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Zhao Rui, Nurfazreen Aina Muhamad Nasharudin, Nurul Afiqah Zulkifly & Zaiton Hassan

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The roles of entrepreneurial leadership and strategic flexibility in the relationship between learning capability and organizational innovation among Chinese technology SMEs

Zhao Rui¹

Institute for social science studies, Universiti Putra Malaysia, 43400 Seri Kembangan, Malaysia

Email: megan.zhao-rui@outlook.com

Nurfazreen Aina Muhamad Nasharudin² (corresponding author)

Department Professional Development and Continuing Education, Faculty of Educational Studies, Universiti Putra Malaysia, 43400 Seri Kembangan, Malaysia

Email: fazreenasha2@gmail.com

Nurul Afifah Zulkifly³

Department Professional Development and Continuing Education, Faculty of Educational Studies, Universiti Putra Malaysia, 43400 Seri Kembangan, Malaysia

Email: nurulafiqah@upm.edu.my

Zaiton binti Hassan⁴

Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia,

Email: Hzaiton@unimas.my

Abstract

Despite growing interest in organizational innovation, the specific pathways through which technology-based SMEs transform learning capability into innovation via entrepreneurial leadership remain insufficiently understood. Furthermore, the moderating role of strategic flexibility in this process has received limited empirical attention. This study investigates how learning capability fosters organizational innovation in technology-based SMEs. It highlights the mediating role of entrepreneurial leadership and the moderating effect of strategic flexibility in shaping this process. Survey data collected from 506 entrepreneurs in Shanxi, China were analysed using SPSS and AMOS. The results show that both learning capability and entrepreneurial leadership positively influence organizational innovation, with entrepreneurial leadership mediating the learning capability and organizational innovation relationship, strategic flexibility strengthens the relationship between learning capability and entrepreneurial leadership. Theoretically, this study contributes to the literature by demonstrating how learning capability acts as a foundational

resource that requires dynamic alignment of entrepreneurial leadership and the moderating mechanism of strategic flexibility to organizational innovation. Practically, the findings advise SME managers to prioritize not only knowledge acquisition but also the development of strategic agility, ensuring that leadership can effectively reconfigure resources to drive innovation in turbulent markets.

Keywords

Chinese technology-based SMEs, Entrepreneurial Leadership, Learning Capability, Organizational Innovation, Strategic Flexibility

1. Introduction

In today's hyper-competitive and unpredictable market landscape, organizations increasingly rely on innovation not merely as a growth engine, but as a fundamental pillar for strategic resilience and sustainable growth [1]. Against this backdrop, entrepreneurial leadership has emerged as a distinctive multidimensional construct crucial for opportunity recognition and resource orchestration [3]. Meanwhile, learning capability, as the core ability of organizations to acquire knowledge, create knowledge, and transform it into innovative outcomes, is considered the foundation supporting long-term innovation performance [4,5]. In addition, strategic flexibility is crucial for organizations seeking to adapt to rapid changes, capitalize on opportunities, and mitigate risks [6]. Prior research has predominantly examined organizational innovation through the lens of individual antecedents, such as leadership styles, knowledge management, or environmental factors often in isolation [94,95]. While these contributions are significant, they largely fail to account for the integrative mechanisms through which multiple organizational resources jointly shape innovation outcomes [96]. Consequently, a critical research gap persists: the specific pathways through which technology-based SMEs transform knowledge resources into innovation via strategic leadership behaviours remain insufficiently understood.

Grounded in dynamic capabilities theory [10], this study moves beyond the

traditional view of resources as static assets. DCT posits that firm competitive advantage stems from the ability to sense, seize, and reconfigure internal and external competences [97]. This study posits that entrepreneurial leadership mediates the effect of learning capability on organizational innovation. Entrepreneurial leaders, through risk-taking, innovative thinking, and market sensitivity, can stimulate knowledge acquisition, challenge assumptions, and encourage experimentations [12]. This logic is consistent with recent evidence suggesting that entrepreneurial leadership serves as a vital catalyst in identifying opportunities and orchestrating resources to foster innovation [92]. They also create organizational conditions, through resource allocation, design, and incentives, that enable learning to translate into innovation [13]. This mediating role, however, has received limited empirical testing, especially under varying environmental dynamism [14].

Learning capability, a core element of dynamic capabilities [7], enhances organizations' ability to absorb external knowledge, coordinate resources, and convert ideas into market innovations [7,9,10]. Strategic flexibility serves as a contextual factor that allows organizations to reconfigure resources and adjust strategies in real time [15,16]. It allows organizations to reconfigure resources and adjust strategies, shaping the effectiveness of entrepreneurial leadership in converting learning capability into innovation. Indeed, the relationship between strategic resources and organizational outcomes is not static but depends on the firm's ability to reconfigure its capabilities through adaptive mechanisms [93]. While DCT emphasizes resource reconfiguration [99], the specific moderating role of strategic flexibility in the leadership-innovation link remains underexplored.

Building on this analysis, this study develops an integrated model to examine how learning capability, entrepreneurial leadership, and strategic flexibility interact to drive organizational innovation. The study addresses two key gaps: clarifying the leadership mechanism and identifying the strategic conditions that affect its effectiveness. This study is designed to explore the following research questions: (1) How does learning capability influence the

development of entrepreneurial leadership? (2) What influence does learning capability exert on the advancement of organizational innovation? (3) How does entrepreneurial leadership contribute to organizational innovation? (4) Does entrepreneurial leadership function as a mediator between learning capability and organizational innovation? (5) To what extent does strategic flexibility serve as a moderating factor?

The remainder of this paper is organized as follows: Section 2 reviews the literature and develops hypotheses. Section 3 describes the research methodology. Section 4 presents the data analysis and results. Finally, section 5 discusses the theoretical and managerial implications and concludes the study.

2. Literature review and hypotheses

2.1 Theoretical Framework: Dynamic Capabilities Theory

Dynamic Capabilities Theory (DCT) serves as the central theoretical framework guiding this research. Initially articulated to account for how organizations maintain competitive advantage in contexts marked by rapid and continuous change, DCT focuses on firms' capacities to integrate, develop, and reconfigure both internal and external resources in alignment with shifting environmental conditions [19]. In contrast to static resource-based perspectives that emphasize the mere ownership of valuable assets, this study utilizes DCT to underscore the underlying processes and mechanisms that enable technology-based SMEs to repeatedly adjust, renew, and transform their capabilities over time [75]. This theoretical lens is especially pertinent to the recent competitive landscape, which is increasingly defined by radical uncertainty, technological turbulence, and escalating competitive pressures [76].

At a fundamental level, DCT frames organizational adaptation as an evolving and path-dependent process structured around three closely connected clusters of capabilities: the sensing of opportunities and threats, the seizing of those opportunities through strategic decision-making, and the reconfiguration of resources and competencies to maintain sustained value

creation [74]. These capabilities function in an interdependent manner rather than independently, as they are deeply embedded in managerial practices, organizational routines, and strategic decisions that jointly influence firm-level outcomes [77]. From this perspective, DCT provides an integrative framework that clarifies not only the presence of firm innovation, but also the mechanisms through which internal capabilities are activated and transformed into concrete innovative results [78].

Within this theoretical lens, learning capability may be conceptualized as a core dynamic capability that allows firms to obtain, absorb, and reinterpret knowledge derived from both internal experience and external contexts [79]. By continually refreshing cognitive schemas, organizational routines, and knowledge bases, learning capability strengthens a firm's ability to sense shifts in the surrounding environment [80]. Viewed through the DCT framework, we argue that learning represents a higher-order capability that provides the necessary informational input for the renewal of other organizational capabilities [75]. Consequently, firms endowed with strong learning capability are better positioned to identify emerging opportunities, although such sensing remains latent without further mobilization.

Nevertheless, DCT underscores that the presence of dynamic capabilities does not inherently ensure superior performance or innovative outputs. Rather, their influence materializes through managerial and organizational mechanisms that structure resource orchestration and inform strategic actions [82]. In this context, entrepreneurial leadership assumes a critical function as the micro-foundation of DCT. We posit that while learning provides the sensing, entrepreneurial leadership operates as the essential agency that facilitates the seizing and transformation of opportunities uncovered through learning [56]. From the perspective of DCT, entrepreneurial leadership operates as an essential micro-foundation that facilitates the seizing and transformation of opportunities uncovered through learning activities [81]. By directing strategic priorities, promoting experimentation, and stimulating initiative-oriented behaviours, entrepreneurial leaders assist in translating

learning-based insights into tangible innovative actions [82].

Organizational innovation, which represents the primary outcome of this study, can be understood as the product of dynamic capability deployment rather than merely the possession of resources [83]. Within the DCT framework, innovation results from the effective execution of sensing, seizing, and reconfiguring processes. We contend that innovation occurs when insights derived from learning are mediated through leadership mechanisms that facilitate experimentation and strategic resource reallocation. This highlights the importance of investigating not only the direct links between capabilities and outcomes but also the intervening processes that translate dynamic capabilities into innovation performance [84].

Beyond internal mechanisms, DCT explicitly acknowledges the influence of contextual and boundary conditions on the effectiveness of dynamic capabilities. The utility of these capabilities depends on a firm's capacity to adapt strategies and resource configurations in response to environmental pressures [85]. Within this study, strategic flexibility is treated as a key boundary condition, defined as a firm's ability to reallocate resources, modify strategic priorities, and respond proactively to evolving circumstances. From a DCT standpoint, strategic flexibility strengthens the impact of learning capability by enabling firms to leverage newly acquired knowledge and leadership-driven initiatives without being hindered by rigid organizational structures or inertial routines [88]. As highlighted by Katila and Shane [87], the capacity to mobilize resources while maintaining flexibility is especially vital for fostering innovation in contexts marked by external crises or resource limitations.

2.2 Learning capability, entrepreneurial leadership and organizational innovation

Learning capability can be understood as a higher-order strategic resource through which organizations absorb, integrate, and exploit knowledge derived from prior experience [17]. In contrast to traditional views that emphasize the static accumulation of knowledge, DCT conceptualizes learning capability as a

fundamental sensing function. Through this function, firms are able to repeatedly recalibrate cognitive schemas and organizational routines, thereby demonstrating reflexivity and adaptive capacity within competitive contexts. Within the DCT perspective, sensing capabilities are not treated as ultimate outcomes; rather, they serve as necessary antecedents to effective seizing activities, which are manifested through entrepreneurial leadership. Paraswati and Pujianto [18] further clarify the multidimensional character of entrepreneurial leadership, highlighting its capacity to align organizational and motivational systems in ways that promote core values such as risk-taking and opportunity recognition.

From a theoretical perspective, the linkage between learning capability and entrepreneurial leadership extends into the domain of dynamic orchestration [19]. Dynamic capabilities theory emphasizes that organizations need to constantly reconfigure resources to respond to environmental changes, which highly aligns with the innovation and opportunity recognition characteristics of entrepreneurial leadership [10]. This process of reconfiguration relies heavily on the interaction between organizational learning capacity and leadership agency. Importantly, the strength and manifestation of this relationship are often shaped by contextual conditions. As demonstrated by Taleb et al. [76], during periods of crisis or heightened uncertainty, the effective utilization of human capital through learning enables leaders to pursue resource bricolage and adopt new technologies. These insights indicate that learning capability functions not simply as a contextual backdrop but as a pivotal driver that enhances leaders' capacity to identify opportunities and mobilize resources [22].

Although extant studies have largely concentrated on how entrepreneurial leadership shapes organizational learning [20,21], the reverse relationship, in which learning capability contributes to the emergence and strengthening of leadership, has received far less systematic investigation. Further research is therefore needed to explicate the underlying mechanisms of capability formation. Makhoulfi et al. [22] demonstrate that learning capability facilitates

leadership development by cultivating environments conducive to knowledge sharing. Even though some empirical findings report mixed or context-dependent statistical significance [24], the inherently complex and interactive character of this linkage cannot be overlooked, particularly within digital business settings where continuous learning constitutes a core entrepreneurial competence [25]. From a DCT standpoint, learning capability functions as a foundational sensing mechanism that activates leadership agency, thereby creating the conditions necessary for opportunity recognition and strategic action [100]. Integrating these perspectives, we contend that learning capability establishes the essential sensing foundation that enables leaders to cope with uncertainty and stimulate innovation. Building on this reasoning, the present study advances the following hypothesis:

H1. Learning capability is positively related to entrepreneurial leadership.

Within organizational management scholarship, learning capability refers to an organization's systematic capacity to acquire, assimilate, and adapt knowledge. From the lens of DCT, this capability serves as the primary sensing mechanism, whereby ongoing learning processes enable the active engagement of members in generating knowledge and driving innovation [25]. Correspondingly, organizational innovation is understood as a dynamic process in which enterprises break through existing frameworks, continuously improve production and technological innovation capabilities through knowledge absorption and utilization across technological and management innovation dimensions [27]. In this framework, innovation represents the ultimate 'transforming' outcome of the organization's capacity to achieve development through continuous learning and adaptation.

The connection between learning capability and organizational innovation holds substantial scholarly relevance, especially amid environments characterized by growing dynamism and intensified competition. DCT offers a solid conceptual basis for examining how learning provides the necessary cognitive infrastructure to drive innovation. Hael et al. [28] demonstrate, using bibliometric analysis, that scholarly interest in organizational learning and

innovation has become a prominent theme within academic research. Haile and Tüzüner [29] investigated how organizational learning capabilities influence organizational innovation. Their findings suggest that these capabilities are essential in promoting innovation, especially in the development of products and processes. However, moving beyond a descriptive summary of these findings, it is critical to recognize that learning capability facilitates innovation by allowing firms to bypass 'competency traps' and update their knowledge repositories. Migdadi [30] proposes an integrative model that connects organizational learning capability with both innovation and organizational performance. Empirical evidence supports the notion that enhanced learning capabilities positively influence both innovation and overall organizational effectiveness.

Although the positive association between learning capability and organizational innovation, the strength of this relationship is contingent upon organizations' capacity to overcome structural inertia and knowledge barriers. Mohammad et al. [31] identify insufficient knowledge sharing and risk-averse organizational cultures as common impediments to learning-driven innovation. Similarly, Mendoza and Dayao [32] emphasize the necessity of dismantling outdated routines and value systems that constrain adaptive learning. From a DCT perspective, these barriers represent the organizational inertia that disrupts the 'seizing' and 'transforming' phases of dynamic capability deployment. Crucially, it is precisely firms with strong learning capability that are better equipped to detect and dismantle such inertia, thereby sustaining the conditions necessary for continuous innovation. Based on the above literature review, we can clearly identify that organizations with higher learning capability are more effective in creating and utilizing knowledge, thereby sensing innovation opportunities and fostering the generation and implementation of organizational innovation [33]. This relationship demonstrates that learning is not a static resource but a higher-order capability that underpins the continuous reconfiguration of organizational assets. Accordingly, the following hypothesis is proposed:

H2. Learning capability is positively related to organizational innovation.

Entrepreneurial leadership, a leadership approach that integrates managerial competencies with an entrepreneurial mindset, has garnered growing interest in organization studies. Ercantan et al. [34] describe entrepreneurial leadership as a leadership style that facilitates organization transformation and cultivates an innovation-oriented climate. Within the integrated DCT framework, entrepreneurial leadership represents the critical seizing capability required to mobilize and orchestrate resources toward identified opportunities. Organizational innovation, as the focal outcome, denotes an organization's ability to adopt and implement new ideas or offerings. Consistent with DCT, innovation is not a static property but the tangible manifestation of a firm's transforming capacity, where internal routines are reconfigured to achieve sustainable competitive advantage in dynamic environments [35].

From a DCT perspective, the relationship between leadership and innovation transcends simple behavioural influence; it reflects a higher-order process of resource reconfiguration [90]. While traditional views may focus on the traits of leaders, the dynamic capabilities lens emphasizes that entrepreneurial leaders serve as the primary micro-foundations that activate the organization's seizing and transforming functions. These leaders influence the interpretation of environmental information and determine the strategic allocation of resources toward high-risk, high-reward innovation activities [37]. By emphasizing opportunity-seizing, entrepreneurial leadership directly determines the strategic direction and the degree to which an organization can transform its knowledge base into innovative outcomes.

The mechanism through which entrepreneurial leadership affects organizational innovation has been widely supported in existing literature. First, entrepreneurial leadership creates an environment conducive to innovation by shaping organization culture [36]. In this sense, leadership serves as the agency that overcomes organizational inertia, facilitating the reconfiguration of assets during the transforming phase. Second, research by

Malibari and Bajaba [38] confirms that entrepreneurial leadership stimulates employees' innovative behaviour. Furthermore, in contemporary digital contexts, this leadership orientation is essential for sensing and seizing technological opportunities, thereby promoting the formation of an innovation-absorption capacity [39]. By synthesizing these perspectives, we argue that entrepreneurial leadership provides the necessary strategic agency to bridge the gap between initial sensing and successful innovative transformation. From a DCT standpoint, entrepreneurial leadership operates as the primary seizing foundation that translates sensing-derived insights into concrete innovative outcomes, thereby serving as the pivotal mechanism through which dynamic capabilities are activated at the organizational level [101]. Drawing upon the preceding literature analysis, the study therefore puts forward the following hypothesis:

H3. Entrepreneurial leadership has a positive relationship with organizational innovation.

2.3 The Mediating Function of Entrepreneurial Leadership

The interaction between learning capability, entrepreneurial leadership, and organizational innovation has become a central focus in management research. Within the DCT framework, this relationship is conceptualized as a continuous process where sensing capabilities are transformed into innovative outcomes through strategic leadership agency. Rather than viewing these variables as isolated assets, DCT positions learning capability and entrepreneurial leadership as interrelated mechanisms that collectively drive competitive advantage [90]. Learning capability serves as the foundational 'sensing' mechanism required for innovation. Gomes et al. [43] highlight learning capability as a fundamental catalyst for innovation. However, from a DCT perspective, the mere sensing of information through learning does not automatically result in innovation; it requires a seizing mechanism to mobilize and orchestrate these resources [89]. Entrepreneurial leadership functions as this pivotal intervening force. As Shiferaw et al. [44] assert, entrepreneurial leaders actively leverage institutional resources and shape followers'

perspectives to steer focus toward entrepreneurial objectives. This leadership agency effectively bridges the gap between the acquisition of knowledge and its strategic application. Sawaeen and Ali [45] found that entrepreneurial leadership positively influences an organization's capacity for innovation, suggesting that leadership acts as the transformative engine that reconfigures sensed insights into 'transforming' outcomes. The relationship between learning capability and entrepreneurial leadership is also notably significant, as learning-oriented environments provide the cognitive infrastructure for leadership to flourish [39]. By synthesizing these perspectives under DCT, we can discern a coherent theoretical framework: learning capability provides the sensing foundation for innovation, while entrepreneurial leadership serves as the critical seizing and mediating mechanism that transforms this knowledge into organizational innovation. From a DCT perspective, entrepreneurial leadership constitutes the essential seizing bridge between learning derived sensing and innovation-oriented transforming, thereby functioning as the core mediating mechanism through which dynamic capabilities are converted into organizational innovation [102]. This configuration explains how internal capabilities are effectively mobilized and converted into tangible innovative performance. Based on this, the following hypothesis is suggested:

H4. Entrepreneurial leadership acts as a mediator in the relationship between learning capability and organizational innovation.

2.4 Strategic Flexibility as a Moderating Factor

Strategic flexibility, as a fundamental organization capability for responding to environmental shifts, holds critical importance in today's dynamic business landscape [46]. Strategic flexibility denotes an organization's capacity to adjust its strategic orientations and reallocate resources effectively in response to shifting market conditions and environmental volatility. It is often conceptualized through key dimensions such as resource flexibility, coordination flexibility, and strategic options, which together enable companies to navigate uncertainty and sustain competitive advantage [47]. Within the Dynamic DCT framework, strategic flexibility functions as a higher-

order reconfiguring capability that determines the efficiency and speed of the sensing and seizing process. Recent studies emphasize that strategic flexibility enhances organization resilience and innovation by allowing companies to proactively realign their strategic objectives in response to external disruptions [48].

From a DCT perspective, while learning capability and entrepreneurial leadership are core elements for addressing challenges [49], their synergy is not automatic and is often contingent upon the organization's internal agility. As highlighted by Aldaibat & Alzoubi [91], the ability to effectively leverage human capital and knowledge resources is significantly amplified in flexible organizations that can bypass structural rigidities during crises. Marrucci and Rialti [49] found that strategic flexibility functions as a mediating mechanism between learning orientation and product innovation, suggesting that knowledge acquired through learning must be transformed into concrete innovation outputs via the organization's adaptive capabilities. Herhausen et al. [50] highlighted that organizations possessing a high degree of strategic flexibility are better equipped to swiftly realign their strategic direction and efficiently leverage knowledge acquired through learning, thereby enhancing the positive impact of learning capability on entrepreneurial leadership.

This suggests that strategic flexibility acts as a critical boundary condition, providing the strategic latitude necessary for sensed knowledge to be effectively seized by leaders. Conversely, enterprises with low strategic flexibility may struggle to transform learning outcomes into strategic actions, thus limiting the facilitating effect of learning capability on entrepreneurial leadership. By integrating this contingency view into the DCT framework, this study advances a more nuanced theoretical account that differentiates the boundary conditions under which dynamic capabilities translate into innovation outcomes. From a DCT standpoint, strategic flexibility amplifies the sensing, seizing and transforming chain by reducing structural inertia, thereby creating the organizational conditions under which learning capability and entrepreneurial leadership most effectively combine to produce innovation

[103]. Drawing upon the preceding literature analysis, this study formulates the following hypothesis:

H5. Strategic flexibility moderates the positive connection between learning capability and entrepreneurial leadership.

Based on the foregoing literature review and theoretical reasoning, the following hypotheses are proposed in this study:

H1: Learning capability is positively related to entrepreneurial leadership.

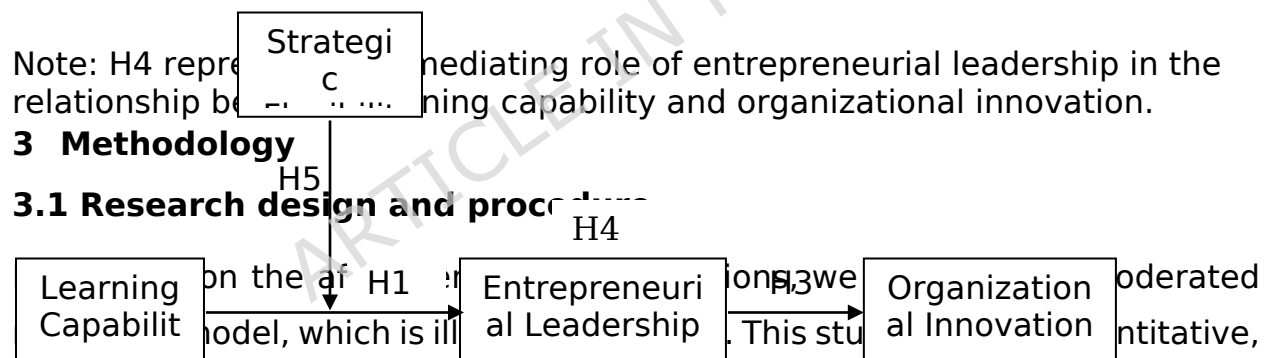
H2: Learning capability is positively related to organizational innovation.

H3: Entrepreneurial leadership has a positive relationship with organizational innovation.

H4: Entrepreneurial leadership acts as a mediator in the relationship between learning capability and organizational innovation.

H5: Strategic flexibility moderates the positive connection between learning capability and entrepreneurial leadership.

Figure1 Proposed conceptual framework



3 Methodology

3.1 Research design and procedure

This study employs a cross-sectional research design to empirically test the moderated mediation model illustrated in Fig. 1. This methodological choice is specifically designed to provide a systematic answer to the research questions posed in Section 1 and to statistically validate the hypotheses (H1 to H5) developed in Section 2.2-2.4. By examining the causal mechanisms between learning capability, entrepreneurial leadership, and organizational innovation, this design ensures that each analytical step is directly aligned with the research objectives. This study focuses on entrepreneurs from technology-based SMEs in Shanxi Province as the primary research subjects. The main reasons are as follows:

First, Shanxi Province represents a significant case of resource-based regional transformation in China. He, Liu et al. [51] conducted a comprehensive evaluation of innovation efficiency in China's resource-based cities, revealing that Shanxi demonstrates distinctive patterns in high-tech industry development, particularly in the integration of traditional and emerging industries. Secondly, Innovation Ecosystem Construction Process Data from the Shanxi Province Science and Technology Innovation Survey Annual Report (Shanxi Provincial Bureau of Statistics, 2023) shows that Shanxi Province is building a science and technology innovation system characterized by "government guidance, enterprise leadership, and market orientation." The construction process of this innovation ecosystem provides a typical case for studying regional innovation system development and has significant research value.

The research population consists of 6,486 technology-based SMEs entrepreneurs in Shanxi Province, all these enterprises are selected in accordance with the criteria set forth in "The Interim Administrative Measures for Technology Innovation Fund Projects of technology-based SMEs," a policy directive collaboratively issued by China's Ministry of Science and Technology (MOST) and Ministry of Finance (MOF), exhibiting high homogeneity in operational scale and industry characteristics. For sample size determination, this study adopts the calculation method proposed by [52]. This method is particularly suitable for business research with a known population and high homogeneity, using the formula:

$$n = N / (1 + Ne^2)$$

In this context, n represents the necessary sample size, while N denotes the total population (6,486), and e signifies the sampling error, which is set at 0.05 with a 95% confidence level. According to Daniel [53], this error margin is widely recognized and accepted in business research. The calculation yields a theoretical sample size of approximately 378. To ensure the sample's representativeness and achieve sufficient statistical power, a systematic sampling frame was established to identify 529 target enterprises from the

total population.

Data collection is scheduled from July to September 2024, spanning three months. This study adopts an online questionnaire distribution approach. To mitigate the low response rates typically associated with cold-contact enterprise surveys, a rigorous "Pre-notification and Follow-up" protocol was implemented. First, we contacted the target enterprises to confirm their availability and obtained strong institutional endorsement from relevant government departments. This transformed the survey into a recognized industry-wide data collection initiative, significantly enhancing perceived legitimacy and trust. Second, questionnaires were distributed only to the 529 entrepreneurs who had confirmed their willingness to participate.

During the three-month collection period, three rounds of bi-weekly follow-up reminders were conducted via telephone and email. In the end, 506 valid questionnaires were collected, yielding a 95% response rate relative to the confirmed participants. To validate the credibility of this high response rate and ensure the absence of non-response bias, a wave analysis was performed to compare early and late respondents across key characteristics, no significant differences were observed ($p > 0.05$). Participation was voluntary, and all respondents were informed of the research purpose and guaranteed anonymity prior to completing the survey.

3.2 Measurement

The designed questionnaire adopts a closed form, requiring the respondents to choose among a limited number of given options. The questionnaire items were assessed using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), allowing respondents to indicate their degree of agreement. The questionnaire is mainly divided into 4 parts, namely learning capability (Part A), entrepreneurial leadership (Part B), strategic flexibility (Part C), and organizational innovation (Part D). As the study was conducted among Chinese technology-based SMEs, the survey instrument was originally developed in English and translated into Chinese following a standard forward-backward translation procedure to ensure conceptual

equivalence. The complete bilingual measurement items utilized in this study are provided in ESM 1.

Learning capability was measured using the scale developed by Jerez-Gómez et al. [55] which comprises four dimensions and includes a total of 16 items. Within the learning capability measurement instrument, four dimensions are captured: commitment at the managerial level, perspective from a systems approach, experimentation and openness, along with the integration and transfer of knowledge.

The measurement of entrepreneurial leadership employed an eight-item scale that was constructed by Renko et al. [56], a tool that has found recent application in studies focused on entrepreneurship.

The assessment of strategic flexibility utilized a six-item measurement instrument developed by Zhou and Wu [56] drawing upon the conceptual framework originally advanced by Sanchez [58]. This scale emphasizes the adaptability of resource allocation and coordination in response to dynamic environmental changes.

For evaluating organizational innovation, researchers employed a four-item measurement instrument constructed by Azeem et al. [59] providing a methodical assessment of innovative capacity within organization contexts. It is mainly divided into administrative innovation and technical innovation.

3.3 Statistical analysis

SPSS 27.0 and AMOS 26.0 were utilized as the main statistical software packages for conducting the data analyses in this study. To ensure that the analytical procedures were explicitly aligned with the research objectives and research questions, a systematic and purpose-oriented analytical strategy was implemented. Initially, reliability and validity assessments were carried out to evaluate the psychometric quality of the measurement instruments and to provide a solid empirical basis for subsequent hypothesis testing. Following this step, Pearson product-moment correlation analysis was applied to explore the initial relationships among the core variables examined in the study. Subsequently, mediation and moderation analyses were undertaken to

examine the proposed relationships in greater depth, with particular attention to the underlying mechanisms and conditional effects articulated in the theoretical framework. Taken together, these analytical techniques establish a rigorous methodological foundation for addressing the research questions and for deriving conclusions that are both valid and reliable. By adopting this integrated analytical approach, the study yields a refined understanding of the interactions among the key constructs and contributes substantive insights to the academic literature.

4 Data analysis and results

4.1 Reliability and validity test

We employed SPSS 27.0 for evaluating data reliability within the sample, and these analytical outcomes are presented in Table 1. Each measurement scale demonstrated satisfactory reliability, as evidenced by Cronbach's α coefficients surpassing the recommended minimum value of 0.7. We then evaluated the sample's validity using AMOS 24.0, examining the fit of the theoretical model through multiple fit indices. The findings are presented as follows: $\chi^2/df = 3.636 < 5$, incremental fit index (IFI) = 0.942 > 0.9, comparative fit index (CFI) = 0.941 > 0.9, TLI=0.932>0.9. RFI=0.909>0.9.NFI=0.92>0.9. The results for all fit indices exceeded the recommended thresholds, indicating a strong alignment between the sample data and the proposed model. To evaluate potential common method bias, we followed a multi-step diagnostic approach. First, we performed a statistical check to ensure that no single factor accounted for the majority of the total variance in the data. Subsequently, we conducted a single-factor Confirmatory Factor Analysis (CFA) to further test the common factor structure. The results indicated that the single-factor model exhibited a poor fit to the data, significantly underperforming compared to our proposed multi-factor measurement model. This suggests that the indicators are not dominated by a single general factor, and therefore, common method bias is unlikely to be a serious concern in this study. Table 2 presents the detailed test outcomes.

Furthermore, the convergent validity assessment indicated that factor loadings exceeded 0.5, composite reliability (CR) was greater than 0.7, and average variance extracted (AVE) surpassed 0.5, all of which met the established criteria. The results indicate that the constructs demonstrate adequate convergent validity. Table 3 shows the test results.

Table 1 N of Items, Mean, and Cronbach's alpha of all variables

Variables		N of Items	Mean	Cronbach's Alpha	
Learning Capability	MCT	4	4.270	0.840	0.951
	SP	3	4.260	0.867	
	OE	4	4.360	0.908	
	KTI	3	4.260	0.808	
Entrepreneurial Leadership		7	4.170	0.905	
Strategic Flexibility		6	4.333	0.946	
Organizational Innovation		4	4.207	0.909	

Note: MCT= Managerial Commitment, SP= Systems Perspective, OE= Openness and Experimentation KTI= Knowledge Transfer and Integration

Table 2 Fit Indices for Measurement Models

Model	X ² /df	NFI	CFI	IFI	TLI	RFI
M1: Single-factor	10.400	0.866	0.877	0.877	0.744	0.857
M2: Multi-factor	3.636	0.922	0.941	0.942	0.932	0.909

Table 3 Factor Loading, AVE and CR of all variables

Construct/Item	Factor Loading (>0.5: greater) (>0.7: ideally exceed)	P	CR (CR>0.7)	AVE (AVE≥0.5)
Entrepreneurial Leadership			0.943	0.704
EL01	0.683	***		
EL02	0.848	***		
EL04	0.872	***		
EL05	0.886	***		
EL06	0.868	***		
EL07	0.905	***		
EL08	0.791	***		
Organizational Innovation			0.717	0.910
OI01	0.880	***		
OI02	0.868	***		
OI03	0.802	***		
OI04	0.835	***		

Learning Capability				<i>0.971</i>	<i>0.892</i>
<i>MCT</i>		<i>0.908</i>	***		
	MCT01	<i>0.607</i>	***	<i>0.852</i>	<i>0.593</i>
	MCT03	<i>0.775</i>	***		
Table 3 Continued					
	MCT04	<i>0.853</i>	***		
	MCT05	<i>0.822</i>	***		
<i>SP</i>		<i>0.955</i>	***		
	SP01	<i>0.803</i>	***	<i>0.864</i>	<i>0.679</i>
	SP02	<i>0.816</i>	***		
	SP03	<i>0.853</i>	***		
<i>OE</i>		<i>0.975</i>	***		
	OE01	<i>0.845</i>	***	<i>0.908</i>	<i>0.712</i>
	OE02	<i>0.868</i>	***		
	OE03	<i>0.803</i>	***		
	OE04	<i>0.859</i>	***		
<i>KTI</i>		<i>0.939</i>	***		
	KTI01	<i>0.804</i>	***	<i>0.824</i>	<i>0.614</i>
	KTI02	<i>0.917</i>	***		
	KTI04	<i>0.604</i>	***		
Strategic Flexibility				<i>0.746</i>	<i>0.946</i>
	SF01	<i>0.890</i>			
	SF02	<i>0.836</i>	***		
	SF03	<i>0.897</i>	***		
	SF04	<i>0.861</i>	***		
	SF05	<i>0.859</i>	***		
	SF06	<i>0.837</i>	***		

Note: N=506; p<0.001= ***; p<0.01=**; p<0.05=*

EL=Entrepreneurial Leadership, SF=Strategic Flexibility, MCT=Managerial Commitment, SP=Systems Perspective, OE=Openness and Experimentation, KTI=Knowledge Transfer and Integration, OI=Organizational Innovation

4.2 Hypotheses tests

4.2.1 Regression analysis

Using data from 506 valid observations, this study employed Pearson correlation and regression analyses to investigate the potential link between the two variables and to determine whether the relationship is positive or negative in nature. The results of the correlation analysis are summarized in the Table 4 below.

Table 4 Correlation between all variables

	Learning Capability	Entrepreneurial Leadership	Strategic Flexibility	Organizational Innovation
Learning Capability	1			

Entrepreneurial Leadership	.804	1		
Strategic Flexibility	.813	.802	1	
Organizational Innovation	.724	.7*	.700**	1

Note: N=506; $p < 0.001 = ***$; $p < 0.01 = **$; $p < 0.05 = *$

The results reveal a statistically significant and positive correlation between learning capability and entrepreneurial leadership ($r = 0.789, p < 0.01$), entrepreneurial leadership and organizational innovation ($r = 0.689, p < 0.01$), learning capability and organizational innovation ($r = 0.718, p < 0.01$). This suggests that higher levels of learning capability are associated with corresponding increases in entrepreneurial leadership, indicating a moderately strong concurrent relationship between the two constructs. Similarly, as entrepreneurial leadership increases, organizational innovation also increase. As learning capability increases, organizational innovation also increases. According to Cohen [60] effect size criteria for correlation coefficients, $|r| > .50$ represents a strong correlation effect. Therefore, the correlation coefficients obtained in this study all exceed 0.5, reflecting a strong association between the two constructs.

The regression analysis results reveal significant positive correlations among the following three groups of relationships: learning capability and entrepreneurial leadership, learning capability and organizational innovation, entrepreneurial leadership and organizational innovation. Specifically, the regression coefficient of learning capability on entrepreneurial leadership is 0.793 ($t = 28.855, p < 0.001$). The coefficient of learning capability on organization innovation is 0.723 ($t = 23.201, p < 0.001$), and for entrepreneurial leadership on organization innovation, it is 0.690 ($t = 21.280, p < 0.001$). To address the precision of these estimates, both t-statistics and exact probability values are reported as uncertainty indicators, confirming the high statistical power and robustness of these hypothesized paths.

Table 5 Regression Analysis Table of Learning Capability, Entrepreneurial Leadership and Organizational Innovation

	Entrepreneurial Leadership				Organizational Innovation				Organizational Innovation			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	β	t	β	t	β	t	β	t	β	t	β	t
Control												
Gender	0.004	0.083	0.009	0.305	0.014	0.310	0.003	0.091	0.014	0.31	-0.012	-0.348
Turnover	0.034	0.599	0.060	1.701	0.029	0.508	0.053	1.315	0.029	0.508	0.006	0.132
Size	0.028	0.499	-0.060	-1.720	0.005	0.084	0.076	1.914	0.005	0.084	-0.015	-0.358
Variables												
Learning Capability			0.793**	28.855			0.723	23.201				
Entrepreneurial Leadership											0.690**	21.280
Statistics												
R ²	0.003		0.626		0.001		0.518		0.001		0.475	
ΔR^2	-0.003		0.623		-0.005		0.515		0.001		0.474	
F	0.524		209.204		0.182		134.853		0.182		113.471	

Note: N=506; $p < 0.001 = ***$; $p < 0.01 = **$; $p < 0.05 = *$

The results indicate a statistically significant positive association between learning capability and entrepreneurial leadership, thereby supporting *Hypothesis 1*. The findings also demonstrate a significant positive association between learning capability and organizational innovation, thereby confirming *Hypothesis 2*. Finally, the results indicate a significant positive relationship between entrepreneurial leadership and organizational innovation, thus supporting *Hypothesis 3*.

4.2.2 Mediation

As presented in Table 6, the mediation analysis evaluates the role of entrepreneurial leadership in the relationship between learning capability and organizational innovation. To ensure statistical transparency, we report t-statistics and explicit p-values as primary uncertainty indicators for all estimated paths. First, the independent variable learning capability significantly and positively predicts the mediating variable entrepreneurial leadership ($\beta = 0.793$, $t = 28.855$, $p < 0.001$), suggesting that higher learning capability directly fosters entrepreneurial leadership. Second, learning

capability is found to positively predict the dependent variable organizational innovation ($\beta = 0.723$, $t = 23.201$, $p < 0.001$), highlighting its critical role in driving innovation. Finally, when both learning capability and the mediator (entrepreneurial leadership) are included in the model to predict organizational innovation, learning capability ($\beta = 0.392$, $t = 7.062$, $p < 0.001$) and entrepreneurial leadership ($\beta = 0.302$, $t = 6.191$, $p < 0.001$) both exhibit significant explanatory power. These results confirm that entrepreneurial leadership serves as a significant mediator between learning capability and organizational innovation.

Table 6 Analysis of the Mediating Effect of Entrepreneurial Leadership

	Entrepreneurial Leadership				Organizational Innovation				Organizational Innovation			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	β	t	β	t	β	t	β	t	β	t	β	t
Control												
Gender	-0.004	-0.083	0.009	0.305	-0.014	-0.310	-0.003	-0.091	-0.014	-0.310	-0.012	-0.401
Turnover	0.034	0.599	0.060	1.701	0.029	0.508	0.053	1.315	0.029	0.508	0.017	0.449
Age	0.028	0.499	-0.060	-1.720	0.005	0.084	-0.076	-1.914	0.005	0.084	-0.037	-0.970
Variable												
Learning Capability			0.793***	28.855			0.723***	23.201			0.392***	7.062
Mediator												
Entrepreneurial Leadership											0.302***	6.191
Statistic												
	0.003		0.626		0.001		0.518		0.001		0.564	
2	-0.003		0.623		-0.005		0.515		-0.005		0.559	
	0.524		209.204		0.182		134.853		0.182		107.559	

Note: N=506; $p < 0.001 = ***$; $p < 0.01 = **$; $p < 0.05 = *$

To further confirm the mediation effect, this study utilized the Bootstrap method for a more thorough analysis, ensuring the robustness and reliability of the results. Specifically, the mediation effect was considered significant if the 95% confidence interval for the indirect effect excluded zero. When the direct effect's 95% confidence interval contains "0," it suggests a full mediation model. If both the direct and indirect effects' 95% confidence intervals do not contain "0," the model indicates partial mediation. Based on this study, the Bootstrap test was applied to evaluate the mediation effect by observing the upper and lower bounds of the direct and indirect effects within the 95% confidence interval.

When learning capability serves as the independent variable, the detailed test results are reported in Table 7. The 95% confidence interval for the indirect effect is [0.18, 0.43], clearly excluding zero, indicating that the mediating effect within the model is statistically significant. Similarly, the 95% confidence interval for the direct effect is [0.40, 0.72], indicating a statistically significant result as zero is not included. These results support the conclusion that entrepreneurial leadership functions as a partial mediator in the relationship between learning capability and organizational innovation.

Table 7 Bootstrap Test-The independent variable is learning capability

	Effect	BootSE	BootLLCI	BootULCI	Effect ratio
Indirect Effect	0.30	0.06	0.18	0.43	35.18%
Direct Effect	0.56	0.08	0.40	0.72	64.82%
Total Effect	0.86	0.04	0.79	0.93	

The findings from the above analysis provide empirical support for "*Hypothesis 4*," demonstrating that entrepreneurial leadership operates as a mediating variable in the relationship between learning capability and organizational innovation. This mediating effect is specifically observed within technology-based SMEs in Shanxi Province, China.

4.2.3 Moderation

The regression results (Table 8) reveal that learning capability exerts a significant positive influence on entrepreneurial leadership ($\beta=0.509$, $t=12.549$, $p<0.001$). Strategic flexibility also shows a significant positive impact on entrepreneurial leadership ($\beta=0.364$, $t=9.007$, $p<0.001$). Upon introducing the interaction term (Learning Capability $\times$ Strategic Flexibility), the model's explanatory power further increased to $R^2 = 0.678$ ($F=178.764$, $p<0.001$). The interaction effect is statistically significant and positive ($\beta=0.074$, $t=2.717$, $p<0.01$), providing the empirical basis for a positive moderation.

Table 8 Regression Results for Strategic Flexibility's Moderating Effect

	Entrepreneurial Leadership					
	Step1		Step2		Step3	
	β	t	β	t	β	t

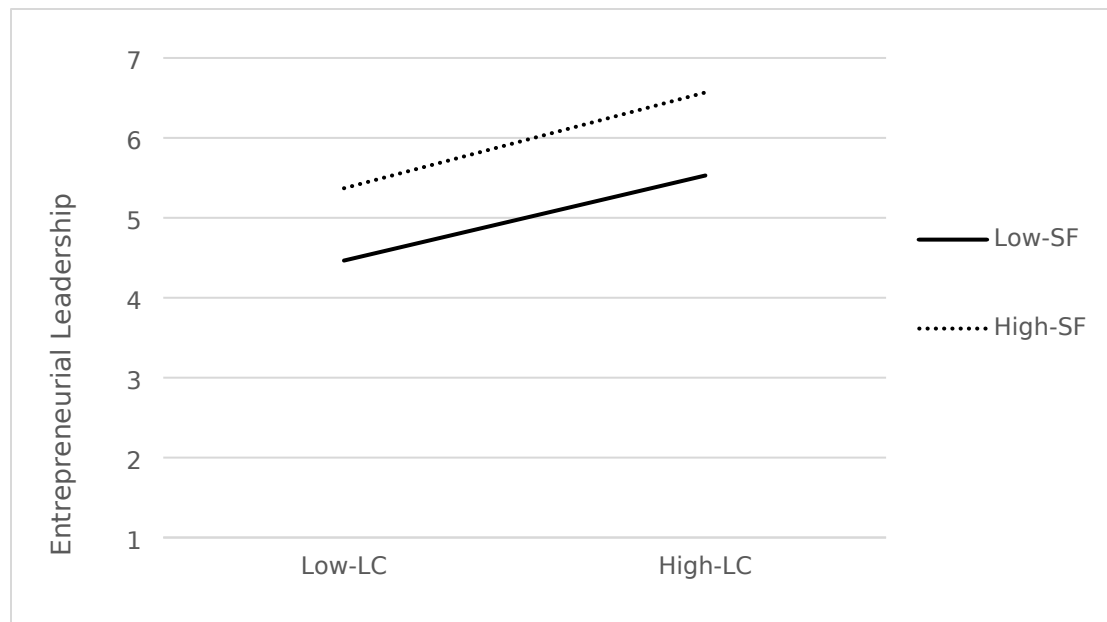
Control Variable						
Gender	-0.004	-0.083	0.004	0.161	0.002	0.084
Turnover	0.034	0.599	0.024	0.724	0.025	0.763
Size	0.028	0.499	-0.022	-0.671	-0.026	-0.787
Independent Variable						
Learning Capability			0.509***	12.549	0.514***	12.748
Strategic Flexibility			0.364***	9.007	0.388***	9.434
Interaction Effect						
Learning Capability×Strategic Flexibility					0.074**	2.717
Statistics						
R2	0.003		0.678		0.682	
ΔR2	-0.003		0.675		0.679	
F	0.524		210.355		178.764	

Note: N=506; $p < 0.001 = ***$; $p < 0.01 = **$; $p < 0.05 = *$

LC=Learning capability, SF= Strategic flexibility, EL= Entrepreneurial leadership

To interpret the nature of this interaction, a simple slope analysis was conducted and visualized in Figure 2. As illustrated, the positive gradient of the relationship between learning capability and entrepreneurial leadership steepens as strategic flexibility increases from low to high levels. Specifically, while learning capability consistently promotes entrepreneurial leadership, this effect is significantly amplified in environments or individuals with high strategic flexibility, confirming a synergistic moderation effect. This suggests that strategic flexibility acts as a catalytic resource that allows entrepreneurs to more effectively translate their learning capabilities into leadership behaviours.

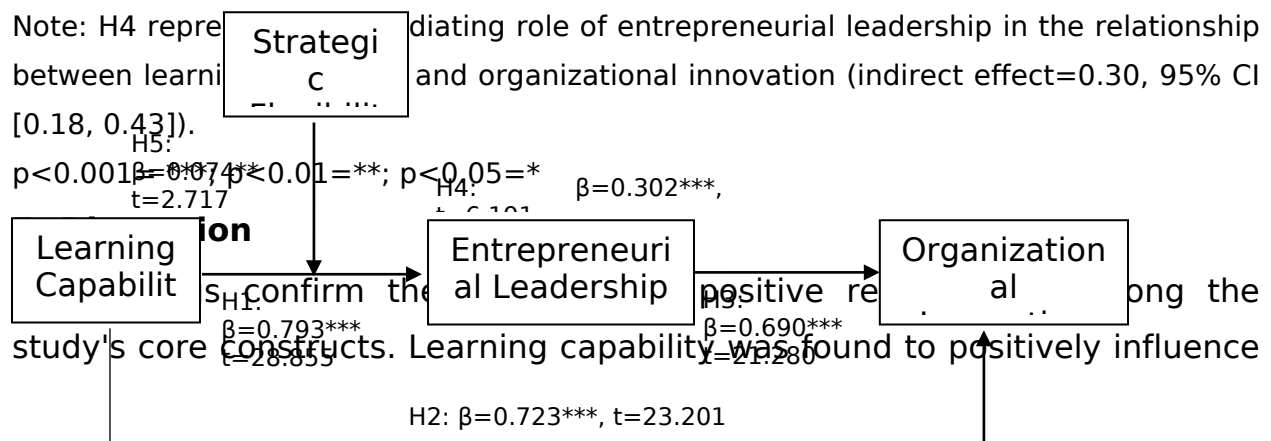
Figure 2 Interaction effect of learning capability and strategic flexibility on entrepreneurial leadership



Note: LC = Learning capability; SF = Strategic flexibility. The lines represent the predicted values of EL based on the regression equation. Simple slope analyses at high and low levels of SF (± 1 SD) indicate that the relationship between LC and EL varies significantly, supporting the robustness of the moderating effect.

The above analysis provides empirical confirmation of “Hypothesis 5”. Thus, strategic flexibility serves as a moderating factor in the positive relationship between learning capability and entrepreneurial leadership among Science and Technology-based Small and Medium-sized Enterprises in Shanxi Province, China, further strengthening this association. Following the completion of all hypothesis tests, Figure 3 presents the verified conceptual framework summarising the empirically supported relationships among the study constructs.

Figure 3 Verified conceptual framework



both entrepreneurial leadership and organizational innovation, consistent with DCT's conceptualization of learning as a foundational sensing mechanism. Entrepreneurial leadership similarly demonstrated a significant positive effect on organizational innovation, affirming its role as a critical seizing foundation within the dynamic capability chain. Our findings provide robust empirical support for the dynamic capability theory, which asserts that learning constitutes a fundamental component within the dynamic capability framework [61]. Specifically, for technology-based SMEs in Shanxi Province, which is a region currently navigating a critical transition from resource-heavy industries to high-tech sectors, learning capability operates as a continuous knowledge-processing system rather than a static resource. While the foundational logic of these capabilities may have broad implications, our findings are uniquely salient for firms in such transitional and resource-constrained contexts. By facilitating knowledge acquisition and underpinning the generation of novel combinations [62], this capability provides the requisite cognitive inputs that allow firms to break path dependency and sustain innovation momentum amidst high environmental volatility. This is consistent with prior studies demonstrating that dynamic capabilities serve as a critical mechanism through which SMEs translate internal resources into sustained innovative outcomes [106,107].

Central to the process-oriented contribution of this study is the evidence that entrepreneurial leadership serves as the primary mediating pathway through which latent learning capability is operationalized into tangible organizational innovation. This mediation effect indicates that the translation of learning into innovation outcomes is not automatic but remains contingent upon the strategic agency of leadership [63]. This finding addresses a significant knowledge and action gap that is frequently pronounced in SMEs within emerging or transitioning economies, where firms may possess high learning potential but fail to innovate due to rigid management. Our results clarify a behavioural sequence whereby entrepreneurial leadership acts as the critical foundation [64,44], identifying and exploiting opportunities inherent in

acquired knowledge to convert cognitive resources into solution oriented innovative outcomes.

Furthermore, the regression results provide insight into the dynamic boundary conditions of this translation process, confirming that strategic flexibility moderates the efficiency of the linkage between learning capability and entrepreneurial leadership ($\beta = 0.074$, $p < 0.01$). As illustrated in the interaction plot, the impact of learning capability on entrepreneurial leadership is significantly amplified under conditions of high strategic flexibility, suggesting that an organization's capacity for resource reconfiguration determines the velocity at which knowledge informs leadership behaviours. Strategic flexibility facilitates the rapid mobilization of knowledge, ensuring that leaders can more effectively champion opportunity seeking and calculated risk-taking [38]. This finding resonates with Sarwar et al. [108], who demonstrated that strategic agility serves as a critical enabler through which organizations optimize the translation of analytical capabilities into innovation performance. Consequently, strategic flexibility acts as a functional catalyst that optimizes the information flow from the initial learning stage to the subsequent leadership-driven action stage [65].

In summary, this study delineates the sequential process of knowledge acquisition (learning capability), behavioural activation (entrepreneurial leadership), innovative realization (organizational innovation). The findings demonstrate that learning capability enhances organizational innovation not through a simple direct effect, but through a multi-stage conversion process mediated by entrepreneurial leadership and moderated by strategic flexibility. While caution should be exercised when generalizing these results to established market economies, this study offers a specialized roadmap for SMEs in transitioning regions. It highlights that innovation success in these contexts depends on the strategic agility to effectively channel internal capabilities into leadership-driven action.

6. Implications

6.1 Theoretical implications

This study offers several theoretical contributions to the literature on organizational learning, entrepreneurial leadership, and innovation. Although previous studies [66,66] have recognized the significance of learning capability in fostering organizational innovation, limited attention has been given to systematically investigating the mediating function of entrepreneurial leadership within this association. By empirically demonstrating that entrepreneurial leadership serves as mediation within this relationship, this study extends Dynamic Capabilities Theory beyond its original focus on resource reconfiguration, offering a more granular account of how the sensing, seizing and transforming chain operates in practice. Specifically, this study clarifies that the relationship between learning capability and organizational innovation is not direct but operates through the mediating role of entrepreneurial leadership, thereby offering a more process-oriented theoretical account of how dynamic capabilities are activated and converted into innovation outcomes in technology-based SMEs.

Second, this study contributes to the literature on Dynamic Capabilities Theory by providing empirical validation of strategic flexibility as a significant moderating factor in the relationship between learning capability and entrepreneurial leadership. While prior research has acknowledged that organizational and individual characteristics may shape the effectiveness of learning capability [68,69], the specific moderating role of strategic flexibility as a higher-order reconfiguring capability within this relationship has remained underexplored. Awais et al. [104] highlight that strategic flexibility is particularly relevant and effective in dynamic environments, suggesting that its moderating influence varies across organizational contexts. Our findings extend this logic by demonstrating that strategic flexibility specifically amplifies the conversion of learning capability into leadership driven innovation by reducing structural rigidities that would otherwise impede resource mobilization. This finding advances DCT by clarifying that the sensing,

seizing and transforming chain is not a deterministic process but one whose efficiency is shaped by the organization's capacity for strategic reconfiguration [105].

6.2 Practical implications

Beyond its theoretical implications, the present research offers meaningful practical guidance for managers and strategic decision-makers and practitioners. The confirmed positive relationships among learning capability, entrepreneurial leadership, and organizational innovation suggest that technology-based SMEs should treat these three elements as an integrated capability system rather than isolated organizational assets. Managers are advised to simultaneously invest in knowledge acquisition infrastructure, leadership development, and organizational flexibility to fully activate the innovation potential embedded within their firms.

The significant mediation effect of entrepreneurial leadership suggests that relying solely on the enhancement of learning capability may not be sufficient to maximize organizational innovation. Instead, organizations should actively foster entrepreneurial leadership to effectively bridge and strengthen this link [70]. This implies that management practices should not only focus on increasing knowledge acquisition but also on investing in leadership development that facilitates the emergence of entrepreneurial behaviours [71].

Furthermore, organizations should cultivate strategic flexibility as a structural enabler that amplifies the effectiveness of both learning capability and entrepreneurial leadership [72]. Specifically, organizations seeking to improve organizational innovation should cultivate strategic flexibility, as elevated levels of strategic flexibility amplify the positive linkage between learning capability and entrepreneurial leadership [73]. These findings suggest that managerial efforts should not be limited to promoting learning capability in isolation but should also prioritize the strategic alignment between internal capabilities and the organization's capacity for rapid resource reconfiguration.

7. Conclusion

This study provides a comprehensive investigation into the relationship between learning capability and organizational innovation, highlighting the pivotal influence of entrepreneurial leadership and strategic flexibility in facilitating innovation outcomes. Our findings suggest that while learning capability is a necessary condition for an enterprise's sustainable development, its effectiveness is significantly contingent upon leadership dynamics and organizational adaptability. More precisely, both learning capability and entrepreneurial leadership exert positive effects on organizational innovation, wherein entrepreneurial leadership functions as a vital mediating variable that translates learning into action.

Moreover, the connection between learning capability and entrepreneurial leadership is moderated by strategic flexibility. In other words, the efficacy of learning capability in nurturing entrepreneurial leadership is significantly amplified in the presence of high strategic flexibility. This underscores that strategic flexibility acts as a catalyst, enabling entrepreneurs to better leverage learning resources to enhance their leadership influence. By integrating these variables into a single framework, this research transcends fragmented perspectives and offers a more holistic understanding of how organizations navigate complexity.

In the future, scholars and practitioners can develop more comprehensive strategies for leveraging learning capabilities to drive sustained innovation. Organizations that emphasize ongoing learning and adaptability are more likely to effectively manage the complexities of contemporary business landscapes and sustain a competitive advantage amid rapid technological advancements and market fluctuations. This study thus lays a robust foundation for future research to further explore the interplay between cognitive capabilities and structural agility in the digital age.

Founding

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Competing interests

The authors report no conflict of interest.

Availability of Data and Materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval

This study involving human participants was conducted in accordance with the ethical standards of the Declaration of Helsinki and the relevant national and institutional guidelines. Ethical approval for this research was obtained from the Ethics Committee for Research involving Human Subjects Universiti Putra Malaysia, under protocol number JKEUPM-2024-276 prior to data collection.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Consent to publication

Consent to publish was obtained from all participants.

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