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CanAdoptingLeanStartupStrategyPromote the SustainableDevelopment of NewVentures? The Mediating Role of Organizational Iterative Learning: A Review

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ABSTRACT

In the context of entrepreneurship, where uncertainty is a prevailing challenge, the concept of entrepreneurial failure often serves as the initial hurdle for new ventures. This assertion underscores the fundamental difficulty faced by startups in navigating volatile market conditions and evolving technological landscapes. Amidst this uncertainty, establishing a strategic orientation becomes crucial for enhancing organizational learning efficiency and ultimately achieving sustainable development.

The Lean Startup theory emerges as a pivotal framework in this scenario. It posits that entrepreneurship is a continuous process of iterating and updating organizational cognition. This iterative learning process is driven by early customer insights and aims to refine business opportunities effectively. The Lean Startup methodology advocates for a systematic approach to entrepreneurship, emphasizing rapid experimentation, validated learning, and iterative adjustments based on market feedback. The paper in question seeks to explore the relationship between Lean Startup strategy, organizational iterative learning, and sustainable development within new ventures, particularly within the technological context of China.

1. Introduction

In the face of the pandemic and the new industrial revolution, businesses are looking more and more to transformation as a vital strategy to boost profitability and growth. The intricate interplay between conventional economic models and digital technologies like artificial intelligence and cloud computing has not only expedited enterprise-wide transformation but also increased the complexity of the entrepreneurial environment. Traditional entrepreneurial paradigms that emphasize independence and visionary thinking are less effective in the current unstable climate [1, 2]. Moreover, a lack of experience in the entrepreneurial learning process makes entrepreneurs more vulnerable to the dangers of overconfidence and reckless risk-taking [3, 4], which frequently results in poor decisions and even business failures. Correcting misunderstandings about entrepreneurial strategic thinking and assisting new businesses in setting benchmarks based on value-driven needs a midst uncertainty.

Lean startup (LS) theory is a market-oriented approach to entrepreneurship, according to recent literature. It refines initial products through useful market insights and dynamic organizational learning, fostering the development of innovative business acumen. Studies show that lean startup strategies (LSS) can significantly increase the productivity of product development [6], innovate within businesses [7, 8], and open up new markets [9–11].

2. Literature review and hypotheses development

2.1 Lean startup theory (LST) and organizational iterative learning (OIL)

In today's volatile entrepreneurial environment, the relationship between supply and demand has grown more complex, emphasizing the need for high-quality decision-making among entrepreneurs to mitigate trial-and-error costs and risks [13]. Drawing from "Lean Production" principles, [5] introduced lean startup theory, advocating for a methodical approach in uncertain conditions. This theory suggests that new ventures should begin with a minimum viable product (MVP), continually refining products through iterative experiments and customer feedback to swiftly create value and minimize inefficiencies [5].

The essence of lean startup theory revolves around a confirmatory learning cycle of "development-measurement-learning" [5, 14], which fosters cognitive updates and organizational learning. It emphasizes a continuous learning process for lean enterprises [15–17], building iterative capabilities rooted in organizational learning [18]. Lean startup adopts paths of "confirmatory learning" and a "simple model—interaction and trial and error—

adjustment and optimization" approach to customer development, fostering an iterative process of "response—interaction—trial and error—optimization".

Initially, lean startup encourages rapid responses to customer needs and cost-effective development of basic prototypes [19, 20]. It then promotes market validation to ensure alignment with customer preferences early on [5, 21]. Subsequently, it enhances learning through frequent customer engagement, enabling quicker adaptation to changing market demands compared to competitors [14, 20, 22]. This dynamic learning process aims to deliver high-quality products promptly, achieving optimal "service-market" fit and maximizing customer value.

Lean startup theory seeks to liberate entrepreneurs from traditional constraints and information asymmetry, establishing iterative learning practices within entrepreneurial organizations. Through platforms, customer feedback loops, and user tracking, lean enterprises iteratively refine their understanding of customer needs. Agile R&D practices and continual optimization enable them to launch precisely tailored products that meet customer demands effectively, fostering sustainable entrepreneurial growth through iterative cycles.

2.2 Lean startup strategy and sustainable development of new ventures

The following hypothesis is based on the preceding discussion:

H1: *Lean startup strategy positively affects sustainable development of new ventures.*

Bortolini et al (2021) believes that goal of lean startup is to revolutionize enterprise development methods by guiding entrepreneurs with user logic to enhance control over new venture goals. This approach emphasizes launching minimum viable products (MVPs) efficiently, minimizing waste in product and business development processes, and halting activities that don't add value [11]. Each product launch involves immediate evaluation of its impact and customer feedback, which validates basic assumptions and informs subsequent product development goals [12]. This iterative approach bridges the gap between requirements and understanding, reducing resource waste and entrepreneurial risk [23].

The lean startup strategy formalizes and visualizes the product development process, allowing entrepreneurs to monitor key performance indicators like resources, costs, and sustainability [21]. This monitoring enhances the enterprise's lean capabilities, improving the likelihood of entrepreneurial success with reduced marketing expenses. In contrast to traditional entrepreneurial models focused on self-imagination, the lean startup strategy offers innovative approaches to overcome resource constraints and seize opportunities. It guides entrepreneurs to identify and leverage high-quality resources efficiently [18, 24], while fostering customer feedback to enhance interaction quality and pinpoint product design improvements. By nurturing deep customer relationships, new ventures gain valuable feedback inexpensively, enabling better market understanding and adaptation [25, 26].

The lean startup strategy shifts focus from technological perfection to market orientation [14], emphasizing the creation and enhancement of customer value through iterative processes. Achieving competitive edge in lean enterprises hinges on effectively seeking, acquiring, and sharing demand information [27]. Establishing interactive business networks with stakeholders deepens customer engagement and fosters brand loyalty, thereby promoting sustainable development through lean practices.

2.3 The mediating effect of organizational iterative learning

The following hypothesis is based on the preceding discussion:

H2: *Organizational iterative learning can play a mediating role between lean startup strategy and sustainable development of new ventures.*

Implementing lean practices in enterprises is a multifaceted endeavor [28]. Lean entrepreneurship extends beyond procedural optimization to encompass sustainable enterprise transformation [29]. In early-stage entrepreneurship, the lean startup strategy encourages embracing failure as a learning opportunity to iterate knowledge and swiftly adjust technical paths that align with market expectations. However, maintaining balanced learning attention across stages remains a challenge for organizations, impacting organizational performance [30]. Amid heightened market uncertainty, lean startup stresses resource efficiency, prompting cautious resource investments by entrepreneurs. The complex and rapidly evolving R&D landscape also underscores the need for organizational iterative learning mechanisms within the lean startup framework.

Organizational iterative learning extracts market demand signals through active learning, transforming them into actionable insights that drive knowledge evolution within enterprises [31]. It emphasizes agile responsiveness to consumer needs, bridging gaps in understanding "unknown needs" in entrepreneurship [32, 33]. This learning mode facilitates customer engagement and reflective learning, enhancing product stickiness and offering a cost-efficient pathway for enterprise R&D.

For instance, Xiaomi leveraged extensive user feedback to rapidly enhance smartphone performance and expand the market share of its MIUI system, thereby establishing a sustainable ecosystem [34]. The interaction between entrepreneurs and users drives resource development and iteration, enhancing perceived value creation [46]. Organizational iterative learning not only facilitates product development but also equips enterprises to navigate market competition and environmental changes effectively [35]. Coupled with the lean startup strategy, it enables enterprises to refine market insights, rectify R&D errors, and foster continuous innovation through iterative cycles of "response-interaction-trial and error-optimization". This approach reduces entrepreneurial uncertainty and promotes sustainable entrepreneurial growth.

2.4 The moderating effect of environmental dynamics

The following hypothesis is based on the preceding discussion:

H3a: *Market dynamics can positively moderate the relationship between organizational iterative learning and sustainable development of new ventures.*

H3b: *Technology dynamics can negatively moderate the relationship between organizational iterative learning and sustainable development of new ventures.*

Environmental dynamics encompass the unpredictable changes in an enterprise's external environment, including shifts in market conditions and technological advancements over time. As digital technology advances and user needs become more individualized, the entrepreneurial landscape grows increasingly complex and uncertain. Scholars have observed that the performance of new ventures fluctuates with the level of environmental turbulence [36]. Established enterprises often leverage their robust knowledge base to maintain competitiveness amidst dynamic environments, whereas new ventures, with less developed knowledge structures, are more vulnerable to these fluctuations, impacting their sustainable development [37].

In terms of market dynamics, high levels intensify the challenges for new ventures in acquiring essential resources and identifying opportunities.By shortening product development cycles and minimizing learning costs, it enhances the enterprise's agility in adapting to market shifts, thereby fostering a proactive approach to capturing high-value innovations and ensuring sustainability [38]. Additionally, high market dynamics heighten the demand for novel ideas and methods, posing challenges to relying solely on static knowledge. Effective organizational iterative learning enables ventures to swiftly integrate new information and technologies, thereby fostering adaptive knowledge systems that align with the evolving environment, further enhancing sustainable development prospects.

Regarding technology dynamics, rapid technological advancements shorten product life cycles and increase the risk of obsolescence. This poses a significant challenge to enterprise innovation paradigms, especially for new ventures that may struggle to sustain high investments in continuous R&D [39]. While investing in technology upgrades can establish new knowledge bases, it also escalates entrepreneurial risks. Alternatively, enterprises that fail to innovate beyond existing technologies may struggle to meet evolving market demands, thus limiting their sustainable performance and market recognition.

2.5 The moderated mediation

Our study proposes a moderated mediation model (H3 and H4 combined). It suggests that organizational iterative learning acts as a mediator between lean startup strategy and the sustainable development of new ventures. The effectiveness of this mediation varies based on environmental dynamics. In environments with high market dynamics, new ventures are more inclined to iterate and learn, thereby enhancing the efficiency of organizational iterative learning through lean startup strategies. This reduces costs and risks associated with acquiring market knowledge, fostering sustainable development advantages.

Conversely, in high technology dynamic environments, whether new ventures focus on technology iteration or maintaining the status quo for customer feedback can lead to uneven resource allocation and limited opportunity identification. This can hinder the benefits of organizational iterative learning, even when driven by lean startup strategies, thereby potentially negating sustainable development benefits.

The following hypothesis is based on the preceding discussion:

H4a: *Market dynamics can positively moderate the process of lean startup strategy influencing sustainable development of new ventures through organizational iterative learning.*

H4b: *Technology dynamics can negatively moderate the process of lean startup strategy influencing sustainable development of new ventures through organizational iterative learning.*

The theoretical framework (Fig 1) integrates hypotheses H1–H4. It posits that lean startup theory supports new ventures in acquiring necessary market resources for sustainable development. The lean startup strategy enhances organizational iterative learning efficiency, enabling enterprises to develop and share crucial knowledge within stakeholder networks amid dynamic environments. This process stimulates sustainable development advantages for new ventures. Our assumptions propose that lean startup strategy directly promotes sustainable development, with organizational iterative learning mediating this impact. Environmental dynamics moderate both the relationship between organizational iterative learning and sustainable development, and its mediating role.

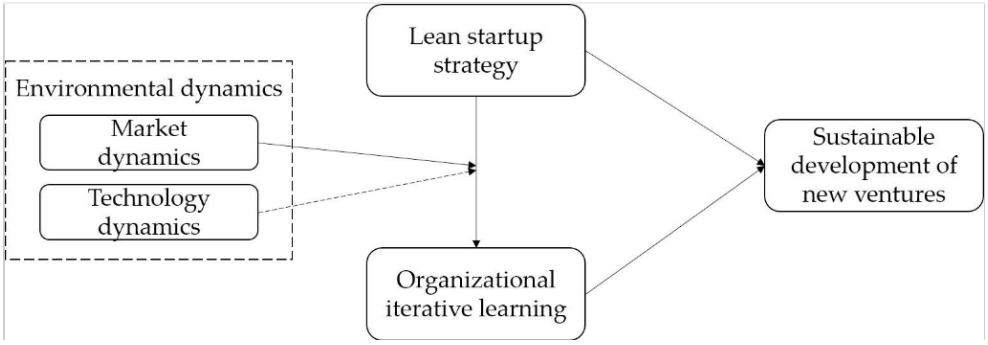

Fig 1. Theoretical model.

Notes: *The solid line represents positive relationship and the dotted line represents negative relationship.*

3. Methodology

3.1 Data sources

The context of this study is technology new ventures in China. While numerous studies on lean startup have been conducted in Western countries, only a few studies have focused on organizational learning issues on emerging economies, especially, those in China. To avoid sample selection bias and endogenous problems, we collected data in stages through combining online and offline methods. Before the formal survey, the questionnaire was further improved through feasibility evaluation by experts in the field of lean startup and also a pre-survey of 15 MBA students to ensure the content validity of the questionnaire. This study focused on technology new ventures aged between one to eight years, selected based on criteria from reference [52]. In 2022, the research obtained survey data through a random sampling method involving 380 enterprises of varying sizes and industries in Yangtze River Delta cities. The survey process consisted of two stages: the first stage gathered data on lean startup strategy, organizational iterative learning, and demographic details, yielding 371 responses. Two weeks later, scales on market dynamics, technology dynamics, and sustainable development were sent to the same participants from the first stage, resulting in 356 responses. Matching and filtering processes eliminated incomplete or irregularly completed questionnaires, yielding 325 usable responses with an effective response rate of 91.30%.

Table 1 illustrates the distribution characteristics of the sample enterprises.

Table 1

Distribution of sample enterprises.

Features	Categories	Number	Percentage (%)
Enterprise age	1~3	102	31.38
	3~5	147	45.23
	5~8	76	23.38
Enterprise nature	State-owned	34	10.46
	Private-owned	257	79.08
	Foreign-owned	26	8.00
	Other	8	2.46
Staff size	≤ 20	43	13.23
	21~50	79	24.31
	51~100	127	39.08
	101~200	51	15.69
	>200	25	7.69
Industry involved	Biomedicine	37	11.38
	Information software	62	19.08
	New energy	45	13.85
	New material	32	9.85
	High-end equipment manufacturing	78	24.00
	Energy and environment	23	7.08
	Others	48	14.77

3.2 Survey Instrument

All the scales used in this research were selected from mature Western literature and had exhibited good reliability and validity. The scales were first translated into Chinese and then translated back into English, and some items were appropriately modified and adjusted according to the agility characteristics of new ventures and the actual research situation. A Likert 5-point scale was adopted for all scales in this study, in which '1' means strongly disagree and '5' means strongly agree. In connection to this, Lean startup strategy: the measurement of this variable mainly referred to the

research of [9], which included 13 items. Such as 'We encouraged our current clients to refer our products to new clients to find out what can be done to improve the process', 'We followed guerrilla tactics in marketing, etc.

Organizational iterative learning was measured using an 11-item scale adapted from [41-43], focusing on responsive, interactive, trial-and-error, and continuous learning aspects. For instance, items included "we frequently adjust designs based on feedback" and "we encourage user feedback on products or services."

Market dynamics and technology dynamics were assessed based on a 3-item scale[44]. Examples of items include "users actively seek new products or services" for market dynamics and "predicting future technological trends in our industry is challenging" for technology dynamics. While, sustainable development was evaluated using a 3-item scale derived from [45], reflecting economic, environmental, and social dimensions. Sample items included "we support social problem-solving through technology, management, and financial assistance" and "we have implemented quality and environmental management systems like ISO18000/14000.". On the other hand, control variables encompassed enterprise age, nature, size, and industry diversity, factors known to influence sustained competitive advantage as indicated in [46].

3.3 Analytical technique

In this study, SPSS 20.0 software was utilized to assess the reliability and validity of the questionnaires and confirm the model's accuracy via hierarchical regression, while controlling for variables. Additionally, Mplus 8.0 software was employed using the three-step method to examine the mediation mechanism of the model and bootstrap analysis to assess moderated mediation effects. To ensure model robustness and deepen understanding of the impact of lean startup strategy and organizational iterative learning on new venture growth, PROCESS 3.3 was utilized to compute confidence intervals for the mediation effects, validating relevant assumptions.

4. Result and Discussion

4.1 Common method bias test and confirmatory factor analysis

To mitigate common method bias, this study employed procedural measures such as random adjustment of variable order and ensuring questionnaire confidentiality and anonymity. Subsequently, confirmatory factor analysis (CFA) and the unmeasured latent method construct (ULMC) method were utilized to assess common method issues. In CFA, the worst fit indices were observed for the single-factor model compared to other multi-factor models, confirming that common method bias was not significant (see Table 2, Model 5). Additionally, following the approach suggested by [60], a method factor was included in the baseline model, resulting in acceptable fit indices ($\chi 2/df = 2.277$, CFI = 0.941, TLI = 0.912, RMSEA = 0.076, SRMR = 0.069). This analysis indicated that any effects of common method bias were within acceptable limits.

Table 2

Confirmatory factor analysis.

Model type	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
M1: LSS, OIL, MD, TD, SD	703.420	309	2.276	0.941	0.913	0.074	0.066
M2: LSS, OIL, MD + TD, SD	844.703	314	2.690	0.826	0.805	0.120	0.074
M3: LSS + OIL, MD + TD, SD	990.872	321	3.087	0.780	0.760	0.133	0.076
M4: LSS + OIL, MD + TD + SD	1058.905	323	3.278	0.758	0.738	0.139	0.077
M5: LSS + OIL + MD + TD + SD	1493.928	324	4.611	0.616	0.584	0.175	0.132

Notes: N = 325, LSS = lean startup strategy, OIL = organizational iterative learning, MD = market dynamics, TD = technology dynamics, SD = sustainable development, the same below.

4.2 Reliability and validity analysis

The study's scale reliability was satisfactory with Cronbach's α values above 0.7 for each variable, indicating good internal consistency. Assessment of aggregation validity in Table 3 revealed that the lowest Composite Reliability (CR) was 0.766, exceeding the threshold of 0.7, and the lowest Average Variance Extracted (AVE) was 0.594, above the 0.5 threshold, affirming acceptable aggregation validity. Discriminant validity was confirmed as well: fit indices in Model 1 met standards and outperformed multi-factor models (Table 2), while the square root of AVE for each variable exceeded its correlation coefficient with other latent variables (Table 3), demonstrating robust discriminant validity among latent variables.

Table 3

Descriptive statistics and correlation analysis.

Variables	CR	AVE	1	2	3	4	5
1. Lean startup strategy	0.807	0.620	0.787				
2. Organizational iterative learning	0.816	0.734	0.335**	0.857			
3. Market dynamics	0.837	0.643	0.208**	0.229**	0.802		
4. Technology dynamics	0.801	0.651	0.467**	0.383**	0.123*	0.807	
5. Sustainable development	0.766	0.594	0.306**	0.463**	0.447**	0.323**	0.771
Mean	/	/	3.580	3.981	3.920	4.017	3.540
SD	/	/	0.825	0.766	0.739	0.747	0.740

Notes

*means p<0.05

** means p<0.01; diagonal value are the square root of AVE.

4.3 Descriptive statistics and correlation analysis

Table 3 presents descriptive statistics and correlation analyses for all variables, highlighting significant correlations among them. Specifically, lean startup strategy showed a positive correlation with sustainable development ($\beta = 0.335$, $p < 0.05$) and organizational iterative learning ($\beta = 0.306$, $p < 0.05$). Organizational iterative learning was positively associated with sustainable development ($\beta = 0.463$, $p < 0.05$). While these findings provide initial support for the hypotheses, hierarchical regression analysis was deemed necessary to rigorously test these relationships.

4.4 Hypothesis test

Prior to hierarchical regression analysis, all focal variables were standardized to mitigate multicollinearity [46]. Two baseline models (Model 1 and Model 3), incorporating only control variables, were established under different conditions of dependent variables. Initially, the study examined the direct relationship between lean startup strategy and sustainable development of new enterprises. Subsequently, it tested the mediating role of organizational iterative learning in this relationship. Thirdly, the study investigated the moderating effects of environmental dynamics on the relationship between organizational iterative learning and sustainable development. Finally, moderated mediation effects were examined.

Table 4 presents the results of direct and indirect regression analyses. The findings indicated that lean startup strategy positively influenced sustainable development ($\beta = 0.294$, $p < 0.001$, Model 4). Compared to Model 3, the inclusion of lean startup strategy enhanced the model's explanatory power by 13.2%. Thus, Hypothesis 1 was supported, confirming a significant direct effect.

Table 4

Regression results for direct and indirect effects.

Variables	Organizational iterative learning		Sustainable development			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Control variables						
Staff size	0.064	0.052	-0.023	-0.036	-0.035	-0.027
Enterprise age	-0.019	-0.013	-0.060	-0.057	-0.056	-0.052
Industry involved	-0.076	-0.071	0.113*	0.127*	0.124*	0.094
Resource constraints	0.083	0.087	0.175*	0.163*	0.170*	0.159*
Independent variable						
LSS		0.317***		0.294***		0.204**
Mediator						
OIL					0.447***	0.373***
R^2	0.034	0.267	0.086	0.219	0.227	0.246
Adj_R^2	0.022	0.256	0.075	0.207	0.215	0.232
F	2.085*	4.147***	1.932*	4.039***	4.364***	5.024***

Notes

* means p< 0.05

** means p< 0.01

*** means p< 0.001.

In Table 4, lean startup strategy was found to positively predict organizational iterative learning ($\beta = 0.317$, $p < 0.001$, Model 2). When both lean startup strategy and organizational iterative learning were included in the regression (Model 6), organizational iterative learning significantly influenced sustainable development ($\beta = 0.373$, $p < 0.001$), while the effect of lean startup strategy on sustainable development attenuated ($\beta = 0.204$, $p < 0.01$). This suggests that organizational iterative learning partially mediates the relationship between lean startup strategy and sustainable development, supporting Hypothesis 2.

In Table 5, regression results on moderating effects revealed that the interaction between organizational iterative learning and market dynamics positively impacted sustainable development ($\beta = 0.192$, $p < 0.01$, Model 8). Following guidelines from [46], the effect of organizational iterative learning on sustainable development was plotted across different levels of environmental dynamics, as shown in Fig 2. Notably, organizational iterative learning had a stronger positive effect on sustainable development when market dynamics were higher, thereby supporting Hypothesis 3a.

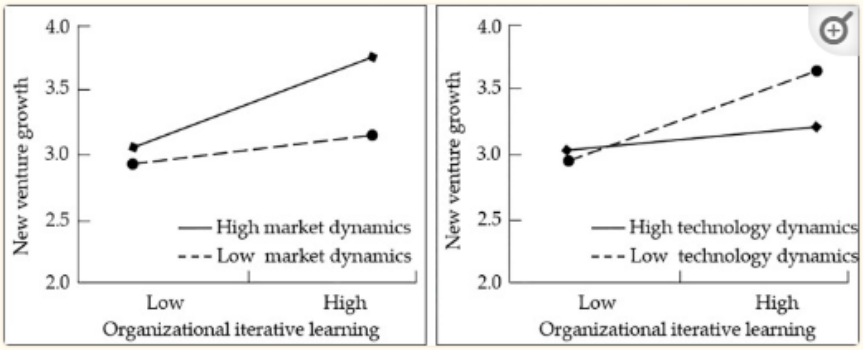

Fig 2

The moderating effect of environmental dynamics.

Table 5

Regression results for moderating effects.

Variables	Sustainable development			
	Model 7	Model 8	Model 9	Model 10
Control variables				
Staff size	-0.031	-0.033	-0.029	-0.041
Enterprise age	-0.059	-0.048	-0.052	-0.044
Industry involved	0.128*	0.085	0.103	0.098
Resource constraints	0.175*	0.143*	0.161*	0.151*
Mediator				
OIL	0.354***	0.305***	0.362***	0.339***
Moderator				
MD	0.283***	0.278***		
TD			0.154*	0.163*
Interaction				
OIL×MD		0.192**		
OIL×TD				-0.201**
R^2	0.236	0.278	0.251	0.282
Adj_R^2	0.226	0.262	0.243	0.266
F	5.212***	6.381***	4.360***	6.021***

Notes
* means p< 0.05
** means p< 0.01
*** means p< 0.001.

In a similar manner, the interaction between organizational iterative learning and technology dynamics negatively affected sustainable development (β = -0.201, p < 0.01, Model 10). Fig 2 illustrates this relationship across varying levels of technology dynamics, showing that higher technology dynamics weakened the positive impact of organizational iterative learning on sustainable development. Hypothesis 3b was supported, confirming a significant moderating effect.

Furthermore, the study explored whether market dynamics moderated the mediating role of organizational iterative learning in the relationship between lean startup strategy and sustainable development. Results in Table 6 revealed that under higher market dynamics, lean startup strategy had a stronger indirect effect on sustainable development through organizational iterative learning (estimate = 0.110, BootSE = 0.054, 95% CI [0.040, 0.218]). Conversely, under lower market dynamics, although still significant, the indirect effect was less pronounced (estimate = 0.066, BootSE = 0.031, 95%

CI [0.027, 0.132]). This indicates that market dynamics moderated the indirect impact of lean startup strategy on sustainable development via organizational iterative learning. Hypothesis 4a was supported.

Table 6

Bootstrapping results for moderated mediation effect.

Moderator	Level	Estimate	BootSE	LLCI	ULCI
Market dynamics	Low (-1SD)	0.066	0.031	0.027	0.132
	High (+1SD)	0.110	0.054	0.040	0.218
Technology dynamics	Low (-1SD)	0.118	0.037	0.059	0.206
	High (+1SD)	0.087	0.049	0.039	0.141

This study also investigated whether technology dynamics moderated the mediating role of organizational iterative learning in the relationship between lean startup strategy and sustainable development. Table 6 shows that under low technology dynamics, lean startup strategy significantly mediated sustainable development through organizational iterative learning (estimate = 0.118, BootSE = 0.037, 95% CI [0.059, 0.206]). Conversely, under high technology dynamics, although still significant, the mediating effect was attenuated compared to low technology dynamics (estimate = 0.087, BootSE = 0.049, 95% CI [0.039, 0.141]). This indicates that technology dynamics moderated the indirect impact of lean startup strategy on sustainable development through organizational iterative learning. Hypothesis 4b was supported.

Conclusion

Based on 325 valid samples collected in two stages, this study revealed that lean startup strategy enhances sustainable development in new ventures through improved organizational iterative learning. Market dynamics amplified the positive impact of organizational iterative learning on sustainable development, whereas technology dynamics diminished this effect. Additionally, market and technology dynamics moderated the mediating role of organizational iterative learning in the relationship between lean startup strategy and sustainable development.

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