Bridging Academia and Industry: Collaborative Innovation Strategies in Chinese University-Enterprise Partnerships

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Abstract

Background: China's pursuit of technological self-reliance and global competitiveness has intensified the need for academia-industry collaboration. As higher education evolves to meet modern economic demands, universities and enterprises face systemic challenges. Against this backdrop, the study situates itself in China's broader agenda to leverage synergistic innovation as a catalyst for economic and educational transformation.

Objective: This research investigates how collaborative innovation strategies between universities and industries in China can bridge institutional divides to foster technological advancement and talent development. It seeks to identify mechanisms that align academic reforms with industry needs.

Method: This study employs a mixed-method approach, combining qualitative and quantitative methodologies to address its objectives. Based on empirical data and the resources available in universities in Hainan Province, the target sample size has been set at 509.For the qualitative aspect of the research, 15 interviewees were selected using purposive and convenience sampling methods, with interviews conducted between September and December 2024.

Findings: The findings reveal how interdisciplinary collaboration, government-industry-academia policy alignment, and digital platforms act as critical enablers of synergistic innovation, underscoring the necessity of multi-stakeholder engagement to strengthen China's innovation ecosystem, arguing that university-enterprise collaboration is not merely a driver of economic growth but a transformative force reshaping higher education's societal role.

Contribution: The insights offer practical implications for policymakers, educators, and industry leaders seeking to optimize collaborative innovation strategies in dynamic, knowledge-driven economies.

Keywords: University-Enterprise Partnerships, Collaborative Innovation Strategies, Synergistic Effects, Higher Education Reform, Innovation Ecosystems

1. Introduction

1.1 Research background

Trends in the Innovative Development of Higher Education

Globally, reshaping the new path for the development of world higher education is becoming an international consensus. Over the past 24 years spanning the turn of the century, UNESCO has hosted three World Conferences on Higher Education, becoming a significant indicator for the reform and innovative development of world higher education. The first World Conference on Higher Education was held in Paris in 1998. The conference issued the "Higher Education in the 21st Century: Vision and Action" declaration, stating that the "21st century will be a century that pays more attention to quality." Emphasizing quality has become the theme of world higher education in the 21st century. The second World Conference on Higher Education was held in Paris in 2009. The conference issued the "New Dynamics of Higher Education and Research for Societal Change and Development" communique, with the main theme being Quality Assurance, calling for the establishment of a quality assurance system in higher education institutions to foster a culture of quality. The third World Conference on Higher Education was held in Barcelona in May 2022. The conference issued the "Beyond Limits: Reshaping a New Path for Higher Education" declaration, with the main theme being "Reshaping Higher Education for a Sustainable Future".

The trend of collaborative innovation between universities and enterprises

Development of University-Industry Cooperation in China

In China, University-industry cooperation is the result of the reform of the science and technology system, the economic system and the education system under the guidance of the national macro-strategy. At present, the cooperation relationship between universities and industries has gone through three stages, from "industry -university -research association" to "industry -university -research combination" to "close combination of industry-university-research" （Li，2020）. In 1992, in order to strengthen the cooperative relationship between universities and enterprises, mobilize the enthusiasm of university-industry cooperation, and accelerate the industrialization of China's high and new technology achievements, China organized and implemented the "Industry-University-Research Joint Development Project" nationwide with the former State Economic and Trade Commission, the Ministry of Education, and the Chinese Academy of Sciences (CAS) as the main leading organizations. Its goal is to promote a number of large and medium-sized enterprises to establish stable and close cooperative relationships with universities and research institutes under the CAS, to promote the exchange of scientific researchers, jointly establish technological development institutions in enterprises through cooperation, to form a community of interests among industries, universities and scientific research institutions, and to form an operational mechanism that promotes the coordinated development of industry, academia and research.

1.2 Research objectives

There are four research objectives in this study, as outlined below:

1) Constructing the theoretical framework of collaborative innovation within university-

industry cooperative organizations

2) Analyzing the relationship between the parties involved in university-industry cooperation through the lens of collaborative innovation and outlining the organizational mechanisms involved

3) Investigating the specific collaborative processes of innovation components within university-industry cooperation

4) Examining the pathways through which collaborative innovation is achieved in university-industry cooperation organizations

2. Literature Review and Hypotheses

2.1 knowledge transfer (KT)

Knowledge transfer, a cornerstone of organizational learning and innovation, encompasses the dynamic processes through which information, skills, and expertise are shared, adapted, and integrated across individuals, teams, and institutions. Scholars emphasize its multifaceted nature: Szulanski (1996) and Argote and Ingram (2000) frame it as a social and relational process influenced by interactions between units, where trust and collaboration enable experiential learning. Nonaka and Takeuchi (1995) broaden this view by distinguishing between tacit and explicit knowledge, arguing that transfer involves not just exchange but the creative combination of knowledge assets—a perspective aligned with Grant's (1996) focus on systematic dissemination across organizational boundaries. Meanwhile, Kogut and Zander (1992) highlight the adaptive dimension, positing that effective transfer requires recipients to reinterpret and contextualize knowledge, transforming it into actionable insights.

2.2 Institutional Innovation (II)

Institutional innovation refers to the deliberate redesign of norms, structures, and practices to drive systemic transformation across social, economic, and governance systems. Scholars emphasize its dynamic interplay between creativity, adaptation, and structural change. Westley and Antadze (2010) define it as the introduction of novel frameworks that disrupt entrenched norms, while Garud and Karnøe (2003) stress its role in enabling organizations to adapt to shifting societal demands through creative problem-solving. Battilana and Dorado (2010) extend this view, linking institutional innovation to the emergence of new organizational forms—such as hybrid entities in academia-industry ecosystems—that reconcile competing priorities (e.g., research autonomy vs. market responsiveness).

2.3 Social Networks (SN)

Social network theory examines how interpersonal and institutional relationships shape information flow, resource access, and collective behavior. Granovetter's (1973) foundational concept of weak ties—loose connections that bridge disparate groups—reveals their critical role in disseminating novel information and enabling opportunities, a framework extended by Burt's (1992) structural holes theory, which positions brokers in these gaps as pivotal for innovation. Watts and Strogatz (1998) advanced structural analysis through small-world networks, demonstrating how localized clusters with sparse global links optimize both cohesion and efficiency, a model applicable to academia-industry ecosystems.

2.4 Organizational Learning (OL)

Organizational learning (OL) focuses on how institutions acquire, share, and apply knowledge to drive adaptation and innovation. Argyris and Schön (1978) distinguish single-loop learning (correcting errors) from double-loop learning (redefining norms), emphasizing reflection and systemic change. Senge's (1990) "learning organization" prioritizes shared vision and systems thinking, while Nonaka and Takeuchi (1995) highlight tacit-explicit knowledge conversion as key to innovation. Unlike individual learning, OL operates through hierarchical structures and cross-departmental dissemination, prioritizing organizational goals over personal growth.

2.5 Collaborative Innovation (CI)

Collaborative innovation (CI) emerges from synergy theory (Haken, 1971), where interconnected subsystems achieve "1+1>2" outcomes through coordinated resource sharing. Defined as cross-organizational processes that dissolve barriers to integrate expertise, knowledge, and infrastructure (Ketchen et al., 2016), CI prioritizes goal alignment and systemic efficiency. Chen Jin (2022) extends this to academia-industry-government ecosystems, framing CI as knowledge co-creation driving scientific advancement.

Hypothesis 1: knowledge transfer has a positive influence on collaborative innovation effect.

Hypothesis 2: Institutional innovation has a positive influence on organizational learning.

Hypothesis 3: Organizational learning has a mediating effect between institutional innovation and collaborative innovation effect.

Hypothesis 4: Institutional innovation has a positive influence on collaborative innovation effect.

Hypothesis 5: Social network has a positive influence on collaborative innovation effect.

3. Methodology

3.1 Research approach

The integration of both quantitative and qualitative data allows for a multifaceted exploration of the research objectives. The study utilizes a well-established and validated questionnaire survey, endorsed by previous scholars for its reliability and validity, to collect data on the research variables. Survey questions were developed using a Likert five-point scale and distributed to the appropriate demographic through an online platform. Statistical analysis software tools such as SPSS and Smart PLS are employed to assess the gathered data and test the assumptions derived from the proposed conceptual framework.

Through in-depth interviews, the qualitative research component provides rich, explanatory insights into the intricacies of university-industry cooperation and offers a deeper exploration of the collaborative innovation landscape.

3.2 Research setting

This study examines collaborative innovation in the context of university-industry partnerships in Hainan, China, with a particular focus on talent development. The survey was carried out in 5 universities affiliated with the Ministry of Education and 5 provincial universities, targeting managers or administrative staff of university-industry cooperation

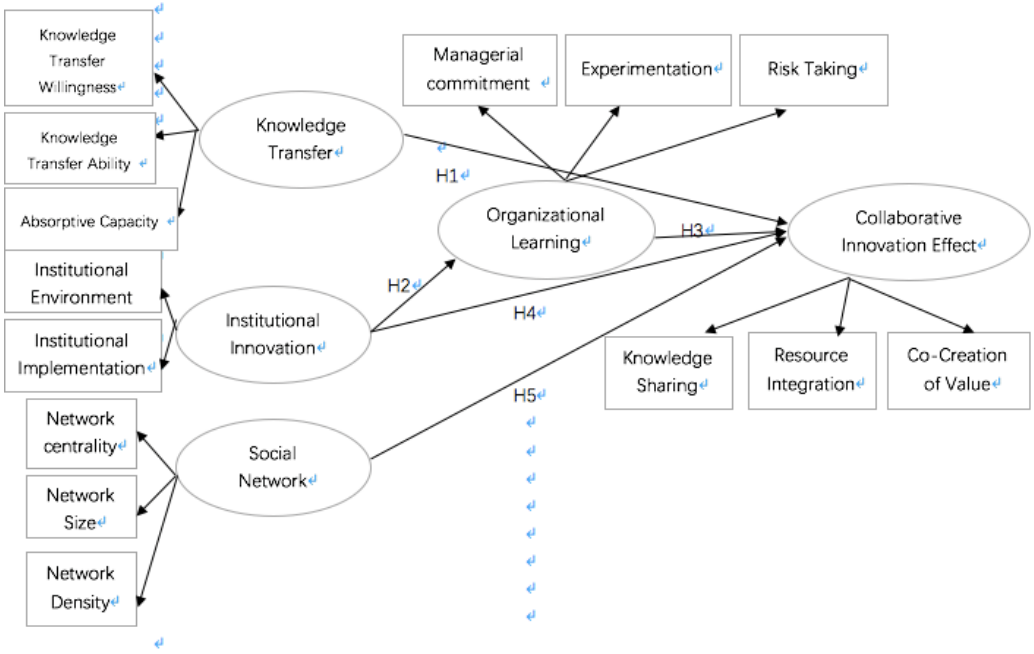
entities, as well as teachers and students.

3.3 Sample and data collection

Based on empirical data and the resources available in universities in Hainan Province, the target sample size has been set at 509. For the qualitative aspect of the research, 15 interviewees were selected using purposive and convenience sampling methods, with interviews conducted between September and December 2024.

3.4 Conceptual model

The conceptual model contains five variables, namely knowledge transfer, institutional innovation, social network, organizational learning and collaborative innovation effects. knowledge transfer, institutional innovation and social network are the independent variable, organizational learning is the moderating variable, and collaborative innovation effect is the dependent variable.



4. Results

4.1 Evaluation of the reflective measurement model

4.1.1 Two- stage measurement models evaluation

The researcher consults Hiar et al. (2022, 110–128) for help on assessing the reflective measurement model.

The researcher utilized a sequential latent variable scoring approach, a two-stage method, to assess measurement models for a reactive second-order model comprising 54 items, 14 first-order structures, and 5 second-order structures. Initially, the researcher assessed the outer

loadings for the 14 first-order constructs and 54 items, as well as the composite reliability (CR) values, average variance extracted (AVE) values, and Cronbach's alpha. Subsequently, in the second stage, the researcher evaluated the outer loadings, composite reliability (CR) values, average variance extracted (AVE) values, and Cronbach's alpha for the 14-dimension first-order structure and the 5-variable second-order structure. This approach allows for a comprehensive evaluation of the measurement models, ensuring that both the first-order and second-order structures are thoroughly examined for their reliability and validity.

Stage 1: Table 4.1 provide the assessment results for the first-order constructs of 54 items and 14 dimensions.

Table 4.1 Assessing 54 items and 14 dimensions first-order constructs

Variables	Items	Outer Loading	Cronbach's Alpha	Composite reliability(rho_a)	Composite reliability(rho_c)	AVE Value
KTW			0.886	0.887	0.922	0.746
	KTW1	0.851				
	KTW2	0.870				
	KTW3	0.858				
	KTW4	0.876				
KTA			0.863	0.864	0.917	0.786
	KTA1	0.893				
	KTA2	0.884				
	KTA3	0.882				
AC			0.828	0.874	0.914	0.726
	AC1	0.865				
	AC2	0.847				
	AC3	0.877				
IE			0.860	0.861	0.905	0.704
	IE1	0.851				
	IE2	0.860				
	IE3	0.809				
	IE4	0.836				
II			0.878	0.879	0.911	0.672
	II1	0.834				
	II2	0.825				
	II3	0.784				
	II4	0.828				
	II5	0.827				
NC			0.876	0.876	0.910	0.669
	NC1	0.835				
	NC2	0.812				

	NC3	0.806				
	NC4	0.814				
	NC5	0.821				
NS			0.859	0.859	0.904	0.703
	NS1	0.851				
	NS2	0.837				
	NS3	0.825				
	NS4	0.840				
ND			0.842	0.842	0.894	0.678
	ND1	0.844				
	ND2	0.825				
	ND3	0.799				
	ND4	0.826				
E			0.837	0.837	0.891	0.671
	E1	0.827				
	E2	0.816				
	E3	0.815				
	E4	0.819				
MC			0.853	0.853	0.901	0.694
	MC1	0.856				
	MC2	0.804				
	MC3	0.840				
	MC4	0.830				
RT			0.816	0.818	0.891	0.731
	RT1	0.848				
	RT2	0.842				
	RT3	0.874				
KS			0.856	0.856	0.902	0.698
	KS1	0.841				
	KS2	0.817				
	KS3	0.843				
	KS4	0.840				
RI			0.865	0.865	0.908	0.711
	RI1	0.845				
	RI2	0.843				
	RI3	0.847				
	RI4	0.839				
CV			0.823	0.823	0.894	0.738
	CV1	0.864				
	CV2	0.853				
	CV3	0.862				

Stage 2: Table 4.2 shows the results of evaluating the 14dimensions and the 5variables that make up the second-order structures.

Table 4.2 Evaluating 14 dimensions first-order structure and 5 variables second-order constructs.

Variables	Dimensions	Outer Loading	Cronbach's Alpha	Composite reliability(rho_a)	Composite reliability(rho_c)	AVE Value
KT			0.929	0.930	0.940	0.610
	KTW	0.886				
	KTA	0.863				
	AC	0.828				
II			0.920	0.920	0.933	0.610
	IE	0.860				
	II	0.878				
SN			0.939	0.940	0.947	0.579
	NS	0.859				
	NC	0.876				
	ND	0.842				
OL			0.927	0.927	0.938	0.578
	MC	0.853				
	E	0.837				
	RT	0.816				
CIE			0.941	0.941	0.949	0.627
	KS	0.856				
	RI	0.865				
	CV	0.823				

4.1.2 Analysis Based on the Sequential Latent Variable Scoring Approach

Indicator Reliability: In this study, all five variables and the 14 dimensions achieved outer loadings above this threshold. This finding indicates that each item significantly contributes to its corresponding construct.

Internal Consistency: In this study, the Cronbach's alpha, rho_a, and rho_c values for all 14 dimensions and the five variables were found to be greater than 0.7 and less than 0.95, confirming acceptable internal consistency.

Convergence Validity: With AVE values surpassing 0.5 for every dimension, the results indicate that the dimensions are well-defined and collectively account for significant variance

in their respective items.

4.2 Evaluation of the structural model

4.2.1 The Path coefficient analysis

Path coefficient values typically range from -1 to 1, where values close to 1 indicate a strong positive relationship, and those close to -1 suggest a strong negative relationship. Significance is commonly assessed at a 95% confidence level.

Table 4.3 Path coefficients list

Variable	Path coefficients
CIE -> CV	0.914
CIE -> KS	0.944
CIE -> RI	0.949
II -> CIE	0.004
II -> IE	0.930
II -> IIN	0.952
II -> OL	0.809
KT -> AC	0.892
KT -> CIE	0.105
KT -> KTA	0.913
KT -> KTW	0.891
OL -> CIE	0.637
OL -> E	0.917
OL -> MC	0.931
OL -> RT	0.879
SN -> CIE	0.186
SN -> NC	0.943
SN -> ND	0.916
SN -> NS	0.901

4.2.2 The test results of hypothesis

It is important to note that in order to evaluate the relationship between variables or make inferences about a population based on sample data, hypotheses are typically tested using statistical methods. The type of hypothesis being tested and the statistical technique employed can influence the specific test findings of a hypothesis test. The author attempted to integrate multiple statistical techniques to test the results of the hypothesis.

Table 4.3 The test results of hypothesis

Hypothesis	path	Total effect	Direct effect	T Statistics (|O/STDEV|)	P value	Confidence 2.5 %	Confidence 97.5 %	Results
H1	KT -> CIE	0.105	0.105	1.589	0.000	0.102	0.356	support
H2	II -> OL	0.809	0.809	31.377	0.000	0.753	0.855	support
H3	OL-> CIE	0.637	0.637	10.101	0.000	0.505	0.751	support
H4	II -> CIE	0.520	0.520	7.803	0.000	0.384	0.647	support
H5	SN -> CIE	0.186	0.186	1.781	0.000	0.128	0.373	support

Table 4.3summarizes the findings for five hypotheses, detailing the total and direct effects of various paths, along with their statistical significance indicators—T statistics, P values, and confidence intervals. The T value, p value, and statistical test volume of the aforementioned hypothesis at p=0.000 all passed the test.

4.3 results

The preliminary testing, formal research, data collection, reliability analysis, and exploratory factor analysis of the questionnaire scale, along with validation factor analysis, have been successfully executed. All the outer loadings of the seven variables and 14 dimensions in this study surpass 0.708, signifying acceptable reliability in the research indicators. Moreover, the Cronbach's alpha, comprehensive reliability rho_a, and comprehensive reliability rho_c of the 14 dimensions and 5 variables in this study all exceed 0.7 and are below 0.95, which is deemed satisfactory. Furthermore, with AVE values exceeding 0.5 for each dimension, the dimensions are distinctly defined and significantly contribute to

the variance in the items. As a result, the findings validate the theoretical framework of knowledge transfer, institutional innovation, social network as independent variables, organizational learning as mediating variables, and collaborative innovation as the dependent variable. The final fitting results for the structural equation model are depicted, revealing 5 pathways, each performing exceptionally well. The t value, p value, and statistical test volume of the hypothesis all passed the test. Additionally, the integration of content analysis and qualitative analysis results provides a comprehensive understanding of the intricate dynamics in the collaborative innovation, reinforcing the theoretical framework and contributing to the broader discourse on the factors driving successful collaboration between academic institutions and industry partners.

4.3.1 H1: The analysis of the data supports Hypothesis 1, which posits that knowledge transfer (KT) has a positive influence on the collaborative innovation effect (CIE). The quantitative results indicate that KT exerts a direct effect of 0.105 on CIE, with a statistically significant path ($P < 0.001$), suggesting that as knowledge transfer increases, so does the effectiveness of collaborative innovation. The confidence interval further reinforces this finding, indicating that the true effect is likely above zero. However, the relatively low T statistic implies that while the relationship is significant, the effect size is modest when compared to other variables in the study.

Qualitative insights gathered through in-depth interviews further illuminate this relationship. Respondents consistently highlighted that effective knowledge transfer mechanisms—such as joint workshops, collaborative research projects, and informal networking—significantly enhanced their ability to innovate collectively. For instance, one interviewee noted, "When we share our knowledge and expertise, it leads to new ideas that we wouldn't have developed alone." This sentiment echoes the findings of Tsai (2001), who posited that strong social networks facilitate knowledge sharing, thereby enhancing collaborative innovation outcomes.

4.3.2 H2: The analysis of the data indicates that institutional innovation (II) has a positive influence on organizational learning (OL), with a direct effect size of 0.809. This substantial effect highlights the critical role that institutional innovation plays in enhancing learning processes within organizations. The path analysis reveals a very strong total and direct effect, supported by an exceptionally high T statistic, which indicates robust significance. Furthermore, the confidence interval suggests high precision, lending strong support to this hypothesis.

Qualitative insights from in-depth interviews corroborate these quantitative findings by providing concrete examples of how institutional innovation drives organizational learning. Respondents highlighted that innovative practices, such as the introduction of new technologies and collaborative frameworks, significantly enhance their ability to learn and adapt. One interviewee noted, "Our commitment to innovation has transformed our approach to learning;

we now actively seek out new methods and ideas, which has enriched our knowledge base." This sentiment reflects the idea that institutional innovation creates opportunities for experiential learning, as suggested by Kolb (1984), who emphasized the importance of learning through experience in organizational contexts.

4.3.3 H3: The analysis of the data reveals that organizational learning (OL) serves as a mediating factor between institutional innovation (II) and collaborative innovation effect (CIE). The test results indicate that OL has a direct effect of 0.637 on CIE, demonstrating a strong and significant relationship. This finding is further supported by a high T statistic and a confidence interval that confirms the substantial nature of this effect.

Qualitative insights from the in-depth interviews provide further support for these quantitative findings. Respondents articulated that when their institutions implemented innovative practices, it not only facilitated the acquisition of new knowledge but also promoted a culture of collaboration. One interviewee stated, "The innovative initiatives we adopted have transformed how we approach learning and collaboration; now, we actively share insights and work together on projects, which has significantly improved our innovation outcomes." This aligns with the assertion by Garvin (1993) that organizations that prioritize learning and innovation are better positioned to adapt and thrive in dynamic environments.

4.3.4 H4: The analysis of the data indicates that institutional innovation (II) positively influences the collaborative innovation effect (CIE), with a direct effect size of 0.520. This substantial effect suggests a meaningful relationship between II and CIE, supported by a significant T statistic and a confidence interval that indicates a strong likelihood of the effect being meaningful. Such findings underscore the importance of institutional innovation as a driver of collaborative efforts within organizations.

Qualitative insights from in-depth interviews provide additional context to these quantitative findings. Respondents frequently noted that institutional innovation initiatives, such as the establishment of collaborative platforms and cross-departmental teams, significantly improved their organization’s ability to innovate collectively. One interviewee remarked, "Our new collaborative structures have made it easier for different teams to work together, leading to innovative solutions that we wouldn't have developed in isolation." This sentiment aligns with the findings of Bogers et al. (2017), who found that collaborative innovation is often facilitated by innovative institutional frameworks that promote interaction and knowledge exchange.

4.3.5 H5: The analysis of the data indicates that social networks positively influence the collaborative innovation effect (CIE), with a direct effect size of 0.186. While this relationship is statistically significant, the effect size and T statistic are lower compared to other hypotheses, suggesting that social networks play a less influential role in driving collaborative innovation than institutional innovation or organizational learning.

Qualitative insights from in-depth interviews provide valuable context to these quantitative findings. Respondents noted that while social networks are beneficial for collaboration, their impact on innovation outcomes is often contingent upon the strength and quality of the relationships within those networks. One interviewee commented, "Our informal networks help us share ideas quickly, but it's the strong relationships that really drive our collaborative projects forward." This observation aligns with Granovetter's (1973) theory of the strength of weak ties, suggesting that while weaker ties can provide access to new information, strong ties are crucial for mobilizing resources and achieving collaborative goals.

5. Recommendation

Base on the study, the following countermeasures and suggestions are given to promote the collaborative innovation of higher education in Hainan.

5.1 Creating an Innovative Environment to Strengthen Facilitation

According to the current classification of innovative environments, the focus is primarily on the innovation environments of key regions, industries, and enterprises. Cultivating a favorable innovative environment requires the joint efforts and collaboration of universities, enterprises, and governments to fully leverage the innovative environment's potential in enhancing the collaborative innovation capabilities of university-industry cooperation organizations. Building an innovative environment is a systematic project that requires various innovation stakeholders to promote it at different levels. This is reflected in the government's grasp of macro directions, the micro-level cooperation between universities and enterprises, and the macro-level industrial innovation environment that needs to be jointly created by the government and universities, with participation from enterprises and relevant institutions.

5.2 Strengthening Network Communication to Improve Communication Mechanisms

Network communication enables efficient information transmission and facilitates the comprehensive sharing of information among different stakeholders. University-industry cooperation organizations should enhance the construction of learning networks and strengthen network communication both internally among departments and externally with other organizations. On one hand, the construction of internal learning networks should be reinforced. Departments within university-industry cooperation organizations should promote the sharing of information, knowledge, and skills through the establishment of learning networks. On the other hand, external network communication between organizations should be strengthened to acquire more external information through external learning, thereby enhancing the organization's market adaptability and competitiveness.

5.3 Cultivating Learning Capabilities to Enhance Innovation Capacity

Organizational learning plays a crucial mediating role in the synergy of innovation effects brought about by institutional innovation. Furthermore, the mediating effect of internal

learning is even more pronounced, underscoring the significance of organizational learning as an indispensable capability in university-industry cooperation organizations' collaborative innovation efforts. Every organization is a learning system, and the learning process consists of three stages: knowledge acquisition, knowledge sharing, and knowledge utilization. Therefore, in the innovation network of university-industry cooperation organizations, it is essential to enhance the learning capabilities of collaborative organizations to leverage the synergistic effects of institutional innovation.

6. Conclusion

In conclusion, this research underscores the necessity for continuous evaluation and adaptation of collaborative practices to ensure sustained innovation in the rapidly evolving landscape of higher education and industry. Future studies could further explore the impact of emerging technologies and global trends on collaborative innovation, allowing stakeholders to stay at the forefront of innovation practices and maintain competitive advantages in their respective fields. Overall, the ability of university-industry cooperative organizations to effectively collaborate will play a pivotal role in addressing complex societal challenges and driving meaningful advancements in technology and knowledge

7. limitations and future research

The modest effect size of knowledge transfer (KT)suggests the need to explore moderators (e.g., industry sector, organizational size) and longitudinal designs to capture dynamic interactions. Future studies could also integrate mixed methods approaches to further unpack the interplay between quantitative pathways and qualitative mechanisms. By synthesizing quantitative and qualitative insights, this discussion advances a holistic model of collaborative innovation, offering actionable strategies for academia and industry to harness the synergistic potential of knowledge transfer, institutional innovation, and organizational learning.

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