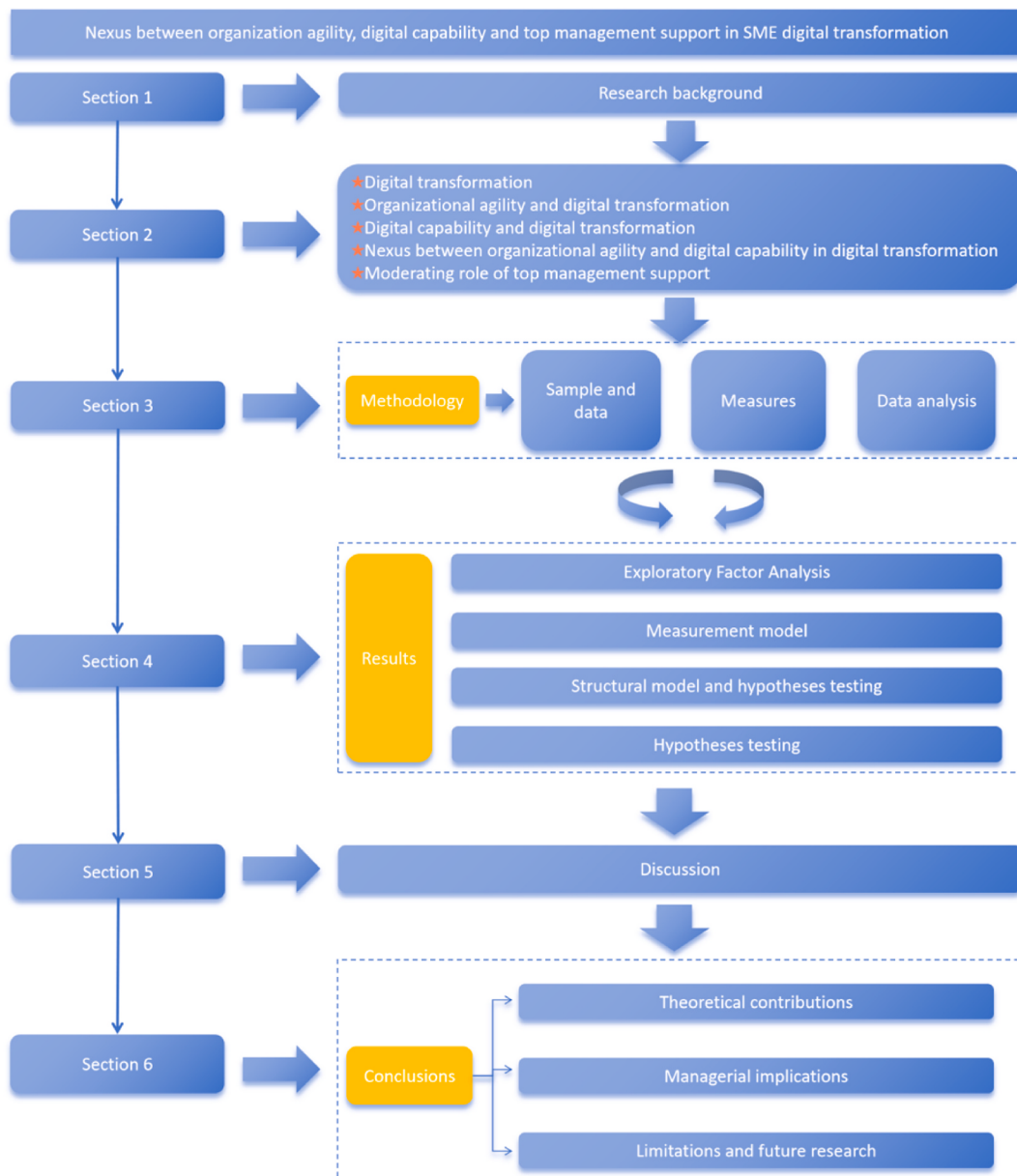


Fig. 1. Research logic of organization agility, digital capability and top management.

technology to create value for its customers. Furthermore, according to a recent study conducted by Wessel et al. [29], DT can be defined from an organizational change perspective as the process of redefining an organization's value proposition and identity. Zaoui and Souissi [31] have revealed that the process of DT encompasses evaluating the current digital state of a company, defining its digital transformation approach, setting strategic objectives, and devising innovative methods to achieve them. Despite these differences, the majority of the existing literature emphasizes the impact of digital technology on various aspects of firms such as products, business processes, cultures, values, and more [28,32]. Consequently, we have integrated the existing research and defined DT as a process that aims to enhance an organization's product, service, and value proposition by employing digital technologies, while also leveraging organizational characteristics.

The extant literature has been examined from various perspectives in terms of contributing factors to the success of DT. Generally, these factors can be categorized into external and internal factors. A significant number of scholars have analyzed the digital transformation of enterprises from an internal perspective, including information technology, employee skills, digital strategy, innovation strategy, leadership, and organizational culture, among others (e.g., Ref. [16,33,34]). Concurrently, a considerable number of studies have also explored the antecedents of DT from the viewpoint of the external environment. For instance, connectivity, customer demands, network, and so on have shown to have a positive impact on DT [19,35,36]. Furthermore, some literature has summarized the promotion factors of DT. For example, Vogelsang et al. [17] have demonstrated the factors of DT from organizational factors (e.g., pilot projects, autonomy, employee qualification, culture) the external environment (e.g., transparency, collaboration, standards), and technology factors (e.g., infrastructure, reliability, real-time data). Similarly, Zhang et al. [37] have also illustrated the contribution factors of DT from these three aspects, i.e., government support and partnership (environmental factors), IT infrastructure and IT management capability (technological factors), and digital strategy and top management (organizational factors).

Despite the considerable number of investigations conducted thus far, we maintain that the examination of internal factors is of significant value to the implementation of DT within SMEs. Notably, the capacity of organizations to proactively react to changes holds particular importance in DT, as emphasized by Troise et al. [21]. Consequently, we have opted to explore the relationship between organizational agility and digital capability as two distinct variables, and to examine their respective impacts on DT.

2.2. Organizational agility and digital transformation

The advent of digital technology and subsequent digitization have rendered the business environment faced by SMEs more volatile and unpredictable in nature. It is, therefore, imperative that SMEs adapt to change in a timely manner and respond proactively to ensure their future growth and development [38,39]. Organizational agility is a firm's capacity to adeptly handle rapid, unrelenting, and indeterminate changes, and excel in a competitive environment [22]. Simultaneously, agility plays a pivotal role in enabling companies to attain a competitive edge and spur innovation [23,24]. Organizational agility encompasses the management of customer relationships, business processes, and partner affiliations. It can be summarized as agility at both the strategic and operational levels [40]. The ability of a firm's processes to achieve flexibility, accuracy, and efficiency constitutes operational agility, as elucidated by Huang et al. [41]. Conversely, strategic agility places emphasis on the ability to react to new market conditions and generate value through innovation [42].

Previous investigations highlight that the performance of SMEs is positively impacted by their organizational agility [43]. In order to maintain a sustainable competitive advantage amidst intense competition, SMEs must possess the capability to continuously acquire, monitor, and process environmental signals, make innovative decisions, and promptly adjust their processes [44]. Additionally, the adoption of DT is preceded by organizational agility [45,46]. For instance, Carmeli et al. [47] reveal in their study that organizational agility stimulates the need for organizational transformation incorporating digital technology. Correspondingly, DT necessitates the capacity to respond effectively and make rapid, adaptable decisions, as stated by Lewis et al. [48]. Drawing from the discussion of relevant literature above, we propose the following hypothesis.

H1. Organizational agility positively influences the success of SMEs' DT.

2.3. Digital capability and digital transformation

Technological skills and capabilities constitute essential resources necessary for innovation or transformation, as highlighted by Freel [49] and Renko et al. [50]. In the contemporary business landscape, characterized by volatility, uncertainty, complexity, and ambiguity (VUCA), digital resources and capabilities have emerged as the most critical capability for companies seeking to gain a sustained competitive advantage [51,52]. Consequently, scholars have conducted extensive research on digital capability, from technical, commercial, organizational, and other perspectives. Notably, various articles have demonstrated that digital capability is mainly reflected in the application of digital technologies in product, service, and process innovation [53]. The resource-based view posits that the measure of digital capability should be based on the extent to which an enterprise's investment in digital technology leads to superior financial returns [26,54].

In the context of SMEs, digital capability is more about the ability to sense and use digital technology flexibly. The perspective presented herein aligns with the findings of Warner and Waeger [55], who assert that a model of dynamic capability for digital transformation must encompass digital sensing, digital seizing, and digital transforming capabilities. Moreover, Annarelli et al. [56] contend that dynamic capability, as a subset of capabilities, represents the primary source of sustainable competitive advantage in a mutable competitive landscape. Accordingly, we posit that digital capability is a manifestation of dynamic capabilities in the digital era. Additionally, the connotation of digital capability is delineated through three dimensions of dynamic capabilities, namely sensing,

seizing, and reorganizing. Specifically, sensing entails the ability to detect and learn from change, a trait closely associated with an organization's innovativeness [57–59]. In the digital milieu, digital technology propels the swift iteration of business models and the rapid evolution of firms' operational strategies. Thus, the capacity of an enterprise to promptly perceive changes and effectively learn in the digital milieu is referred to as its digital perception capability. Inadequate digital consciousness would render enterprises incapable of maintaining a high level of sensitivity to the digital economy environment, consequently impeding their ability to spot opportunities inherent within the digital economy, ultimately leading to complete disruption soon after [60]. Therefore, in light of the ambiguous and intricate nature of the digital economy, it is imperative for organizations to possess the faculty to discern the trajectory of technological advancements, the potentiality of rivals, and the alteration of client demands. As a result, the digital perception capability, which aligns with the notion of "sensing", serves as a fundamental requirement for the digital transformation of enterprises.

Secondly, in accordance with the dynamic capability theory, seizing denotes the capability of exploiting opportunities and mobilizing resources [61]. This involves responding to perceived technology or market opportunities with novel products/processes/services [58]. In the digital context, seizing is manifested through digital operation capability, which entails leveraging digital technology to revolutionize and innovate products, processes, and services. As a mutable developmental process, DT necessitates operational activities for its promotion. Digital operation capability is a crucial enabler for transforming digital technology into enterprise value creation [62,63]. Consequently, digital operation ability is an indispensable prerequisite for the practice of digital transformation.

Thirdly, the process of reorganizing entails making modifications to a company's procedures and customary practices, while simultaneously utilizing resources in novel ways, as indicated by Yeow et al. [64]. To put it differently, a company engages in reorganization or updating its existing conditions through the incorporation of new technologies or resources in order to cultivate novel competitive advantages [65,66]. In the digital era, reorganizing is exemplified by digital integration capability. For instance, digital technology is employed in innovating enterprise business models, as observed in the works of Kohli and Melville [67] and Saarikko et al. [68]. The extensively researched literature streams unequivocally underscore that the most advanced stage of DT is marked by the emergence of altogether new schemata, which fundamentally transform the nature of work and the structure of organizations [69]. This profound transformation involves a redefinition of an organization's value proposition and identity, as noted by Wessel et al. [29]. Therefore, in the advanced stage of DT, the digital integration capability plays a pivotal, enabling role. Thus, we posit.

H2. Digital capability positively influences the success of SMEs' DT.

H2a. Digital perception capability positively influences the success of SMEs' DT.

H2b. Digital operation capability positively influences the success of SMEs' DT.

H2c. Digital integration capability positively influences the success of SMEs' DT.

2.4. Nexus between organizational agility and digital capability in digital transformation

As previously indicated, organizational agility refers to an organization's capacity to perceive alterations in its surroundings and preserve or attain competitive advantages by utilizing and reallocating internal resources [70]. For SMEs, organizational agility is perceived as a manifestation of ongoing improvement in operations to achieve flexibility, precision, and efficiency [41]. Additionally, it represents the strategic level of corporate awareness concerning environmental changes, and the ability to demonstrate remarkable improvisation and innovation [71]. In the contemporary era of rapid digital technology development, enterprises exhibiting robust organizational agility are markedly more inclined towards the pursuit of novel knowledge and the advancement of digital capabilities, thereby ensuring congruence between the velocity of organizational innovation and digital technological progress [21]. Consequently, organizational agility assumes a pivotal role in augmenting enterprise digital perception, digital technology implementation, and digital resource assimilation. Based on the above discussion, we formulate the following hypothesis.

H3a. Organizational agility positively influences digital capability.

The acquisition of digital capability is a novel driver for SMEs to attain a competitive edge in the digital age. While, this undertaking is interdependent on the backing of an agile organization. Specifically, the attributes of organizational agility namely responsiveness, flexibility, speed, and competence can effectively facilitate the development of digital capabilities [72]. This implies that SMEs endowed with organizational agility are better positioned to exploit their digital capability to accomplish innovative performance in the face of an extremely unpredictable market climate. Furthermore, both process and strategic agility assist SMEs in enhancing digital awareness, adoption, and integration, ultimately promoting sustainable digital transformation via augmented digital capabilities [40]. Thus, we propose the hypothesis.

H3b. Digital capability mediates the relationship between organizational agility and the success of SMEs' DT.

2.5. Moderating role of top management support

The development of the digital economy has a profound impact on the operational processes of businesses. In order to maintain efficiency and competitiveness, firms must engage in digital transformation in response to the rapidly changing external environment. During the digital transformation process, top managers play crucial roles as they are the primary decision-makers who set the firm's digital strategy [73]. Furthermore, they possess significant influence over firm strategies and performance through their

decision-making power [74,75]. There are specific reasons for this phenomenon, namely, top management support provides the necessary funds and resources for innovation and transformation [76]. Additionally, top management acts as supporters within the company, facilitating interaction and collaboration between departments while guiding them to form a unified idea. Consequently, top management support serves as a key driver for overcoming obstacles and enhancing a firm's technological ability to successfully adopt or implement new services or products [77]. Secondly, research suggests that top managers facilitate the establishment of the necessary organizational structure and culture to provide a pathway for the DT of enterprises [78]. Therefore, it is imperative to acknowledge that even with significant organizational agility advantages and digital capability, their efficacy would be rendered futile if there was an absence of top management support for the implementation of DT. The conceptual model of this study is shown in Fig. 2.

H4a. Top management support moderates the relationship between organizational agility and the success of SMEs' DT.

H4b. Top management support moderates the relationship between digital capability and the success of SMEs' DT.

3. Methodology

This particular study employed a quantitative methodology to investigate the interconnections between organizational agility, digital capability, top management support, and the triumphs of SMEs' DT. As a metric for the prosperity of SMEs' DT, we opted for digital innovation performance [79]. What follows is a detailed elucidation of the techniques employed in this study. The studies involving human participants were reviewed and approved by the Ethics Committee of Taizhou Vocational & Technical College (No.20220109). Besides, this study obtained the informed consent of all participants.

3.1. Sample and data

China's digital economy reached 50.2 trillion yuan (\$7.01 trillion) in 2022, ranking second in the world and accounting for 41.5 percent of the country's GDP. In addition, SMEs in China account for over 90 % of firms in the country. Thus, this study focuses on Chinese SMEs as they are an important and representative component of the digital economy. Specifically, the present empirical investigation centers on technology-based SMEs in China because they have more experience in digital transformation and more adequate funding for digital transformation from the National Innovation Fund, which is in line with our research objectives. These enterprises are involved in the fields of electronic information, bio-medicine, new materials, new energy and so on. Data collection was done through an online survey. Initially, we acquired the contact information of SME management departments in each province/city through the government service platform of the Ministry of Science and Technology. Subsequently, with their assistance, we participated in eight online technology-based enterprise forums from March to November in the year 2022 and contacted the participating enterprises as many as possible, ultimately establishing preliminary cooperative intentions with 486 firms. To obtain feedback from individuals who were knowledgeable about the company's strategy, the survey was targeted at either the CEO of the organization. Following this, we dispatched invitation emails to our target respondents. Over the ensuing two weeks, upon receiving reply emails, we proceeded to distribute questionnaires to these respondents via email. This process spanned three months, from December 2022 to February 2023, ultimately culminating in the receipt of 431 responses. After eliminating invalid questionnaires, such as those with short completion times or obvious similarities, we obtained 359 valid questionnaires, for an effective rate of 83.3 %. The findings regarding the final samples are presented in Table 1.

Specifically, out of the total sample size, 88 firms were from the electronic industry, 114 from the machinery industry, 62 from the software and information industry, 55 from the bio and pharmaceutical industry, and 40 from other industries. The majority of companies, amounting to more than 70 % (72.14 %), had 51-300 employees. With regards to the establishment time, the vast majority of SMEs, accounting for 77.15 %, were established after 2008. Furthermore, it is noteworthy that nearly half of the enterprises, that is, 49.86 %, originate from the Pearl River delta.

3.2. Measures

The measures utilized in this study have been presented in Table 2. The items were assessed via a five-point Likert scale that ranged from 1 = "strongly disagree" or "never" to 5 = "strongly agree" or "always". To measure organizational agility, six items were adapted

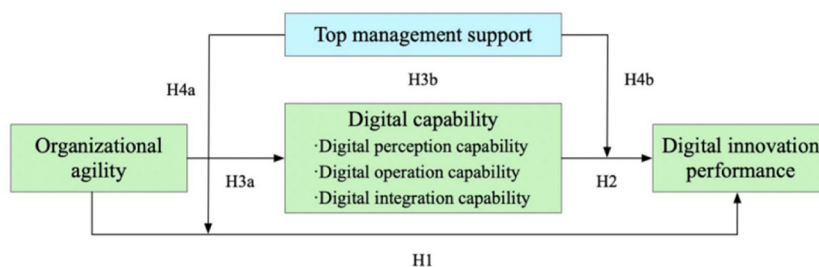


Fig. 2. Conceptual model.

Table 1
Firm profiles.

Firm profile	N	%		N	%
<i>Industry</i>			<i>Number of employees</i>		
Electronic	88	24.51	1–50	42	11.70
Machinery	114	31.75	51–100	131	36.49
Software and information	62	17.27	101–300	128	35.65
Bio and pharmaceutical pharmaceuticals industry	55	15.32	301–500	58	16.16
Others	40	11.14			
<i>Location</i>			<i>Year of establishment</i>		
Yangtze river delta	97	27.02	Before 2007	82	22.84
Pearl river delta	179	49.86	2008–2012	152	42.34
Jing-jin-ji region	62	17.27	2013–2017	73	20.33
Other regions	21	5.85	After 2018	52	14.48

in line with prior researches [80,81]. To measure digital capability, three dimensions were taken into consideration: digital perception capability, digital operation capability, and digital integration capability. As per extant literature [55,82], the three dimensions were assessed by three items, respectively. To evaluate top management support, five indicators were used from Swink [83] and Rodríguez et al. [84]. Additionally, in accordance with prior studies [85–87], digital innovation performance was evaluated by five items.

3.3. Data analysis

The analysis for this study was conducted using the variance-based structural equation modeling method. This was considered as the most suitable data analysis technique for this research in view of the objectives and exploratory nature of this study (the conceptualization of digital capability) and the presence of second order formative constructs in the measurement model [88]. We analyzed this model using SPSS 24.0 and SmartPLS 4.0.9.2 softwares [89]. SPSS was used to perform an exploratory factor analysis of the digital capability indicators. The PLS-SEM technique was chosen because it helps to yield accurate results in exploratory studies. In addition, it is suited to models which have small and medium sample sizes. And this approach also has no strict requirements on the number of latent variables (i.e., a few indicators are acceptable) [90]. Therefore, this method is appropriate for data analysis and model testing. Following the usual approach of PLS-SEM, we conducted model analysis through two-steps, namely assessment of the outer (measurement) model and the inner (structural) model.

4. Results

The following subsections present the results of the analyses of the data collected on 359 companies. The first subsection identifies

Table 2
Construct measurement instrument.

Constructs	Measures
Organizational agility (OA)	OA1: We can respond quickly to customers' needs. OA2: We can adapt our production and/or service provision rapidly to meet demand fluctuations. OA3: We can cope with problems from suppliers rapidly. OA4: We rapidly implement decisions to face market changes. OA5: We continuously search for forms to reinvent or change our firm. OA6: We see market changes as opportunities for rapid development.
Digital capability (DC)	
● Digital perception capability	DC1: We can sense digital technological trends. DC2: We can analyze and interpret digital future scenarios. DC3: We can judge our own/competitors' digital level.
● Digital operation capability	DC4: We can use digital tools to optimize business processes. DC5: We can use digital tools for market analysis and product sales.
● Digital integration capability	DC6: We can use digital tools to improve decision-making effectiveness. DC7: We can use digital technology to integrate and optimize internal and external resources. DC8: We can use digital technology to refresh our business model.
Top management support (TMS)	DC9: We can shape the digital mindset of our employees. TMS1: The top management has explicitly defined digital transformation goal. TMS2: The top management has committed to make the digital transformation success. TMS3: The top management was involved the entire digital transformation process. TMS4: The top management has provided the necessary resources to the digital transformation goal. TMS5: The top management has positively valued the employees' ideas and suggestions.
Digital innovation performance (DIP)	DIP1: We experiment with more new digital technology in our existing market than our competitors. DIP2: The features of our digital solutions are superior compared to our competitors'. DIP3: We invent more new digital products and/or services than our competitors. DIP4: We utilize more new digital opportunities in new markets than our competitors. DIP5: We use more digital distribution channels than our competitors.

three classifications of digital capability indicators by using exploratory factor analysis. The second subsection tests the measurement model. The last part contains the results of the structure model and hypothesis testing.

4.1. Exploratory factor analysis

In this study, we conducted an investigation into the significance of the reliability of the fundamental variables of the nine digital capability (DC) measurements in the survey by means of exploratory factor analysis (EFA). As evidenced by Table 3, we procured three classifications of DC indicators, which are represented by nine distinct indicators.

4.2. Measurement model

To check the quality of the outer model we tested for the indicator reliability, and found no item had an outer loading lower than the minimum value of 0.6 [91,92]. Besides, we assessed all indicators in terms of reliability as illustrated in Table 4. All indicators and constructs meet the measurement criteria. First, all item loadings were significantly above the suggested acceptance limit of 0.7 [91, 93]. Second, in line with Nunnally and Bernstein [94], Cronbach's α was required at a minimum level of 0.8, and our results achieved this criterion. Furthermore, CR values are all above 0.8, higher than the recommended criteria of 0.7 [95]. Additionally, the average variance extracted (AVE) should be higher than 0.5, according to prior literature [96]. And our results showed that no item were having score lower than 0.5. Hence, the convergent validity was satisfied.

To check for the discriminant validity, cross-loading approach was adopted [97]. Table 5 shows that discriminant validity is also strictly confirmed by the measurement model. Hence, this measurement model can be accepted due to its reliability and validity.

4.3. Structural model and hypotheses testing

Prior to testing the structural model, it was necessary to evaluate its collinearity, and it was assessed through employment of the variance inflation factor (VIF), with a desirable outcome being VIF values that approach and do not exceed 3 [90]. Our results reveal that all VIF values fall below this threshold, indicating that no collinearity exists among the constructs. Furthermore, we conducted an examination of the adjusted R^2 value, a metric that serves to indicate the predictive capability of the model by displaying the variance in the endogenous variable that can be accounted for by the exogenous variables. Our adjusted R^2 value of 0.441 provides evidence that the combined constructs can clarify 44.1 % of the variance observed in DIP. Lastly, we assessed the goodness of fit via SmartPLS by analyzing the standardized root mean square residual (SRMR; 0.058) and the normed fit index (NFI; 0.931). SRMR values below 0.08 signify satisfactory model fit [98,99], whereas NFI values (which fall between 0 and 1) that approach 1 suggest an improved fit. Therefore, based on our results, we can assert that the model both predicts and tests the hypotheses.

We tested the proposed hypotheses using SmartPLS (see Fig. 3). We set the bootstrap samples at 5000 and the confidence level at 95 % to estimate confidence intervals. The results have given support to all hypotheses in varying degrees. In particular, H1 was supported ($\beta = 0.137$; $p < 0.009$), demonstrating that organizational agility has a positive effect on digital innovation performance. Besides, H2 was also supported ($\beta = 0.269$; $p < 0.001$), indicating that digital capability has a significant positive impact on digital innovation performance. Further, H3a was supported ($\beta = 0.551$; $p < 0.001$), representing the positive relationship between organizational agility and digital capability. H3b was also supported ($\beta = 0.148$; $p < 0.001$), revealing the mediation impact of digital capability on organizational agility and digital innovation performance. In terms of moderation, the results showed that H4a ($\beta = 0.122$; $p = 0.023$) and H4b ($\beta = 0.111$; $p = 0.030$) were partially supported. The results are reported in Table 6.

5. Discussion

This research established a precise definition of the semantic implications of digital capability from the perspective of dynamic capability. Additionally, an analysis was conducted on the conceptual model that encompasses various variables, namely organizational agility and digital capability, and their interplay and impact on the digital innovation performance of SMEs while being moderated by the influence of top management support. These findings serve to augment the theoretical exploration of the digital capability of SMEs and address the void in the correlation between the primary internal factors in the digital transformation of SMEs.

Table 3
Exploratory factor analysis of digital capability.

Digital capability (DC)	Digital perception capability	Digital perception capability	Digital integration capability
DC1	0.867	0.097	0.159
DC2	0.856	0.119	0.071
DC3	0.879	0.092	0.119
DC4	0.070	0.871	0.172
DC5	0.113	0.839	0.138
DC6	0.127	0.848	0.126
DC7	0.116	0.108	0.870
DC8	0.105	0.181	0.840
DC9	0.132	0.157	0.875

Table 4
Measurement model.

Items	Mean	SD	Loadings	Cronbach's α	CR	AVE
Organizational agility (OA)				0.910	0.910	0.689
OA1	3.134	1.212	0.833			
	0.819		0.819			
	0.835		0.835			
	0.826		0.827			
	0.826		0.826			
	0.84		0.840			
	0.819		0.819			
	0.835		0.835			
	0.826		0.827			
	0.826		0.826			
	0.840		0.840			
OA2	3.131	1.210	0.819			
OA3	3.117	1.190	0.835			
OA4	3.081	1.166	0.827			
OA5	3.128	1.219	0.826			
OA6	3.095	1.258	0.840			
Digital capability (DC)				0.856	0.858	0.777
Digital perception capability (DPC)						
DC1	3.131	1.211	0.891			
DC2	3.162	1.274	0.861			
DC3	3.100	1.264	0.891			
Digital operation capability (DOC)				0.841	0.841	0.759
DC4	3.267	1.192	0.890			
DC5	3.206	1.149	0.858			
DC6	3.253	1.167	0.865			
Digital integration capability (DIC)				0.858	0.859	0.779
DC7	3.253	1.223	0.877			
DC8	3.242	1.200	0.870			
DC9	3.306	1.203	0.900			
Top management support (TMS)				0.898	0.903	0.710
TMS1	3.228	1.234	0.848			
TMS2	3.301	1.241	0.853			
TMS3	3.231	1.182	0.839			
TMS4	3.300	1.188	0.814			
TMS5	3.262	1.261	0.858			
Digital innovation performance (DIP)				0.896	0.897	0.705
DIP1	3.158	1.201	0.831			
DIP2	3.150	1.196	0.850			
DIP3	3.159	1.167	0.832			
DIP4	3.206	1.192	0.857			
DIP5	3.217	1.152	0.829			

Table 5
Discriminant validity.

	OA	DC	TMS	DIP
OA1	0.763	0.415	0.266	0.412
OA2	0.760	0.444	0.277	0.372
OA3	0.844	0.508	0.271	0.392
OA4	0.797	0.449	0.281	0.411
OA5	0.823	0.484	0.250	0.398
OA6	0.755	0.439	0.292	0.371
DPC	0.405	0.692	0.308	0.399
DIC	0.421	0.735	0.269	0.433
DOC	0.435	0.754	0.300	0.441
TMS1	0.222	0.283	0.792	0.433
TMS2	0.354	0.364	0.911	0.498
TMS3	0.276	0.314	0.824	0.450
TMS4	0.221	0.290	0.694	0.379
TMS5	0.288	0.350	0.755	0.412
DIP1	0.364	0.419	0.418	0.738
DIP2	0.416	0.452	0.452	0.804
DIP3	0.425	0.475	0.396	0.788
DIP4	0.406	0.505	0.469	0.855
DIP5	0.359	0.467	0.435	0.785

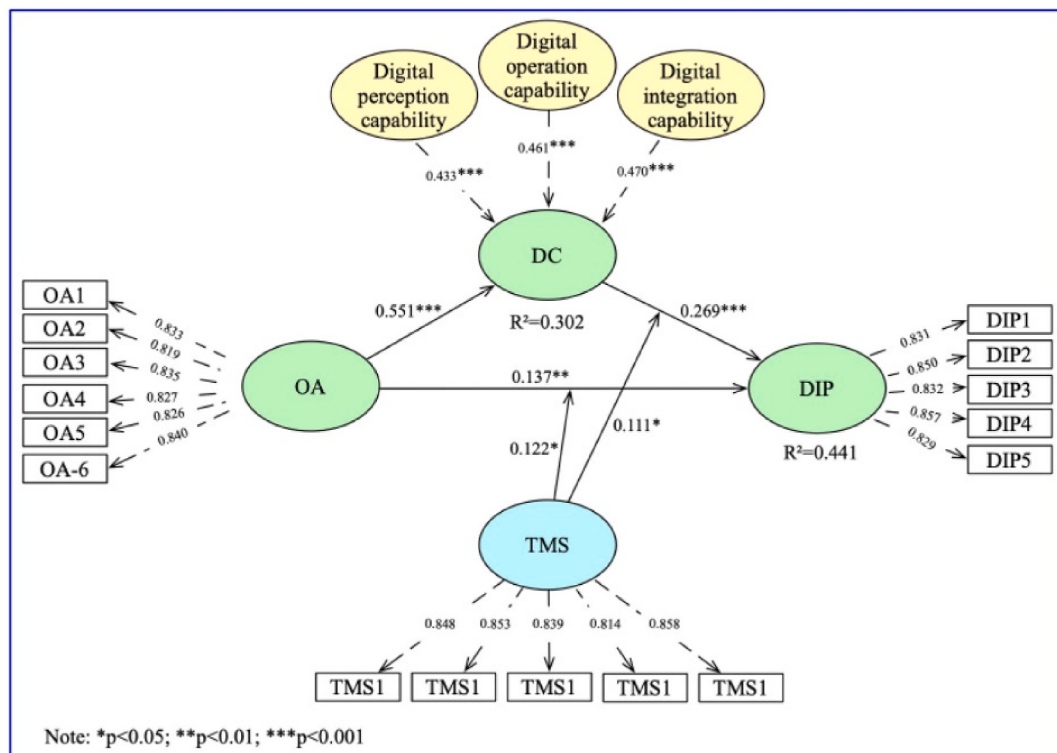


Fig. 3. Results of structure model analysis.

Table 6

Hypothesis testing.

H#	Relationship	β	SD	t-statistics	p-value	2.5%LLCI	97.5%ULCI	Results
H1	OA→DIP	0.137	0.052	2.629	0.009	0.033	0.236	Supported**
H2	DC→DIP	0.269	0.054	4.996	0.000	0.165	0.374	Supported***
H3a	OA→DC	0.551	0.037	15.014	0.000	0.481	0.625	Supported***
H3b	OA→DC→DIP	0.148	0.031	4.796	0.000	0.092	0.213	Supported***
Moderation								
H4a	TMS*OA→DIP	0.122	0.054	2.273	0.023	0.014	0.225	Supported*
H4b	TMS*DC→DIP	0.111	0.051	2.166	0.030	0.010	0.213	Supported*

Note: Path values (β), Bootstrap samples = 5000, *p < 0.05; **p < 0.01; ***p < 0.001.

In terms of the connotation of digital capability, we define three dimensions from the perspective of dynamic capability, namely, digital perception capability, digital operation capability, and digital integration capability. The findings show that all three dimensions make a significant contribution to the content of digital capability (contribution of 0.433 $p < 0.001$ vs. 0.461 $p < 0.001$ vs. 0.470 $p < 0.001$). This is consistent with the view of Ghosh et al. [60] that if firms lack awareness of the digital environment, they will not be able to discover effective digital technologies or tools. Thus, digital perception capability is the most basic digital ability for SMEs. In addition, this result supports Wu et al. [63] perspective that appropriate use of digital technology to improve products, services, processes can help SMEs enhance digital competitiveness, therefore, digital operation capability is the key component of digital capability. What is more, the result is also in line with earlier studies that suggested that the application of digital technology to the reinvention of a business model or operation is an innovation [67,68]. Therefore, digital integration capability is the highest level of digital capability of SMEs.

In relation to the conceptual model, our hypothesis has been fully supported and validated. The findings reveal that the success of SMEs' digital transformation is contingent upon three crucial antecedents: organizational agility, digital capability, and top management support. In accordance with H1, our research demonstrates that organizational agility has a positive impact on digital innovation performance. This outcome is in line with our analysis of the literature, which suggests that organizational agility is a key driver of DT for SMEs. The characteristics of organizational agility, such as rapid responsiveness and adaptability, enable enterprises to innovate and maintain a competitive edge [45,46,48]. Therefore, it is imperative that SMEs uphold organizational agility to facilitate DT and attain innovation performance.

The present study has demonstrated that H2, including H2a, H2b, and H2c, which postulated that digital capability has a positive

influence on the DT of SMEs, has received support. SMEs can achieve DT by promptly detecting changes in digital technology, employing digital technology in a suitable manner to upgrade their products or services, and even reorganizing their existing business models. This finding corroborates the insights from preceding research. Primarily, digital perception capability assists SMEs in identifying opportunities in the intense competition and comprehending customer requirements in the digital context [60]. Secondly, digital operation capability facilitates SMEs' digital transformation by leveraging digital technologies to revolutionize and innovate products, processes, and services [62,63]. Thirdly, digital integration capability can aid SMEs in improving their operational mode and business model, thereby enhancing their digital innovation performance [29,69]. Our findings suggest that to succeed in digital transformation, SMEs must cultivate their ability to promptly perceive and flexibly apply digital technologies, i.e., digital capability.

The proposed hypotheses, H3a and H3b, suggest that organizational agility has a positive impact on digital capability and that digital capability mediates the relationship between organizational agility and SMEs' DT. These hypotheses are in line with previous studies that have shown that SMEs with organizational agility are more inclined to search for and utilize digital technologies in a dynamic digital environment [21]. Our research findings confirm the positive association between organizational agility and digital capability (H3a). Therefore, SMEs should focus on developing organizational agility to enhance their digital perception digital operation and digital integration capability. Moreover, H3b is also supported by empirical evidence. Our results indicate that organizational agility can influence digital innovation performance through digital capability. For instance, an SME with process agility can quickly locate, procure, and apply new digital technologies due to its rapid response mechanism, thus enhancing innovation performance [41]. In summary, hypotheses H1, H2, H3a, and H3b are all supported. However, the results suggest that organizational agility has a less positive impact on digital innovation performance than digital capability, possibly because digital capability integrates digital perception, digital operation, and digital integration, and is crucial in all aspects of digital transformation for SMEs [58]. Conversely, organizational agility is the ability of an organization to respond quickly to a dynamic environment and is a fundamental requirement for SMEs' digital transformation at the organizational level [22–24].

The final two hypotheses in our study explored the moderating effect of top management support. Our findings have confirmed H4a, which suggests that top management support moderates the relationship between organizational agility and digital innovation performance. Additionally, H4b has also been confirmed, which suggests that top management support moderates the relationship between digital capability and digital innovation performance. These results align with previous research, which has indicated that top management support in terms of policy, capital, resources, and internal culture can aid SMEs in their pursuit of organizational agility and digital capability, thereby promoting the success of digital transformation [76,78]. However, our results also demonstrate that the promoting effect of top management support is not as significant as previously believed in the literature. This may be due to the fact that in SMEs, top management support mainly plays a guarantee and an auxiliary role in digital transformation [77].

6. Conclusions

This study focuses on the important antecedents of the digital transformation of SMEs and their relationships from an internal perspective. Specifically, organizational agility, digital capability and top management support were investigated as three vital factors. Among them, the connotation of digital capability was elaborated in our study. In addition, Structural equation modeling was used as a quantitative methodology to investigate the interconnections between three key factors. The following are the main contributions and limitations of this paper.

6.1. Theoretical contributions

This study contributes to the existing literature in four distinct ways. First, it addresses the need for research into how SMEs can thrive in the ever-changing digital economy. This call has been made by scholars such as Cenamor et al. [19] and Troise et al. [21]. While there has been significant research on the motivations, promoting factors, and impacts of enterprise digital transformation in recent years, the perspective of this literature is generally macro, and the research objects are rarely subdivided. Furthermore, scholars have suggested that the reasons for the success of digital transformation are complex, with internal factors of organizations requiring further exploration [16,17]. As such, this study aims to shed new light by exploring key internal factors that have a significant impact on the digital transformation of SMEs. Specifically, we propose the theoretical model of “organizational agility - digital capability - digital innovation performance” from the perspective of SMEs, providing a new framework for SMEs' digital transformation in the digital economy environment.

Second, we explore the connotation of digital capability from the perspective of dynamic capability. Previous studies on digital capability have typically focused on the application of digital technologies and their effects. For example, Nylén and Holmström [53] illustrate that digital capability is mainly reflected in the application of digital technologies in organizations' innovation. However, we propose that digital capability is a manifestation of dynamic capabilities in a digital environment. Drawing on the three aspects of dynamic capabilities - sensing, seizing, and reorganizing - we put forward digital perception capability, digital operation capability, and digital integration capability as the three dimensions of digital capability. The empirical results support our explanation of digital capability in these three aspects. Therefore, our study broadens the research horizon of digital capability.

Third, this study significantly enhances the existing research and insights regarding the interconnection between digital capability and other crucial internal factors of SMEs on DT. The outcomes of this research demonstrate that both organizational agility and digital capability are crucial to the triumph of digital transformation in SMEs. Additionally, it is evident that organizational agility has a robust positive impact on digital capability, while digital capability serves as a mediator in the relationship between organizational agility and DT in SMEs. Our research is an answer to the call of scholars to investigate the impact of critical internal factors such as

organizational agility and digital technology application on enterprise digital transformation in a digital context [26].

Finally, by testing the moderating effect of top management support, we conclude that the support extended by top managers plays a pertinent moderating role in the digital transformation of SMEs. This challenges the previous perception of top management's significance in research. For instance, Finkelstein and Hambrick [73] assert that top managers are responsible for the success or failure of DT since they are the makers of digital strategies. However, our research objectively evaluates the role of top managers and proves that top management support plays a moderating role in organizational agility, digital capability, and SMEs' digital transformation in terms of resource support and organizational coordination [76,78].

6.2. Managerial implications

The present study provides practical implications that are pertinent to the digital transformation of SMEs. Firstly, it is evidenced that digital capability is a crucial enabler of SMEs' digital transformation. This capability extends beyond the mere application of digital technologies by firms and encompasses digital perception capability, digital operation capability, and digital integration capability. As such, SMEs aiming to achieve digital transformation success should not solely limit themselves to the application of various digital technologies. Rather, they should also pay attention to the perception of digital technology development trends and the flexible application of digital innovation to the operational and strategic levels of enterprises [66].

Secondly, our findings reveal that organizational agility is also a critical factor that contributes to SMEs' digital transformation. It is important for SMEs to develop their organizational agility in order to cope with the fast-paced and changeable digital economy environment [43]. For instance, SMEs can streamline operation steps to improve the speed and accuracy of processes to make the organization more agile. Paying more attention to changes in the external environment and actively developing new ways to create value are also good ways to improve agility.

Thirdly, our research found that top management support not only moderates the relationship between organizational agility and SMEs' digital transformation but also between digital capability and SMEs' digital transformation. Therefore, top managers should play a supporting and coordinating role in SMEs' digital transformation. This point has also been affirmed by Finkelstein, Hambrick and Cannella [75]. They must address the resources required for digital transformation and reduce the internal communication cost of SMEs' digital transformation.

6.3. Limitations and future research

Despite the several contributions that this paper has made to the development of digital transformation literature for SMEs, there are still a few limitations. Primarily, the study was conducted on a limited sample size of 359 Chinese technology-based SMEs, which has a specific region. Future studies can overcome the limitations of regionalism and expand the sample size. Additionally, internal factors that may influence SMEs' DT have limited this study. Therefore, it would be worthwhile to explore other essential variables such as digital culture in organizations, corporate cultures, and organizational learning. Lastly, the long-term applicability of the results of this study is limited. The usage of cross-sectional data and the neglect of different stages of an enterprise's digital transformation have limited this study. Owing to this, further studies can adopt a follow-up survey to examine the relationship between variables.

Ethical approval

Ethical approval was obtained from the Ethics Committee of Taizhou Vocational & Technical College, having ethical approval No.20220109. The research meets the requirements of the National Statement on Ethical Conduct in Human Research. The procedures used in this study adhere to the tents of the declaration of Helsinki.

Informed consent statement

Informed consent was obtained from all participants before the data was collected. Participants were informed about their rights, the purpose of the study and to safeguard their personal information.

Data availability statement

Data will be made available upon the request and could be accessed by contacting the corresponding author.

CRediT authorship contribution statement

Mengxin Zhang: Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Xihui Chen:** Writing – review & editing, Resources, Project administration, Conceptualization. **Hongming Xie:** Supervision, Methodology, Funding acquisition. **Luca Esposito:** Writing – review & editing, Supervision, Investigation. **Anna Parziale:** Visualization, Writing – review & editing. **Shilpa Taneja:** Writing – review & editing, Software. **Ahsan Siraj:** Writing – review & editing, Visualization, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e31579>.

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