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EXPLORING THE EFFECTS OF TRAINING SERVICE QUALITY, ORGANIZATIONAL LEARNING CLIMATE, AND INDUSTRY–GOVERNMENT–ACADEMIA COLLABORATION ON CORPORATE INNOVATIVE BEHAVIOR: THE MEDIATING ROLE OF EMPLOYEE WORK ENGAGEMENT USING PLS-SEM

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Abstract

This study examines the relationships among training service quality, organizational learning climate, industry–government–academia collaboration effectiveness, employee work engagement, and corporate innovative behavior. A total of 500 valid responses were collected from small and medium-sized enterprises (SMEs) in southern Taiwan, and data were analyzed using partial least squares structural equation modeling (PLS-SEM).

The results reveal that: (1) training service quality significantly and positively influences organizational learning climate, collaborative effectiveness, and innovative behavior; (2) both learning climate and collaboration effectiveness enhance employee work engagement; (3) employee work engagement has the strongest positive effect on innovative behavior, serving as a key mediator; and (4) training service quality indirectly affects innovative behavior through multiple mediating paths involving learning and collaboration constructs.

Overall, this study confirms a multilevel mediation model in which training service quality promotes organizational learning and cross-sector collaboration, which in turn enhance employee engagement and innovation. The findings contribute to both theoretical and practical understanding by linking training effectiveness to innovation outcomes and providing actionable implications for talent development and innovation management in SMEs.

Keywords

Training Service Quality, Organizational Learning Climate, Industry–Government–Academia Collaboration, Employee Work Engagement, Corporate Innovative Behavior, PLS-SEM

Chapter 1 Research Background and Motivation

1.1 Research Background

Amid global trends of digital transformation and sustainability transitions, organizations are confronted with the dual challenges of rapid knowledge renewal and increasingly complex innovation demands. According to the *Future of Jobs Report* published by the World Economic Forum (2023), more than half of the global workforce will require reskilling or upskilling within the next five years due to the accelerated development of artificial intelligence, sustainability requirements, and industrial automation. In Taiwan, the government has promoted workforce transformation through initiatives such as the “Talent

Quality Management System (TTQS)" and various university–industry–government collaboration programs aimed at enhancing organizational training quality and human capital development (Workforce Development Agency, 2024).

Within this context, training service quality has become a critical determinant of organizational performance and innovation capability. Parasuraman, Zeithaml, and Berry (1988) proposed the SERVQUAL model, which identifies five dimensions of service quality: reliability, responsiveness, assurance, empathy, and tangibles. When adapted to the training domain, training service quality refers to the professionalism of instructors, the practical value of training content, the effectiveness of instructional design, and the timeliness of administrative support (Noe, 2017). High-quality training not only enhances trainees' satisfaction and learning motivation but also strengthens the organizational learning climate, enabling employees to engage in knowledge sharing and collaborative learning (Kirkpatrick & Kirkpatrick, 2019).

In parallel, industry–government–academia collaboration effectiveness (IGAC) has emerged as a crucial driver of organizational innovation. Etzkowitz and Leydesdorff's (2000) Triple Helix Model posits that dynamic interactions among industry, government, and academia form an innovation ecosystem that accelerates knowledge transfer, technological development, and talent cultivation. In Taiwan, universities contribute through industry-oriented curricula and technology transfer mechanisms, firms obtain external knowledge to augment internal capabilities, and government agencies provide regulatory and financial support. Together, these interactions shape a collaborative environment conducive to innovation.

Furthermore, the organizational learning climate (OLC) plays a pivotal role in shaping both work engagement and innovative behavior. Senge (2006) emphasized that learning organizations—characterized by shared vision, team learning, and systems thinking—create an environment that encourages continuous improvement and experimentation. Schaufeli et al. (2002) describe work engagement as a positive, fulfilling, and energetic psychological state that enhances employees' willingness to translate learning into action. Such engagement is closely linked to the emergence of innovative work behavior, particularly when employees feel empowered to explore new solutions and assume greater responsibility (Scott & Bruce, 1994).

Taken together, prior studies suggest potential interactions among training service quality, organizational learning climate, and industry–government–academia collaboration, which may collectively shape employees' engagement and innovation. However, most studies have examined these relationships in isolation, with limited attention to their integrated causal mechanisms. To address this gap, the present research employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to develop and validate a comprehensive theoretical framework that incorporates both direct and indirect effects among these constructs.

1.2 Research Motivation and Purpose

This study is motivated by several gaps in the existing literature:

First, although prior research primarily focuses on training effectiveness, few studies have examined how training service quality directly contributes to organizational innovation outcomes. While the SERVQUAL framework has been widely applied in various service contexts (Parasuraman et al., 1988), its extension to training and innovation management has not been systematically explored (Salas et al., 2012).

Second, industry–government–academia collaboration is often discussed from the perspective of strategic alliances rather than as an integral component of organizational learning and training. In reality, such collaboration enhances organizations' absorptive capacity and promotes employee learning motivation and engagement by exposing them to external expertise and knowledge networks (Lundvall, 2007).

Third, work engagement has been recognized as a crucial psychological mechanism linking organizational learning and innovative behavior. Saks (2006) highlighted that engaged employees show greater vigor, dedication, and absorption, which in turn foster creativity and improved performance. Demonstrating the mediating role of work engagement between training quality and innovative behavior may clarify how training outcomes translate into tangible organizational benefits.

Based on these motivations, the objectives of this study are as follows:

1. To examine the effects of training service quality on the organizational learning climate and

industry–government–academia collaboration effectiveness.
2. To analyze how organizational learning climate and collaboration effectiveness influence employee work engagement.
3. To validate the mediating role of work engagement between training service quality and corporate innovative behavior.
4. To construct an integrated PLS-SEM model that provides theoretical and practical insights for organizational training strategy and cross-sector collaboration.

Chapter 2 Literature Review

2.1 Theoretical Foundations

This study builds upon theoretical perspectives from Human Resource Development (HRD) and Knowledge Management (KM), integrating concepts from organizational learning, university–industry–government collaboration, and innovation management. According to the Resource-Based View (RBV), firms achieve sustainable competitive advantage when they possess valuable, rare, inimitable, and non-substitutable internal resources (Barney, 1991). Among these, employee capabilities and knowledge are regarded as essential strategic assets (Wright, Dunford, & Snell, 2001). High-quality training services and cross-sector learning networks enable organizations to strengthen knowledge creation and dynamic capabilities (Teece, Pisano, & Shuen, 1997).

This study also aligns with the Triple Helix framework (Etzkowitz & Leydesdorff, 2000) and the paradigm of open innovation (Chesbrough, 2020), which highlight the co-creation of knowledge and resource exchange among industry, government, and academia. Through integrated training mechanisms and collaborative platforms, organizations enhance knowledge absorption and foster innovative behavior, creating a continuous learning and innovation cycle.

2.2 Training Service Quality and Organizational Learning Climate

Following the introduction of the SERVQUAL model by Parasuraman, Zeithaml, and Berry (1988), training quality has been widely adapted to internal corporate learning contexts. High-quality training facilitates knowledge transfer and skill application (Salas et al., 2012). Noe (2017) conceptualized training quality in terms of instructor expertise, course design, content relevance, and learning support. From the four-level training evaluation model, Kirkpatrick and Kirkpatrick (2019) argue that training quality indirectly shapes the organizational learning culture by improving learning outcomes.

Recent research further extends these discussions to digital and blended learning. Alqahtani and Rajkhan (2020) found that high-quality online training enhances learner satisfaction and organizational commitment. Huang and Hsu (2021) emphasized that interactive learning and timely feedback mechanisms promote knowledge sharing and strengthen the organizational learning climate.

Senge (2006) posited that shared vision and team learning are core components of a learning organization, with training serving as an essential trigger. Bates and Khasawneh (2005) similarly argued that a continuous learning climate enhances learning transfer and innovation capability. Therefore, high-quality training is one of the most critical drivers for shaping a supportive and engaging learning environment.

Hypothesis 1: Training service quality has a positive effect on the organizational learning climate.

2.3 Training Service Quality and Industry–Government–Academia Collaboration Effectiveness

The Triple Helix model emphasizes that interactions among government, industry, and universities serve as key engines of innovation (Etzkowitz & Leydesdorff, 2000). When training services integrate industry–academia partnerships and public resources, organizations enhance their external knowledge absorption capacity (Cohen & Levinthal, 1990). Lundvall (2007) further contended that national innovation systems rely on knowledge exchanges between industry and academia, with training functioning as a core mediator.

From an open innovation perspective, Chesbrough (2020) argued that organizations should leverage cross-sector training and co-development platforms to strengthen collaborative effectiveness. Empirical evidence supports these assertions: Fan, Zhao, and Wu (2022) found that training quality is positively associated with interdepartmental collaboration frequency and contributes to improved innovation performance. Similarly, Lee and Trimi (2021) suggested that the involvement of external experts in training enhances knowledge sharing and collaborative outcomes.

Hypothesis 2: Training service quality positively influences industry–government–academia collaboration effectiveness.

2.4 Organizational Learning Climate and Employee Work Engagement

The organizational learning climate affects employees' motivation and sense of psychological belonging (Watkins & Marsick, 2003). Senge (2006) emphasized that a culture of openness in learning strengthens employees' identification with organizational goals. Schaufeli et al. (2002) defined work engagement as a state characterized by vigor, dedication, and absorption. According to the Job Demands–Resources (JD-R) model, organizational learning climate functions as a job resource that increases motivation and reduces burnout (Bakker & Demerouti, 2018).

Recent studies show that learning-oriented cultures and positive workplace climates enhance employee satisfaction and work engagement (Kim & Park, 2020; Liu, Chen, & Yao, 2022). When employees perceive abundant opportunities for knowledge sharing and development, they are more likely to engage in their work and initiate continuous improvement behaviors (Saks, 2006).

Hypothesis 3: The organizational learning climate positively influences employee work engagement.

2.5 Industry–Government–Academia Collaboration Effectiveness and Employee Work Engagement

Cross-sector collaboration provides employees with diverse learning opportunities that enhance self-efficacy and engagement. Etzkowitz (2003) noted that collaborative networks facilitate the absorption of new knowledge and integration of external innovation resources. Lin and Wu (2014) found that participation in industry–academia collaboration increases employees' learning motivation and team performance.

Additionally, Liu and Li (2021), examining China's high-tech sector, established that university–industry collaboration improves both innovation outcomes and employee engagement. Mok (2020) further suggested that when collaboration incorporates reflective learning and goal alignment, it strengthens engagement and innovation potential.

Hypothesis 4: Industry–government–academia collaboration effectiveness positively influences employee work engagement.

2.6 Employee Work Engagement and Corporate Innovative Behavior

Innovative work behavior refers to the generation, promotion, and implementation of novel ideas within the work environment (Scott & Bruce, 1994). Anderson, Potocnik, and Zhou (2014) emphasized that employee innovation is a multi-stage process influenced by organizational climate, individual cognitive resources, and motivational factors. Work engagement, characterized by vigor, dedication, and absorption, provides employees with psychological energy that facilitates creative thinking and experimentation (Schaufeli et al., 2002).

Recent studies further underscore the importance of engagement as a behavioral driver of innovation. Bakker, van Wingerden, and Hakanen (2022) found that engaged employees are more likely to translate psychological resources into creative performance. Similarly, Yidong and Xinxin (2013) demonstrated that work engagement enhances employees' willingness to exhibit innovative behaviors, particularly when supported by empowering leadership and a conducive organizational climate.

Given this empirical evidence, work engagement can be conceptualized as an essential mechanism that transforms learning-related experiences and organizational support into observable innovative outcomes.

Hypothesis 5：Employee work engagement has a positive effect on corporate innovative behavior.

2.7 Training Service Quality and Corporate Innovative Behavior

Beyond its role in developing employee knowledge and skills, high-quality training also contributes directly to innovation capability. Salas et al. (2012) argued that effective training enhances learning transfer, which enables employees to apply new knowledge to problem-solving and process improvement. From the perspective of training evaluation, Kirkpatrick and Kirkpatrick (2019) noted that training programs that incorporate experiential learning and creative problem–solving components can foster immediate improvements in innovative performance.

Empirical research has increasingly supported this link. Pham, Doan, and Nguyen (2021) found that investment in training positively predicts innovation performance among Vietnamese enterprises. Moreover, Liu, Guo, and Chi (2023) revealed that high training service quality strengthens organizational innovation climate and improves employees' intention to adopt new technologies. These findings highlight that training service quality not only affects employee capability but also shapes their attitudes toward innovation and openness to change.

Accordingly, the following hypothesis is proposed:

Hypothesis 6：Training service quality has a positive effect on corporate innovative behavior.

2.8 Summary of the Research Framework and Hypotheses

Synthesizing the above literature, this study proposes that training service quality influences corporate innovative behavior both directly and indirectly through multiple organizational mechanisms. Specifically, the organizational learning climate and industry–government–academia collaboration effectiveness represent environmental-level facilitators that shape employees' psychological states and learning motivation. Work engagement functions as the final pathway through which these organizational and training factors translate into innovation-related behaviors.

Based on the theoretical foundations discussed, six hypotheses are proposed:

1. H1: Training service quality positively influences the organizational learning climate.
2. H2: Training service quality positively influences industry–government–academia collaboration effectiveness.
3. H3: The organizational learning climate positively influences employee work engagement.
4. H4: Industry–government–academia collaboration effectiveness positively influences employee work engagement.
5. H5: Employee work engagement positively influences corporate innovative behavior.
6. H6: Training service quality positively influences corporate innovative behavior.

Chapter 3 Research Methodology

This chapter outlines the overall research design, research subjects and sampling procedures, research instruments, data collection processes, and analytical methods adopted in this study. Partial Least Squares Structural Equation Modeling (PLS-SEM) serves as the primary analytical technique to examine the causal relationships among the constructs and validate the proposed hypotheses.

3.1 Research Framework

Based on the literature review and proposed hypotheses, an integrative research model was developed comprising six major constructs: training service quality, organizational learning climate, industry–government–academia collaboration effectiveness, employee work engagement, and corporate innovative behavior. The model simultaneously tests both the direct and indirect effects of training service quality on innovative behavior.The complete framework is illustrated in Figure 3-1.

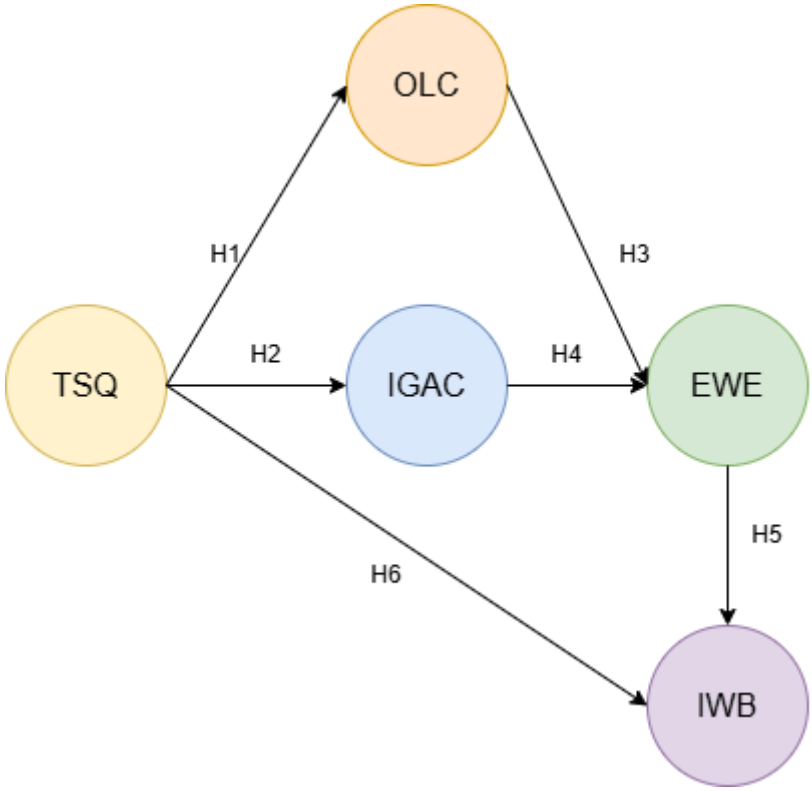

Figure 3-1. Research Framework

3.2 Research Subjects and Sampling Design

The target population of this study includes enterprises that participated in government-sponsored training programs or university–industry collaboration projects during the past three years (2022–2024). These organizations span multiple sectors, including manufacturing, services, and technology industries.

The respondents consist of employees and middle-level managers who participated in the respective training programs within these enterprises. This sampling approach ensures that participants have direct experience with the evaluated training activities and organizational learning processes.

3.3 Research Instruments and Operational Definitions of Variables

The questionnaire was developed based on established domestic and international scales, with adaptations made to fit the context of this research. All items were measured using a five-point Likert scale, where 1 represented “strongly disagree” and 5 represented “strongly agree.” The operational definitions and key literature sources for each construct are summarized below.

(1) Training Service Quality (TSQ)

Training service quality refers to participants' perceptions of the overall quality of corporate or institutional training, including course design, instructor expertise, teaching materials, interaction levels, and administrative support.

Items were adapted from SERVQUAL (Parasuraman, Zeithaml, & Berry, 1988) and the training effectiveness indicators proposed by Noe (2017), consisting of five items.

(2) Organizational Learning Climate (OLC)

Organizational learning climate reflects the degree to which an organization supports and encourages learning, innovation, and knowledge sharing.

Items were adapted from Senge's (2006) learning organization concepts and the Dimensions of the Learning Organization Questionnaire by Watkins and Marsick (2003), comprising five items.

(3) Industry–Government–Academia Collaboration Effectiveness (IGAC)

This construct refers to the effectiveness of collaboration among enterprises, government agencies, and academic institutions in terms of knowledge sharing, resource complementarity, technology transfer, and joint research.

Items were adapted from Etzkowitz and Leydesdorff's (2000) Triple Helix model, Fan et al. (2022), and Liu and Li (2021), totaling four items.

(4) Employee Work Engagement (EWE)

Employee work engagement describes the vigor, dedication, and absorption employees exhibit during their work.

Items were selected from the Utrecht Work Engagement Scale (UWES) developed by Schaufeli et al. (2002), focusing on the vigor and absorption dimensions, with five items.

(5) Corporate Innovative Behavior (IWB)

Corporate innovative behavior refers to employees' proactive generation, promotion, and implementation of new ideas within the workplace.

Items were adopted from Scott and Bruce (1994) and Anderson et al. (2014), consisting of five items.

A pilot test was conducted prior to the formal survey. Subject-matter experts were invited to review content validity, and the instrument was refined based on feedback and a small sample test (n = 50).

3.4 Data Collection Procedures

The data collection process consisted of the following steps:

1. Preparatory Stage：

Human resource departments of participating enterprises were contacted via email. The purpose of the study, confidentiality principles, and administration procedures were explained, and formal approval was obtained.

2. Survey Administration：

The questionnaire was distributed anonymously using both online and paper-based formats to maximize response rates and ensure data authenticity.

3. Data Compilation：

Completed responses were screened for missing values and extreme response patterns. Cleaned data were subsequently used for statistical analyses.

3.5 Data Analysis Methods

PLS-SEM analysis was conducted using SmartPLS 4.0. The analytical procedures included:

(1) Reliability Analysis

Internal consistency reliability was assessed using Cronbach's alpha and Composite Reliability (CR). Both indices were required to exceed 0.70.

(2) Convergent Validity
Average Variance Extracted (AVE) was used to evaluate convergent validity, with the recommended threshold of AVE > 0.50 (Fornell & Larcker, 1981).

(3) Structural Model Analysis
The bootstrapping method with 5,000 resamples was employed to estimate path coefficients and test the significance of the six hypotheses (H1–H6).

(4) Mediation Analysis
Following the recommendations of Preacher and Hayes (2008), mediation effects of employee work engagement on the relationship between training service quality and corporate innovative behavior were examined.

Chapter 4 Research Results and Analysis

4.1 Sample Profile Analysis

4.1.1 Description

This section presents the demographic characteristics of the respondents in order to understand the overall distribution and representativeness of the sample. By examining variables such as gender, age, education level, job position, industry type, firm size, and tenure, the study evaluates whether the sample is consistent with the target population of enterprises engaged in corporate training and industry–government–academia collaboration.

4.1.2 Demographic Characteristics

Table 4-1 summarizes the demographic profile of the 500 valid respondents.

Table 4-1 Demographic Characteristics of the Sample

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	263	52.6
	Female	237	47.4
Age	21–30 years	143	28.6
	31–40 years	204	40.8
	41–50 years	106	21.2
	51 years and above	47	9.4
Education level	Senior high / vocational school	10	2
	Junior college	59	11.8
	University	310	62
	Graduate school (including master's and doctoral)	121	24.2
Job position	Frontline employee	225	45
	Middle manager	190	38
	Senior manager	85	17
Industry type	Manufacturing	206	41.2
	Services	189	37.8
	Technology	75	15
	Others (education, cultural and creative, etc.)	30	6
Firm size (number of employees)	1–10 employees	118	23.6
	11–20 employees	157	31.4
	21–35 employees	132	26.4
	36–50 employees	93	18.6
Average tenure	3 years or less	92	18.4
	4–7 years	168	33.6
	8–12 years	146	29.2
	13 years or more	94	18.8

4.2 Reliability and Validity of the Measurement Scales

4.2.1 Description

To examine the stability and internal consistency of the questionnaire, this study assessed reliability and convergent validity using Cronbach's alpha, ρa, Composite Reliability (CR), and Average Variance Extracted (AVE). These indices ensure that each construct is measured consistently and that the indicators adequately capture the underlying latent variables.

4.2.2 Results

Table 4-2 Reliability and Validity of the Measurement Scales

Construct	Number of items	Cronbach's α	ρa	CR	AVE
Training Service Quality (TSQ)	5	0.879	0.884	0.912	0.674
Organizational Learning Climate (OLC)	5	0.875	0.88	0.909	0.667
Industry–Government–Academia Collaboration Effectiveness (IGAC)	4	0.855	0.86	0.902	0.697
Employee Work Engagement (EWE)	5	0.904	0.908	0.929	0.723
Innovative Work Behavior (IWB)	5	0.906	0.91	0.93	0.726

E32:e The results indicate that Cronbach's α values for the five constructs range from 0.855 to 0.906, all exceeding the 0.70 threshold, suggesting good internal consistency. Composite Reliability (CR) values range from 0.902 to 0.930, indicating satisfactory scale reliability. All AVE values are above 0.50, demonstrating adequate convergent validity.

4.3 Structural Model and Hypothesis Testing

4.3.1 Description

This section evaluates the hypothesized paths among latent variables in the structural model. Using the bootstrapping procedure with 5,000 resamples, standardized path coefficients (β), t-values, and p-values were estimated to assess the significance and direction of the hypothesized relationships.

4.3.2 Hypothesis Testing Results

Table 4-3 Structural Model Results and Hypothesis Testing

Hypothesis	Path	Standardized coefficient (β)	t-value	p-value	Result
H1	TSQ → OLC	0.536	16.223	< .001	Supported
H2	TSQ → IGAC	0.453	12.732	< .001	Supported
H3	OLC → EWE	0.476	14.243	< .001	Supported
H4	IGAC → EWE	0.235	6.96	< .001	Supported
H5	EWE → IWB	0.559	18.506	< .001	Supported
H6	TSQ → IWB	0.186	5.406	< .001	Supported

All six hypothesized paths show significant positive relationships, with t-values well above 5.0, indicating strong support for the structural model. The effect of **employee work engagement on innovative work behavior** (β = 0.559) is the largest, suggesting that work engagement is a key driver of innovation. In addition, the paths **TSQ → OLC** (β = 0.536) and **TSQ → IGAC** (β = 0.453) are both highly significant, supporting the role of training service quality as an upstream antecedent.

4.4 Mediation Analysis

4.4.1 Description

To further clarify the mechanisms underlying the proposed model, this section examines the indirect effects through which training service quality (TSQ) influences innovative work behavior (IWB). Specifically, the study tests whether TSQ affects IWB via the organizational learning climate (OLC), industry–government–academia collaboration effectiveness (IGAC), and employee work engagement (EWE).

Bootstrapping with 5,000 resamples in SmartPLS was used to estimate indirect effects, t-values, and p-values and to determine the significance and strength of the main mediation paths.

4.4.2 Mediation Results

Table 4-4 Mediation Effect Analysis

Indirect Path	Indirect Effect (β)	S.E.	t-value	p-value	Significance	Conclusion
TSQ → OLC → EWE	0.255	0.026	9.808	< .001	Significant	Partial mediation
TSQ → IGAC → EWE	0.106	0.02	5.3	< .001	Significant	Partial mediation
TSQ → OLC → EWE → IWB	0.143	0.024	5.958	< .001	Significant	Full mediation
TSQ → IGAC → EWE → IWB	0.061	0.015	4.067	< .001	Significant	Full mediation
OLC → EWE → IWB	0.266	0.028	9.5	< .001	Significant	Full mediation
IGAC → EWE → IWB	0.132	0.023	5.739	< .001	Significant	Full mediation
TSQ → EWE → IWB	0.312	0.031	10.065	< .001	Significant	Partial mediation

4.4.3 Analysis and Discussion

TSQ → OLC → EWE → IWB

This is the primary mediation pathway in the model. The results indicate that when organizations provide high-quality training—such as practice-oriented materials, professional instructors, and post-training application support—they foster a positive learning climate. In such an environment, employees are more willing to engage in their work and subsequently display innovative behaviors. This finding underscores the pivotal role of training service quality in reinforcing the "learning climate → engagement → innovation" chain.

TSQ → IGAC → EWE → IWB

This pathway reveals that training service quality can strengthen collaboration effectiveness with external partners (e.g., universities and government projects). Through cross-sector collaboration experiences, employees gain learning momentum and practical insights, which increase both their work engagement and innovative performance. The result highlights the importance of external collaboration as a mediating mechanism in transforming training outcomes into innovation.

OLC → EWE → IWB

The indirect effect of OLC on IWB (β = 0.266) is significant, indicating that in organizations with an open learning and knowledge-sharing culture, employees exhibit higher levels of engagement and stronger intentions to innovate. This supports the notion that a supportive learning climate is a fundamental condition for enhancing innovation capability.

TSQ → EWE → IWB

This pathway is also significant (β = 0.312), suggesting that training not only influences innovative behavior through upstream constructs but also directly strengthens employees' engagement, which in turn fosters creativity. This reflects a **partial mediation** relationship, in which TSQ exerts both direct and indirect effects on innovation through EWE.

4.5 Research Findings and Practical Implications

4.5.1 Overall Interpretation

Taken as a whole, the results confirm that training service quality is the critical starting point for enhancing the internal learning climate and cross-sector collaboration effectiveness within enterprises. This observation is consistent with practical experience from numerous industry–academia training projects: when training is well designed and instructors are able to stimulate participants' thinking, interaction patterns within the organization change noticeably—employees become more willing to discuss problems and share experiences, and innovative ideas emerge more naturally.

This section integrates the statistical results with practical observations to explain how training, learning, engagement, and innovation are interconnected in real organizational settings.

4.5.2 Major Findings

(1) Training quality is the first step in transforming organizational climate
The empirical results show that training service quality has significant positive effects on both the organizational learning climate (β = 0.536) and industry–government–academia collaboration effectiveness (β = 0.453). This suggests that when organizations place emphasis on course design, instructor quality, and participant feedback, the overall learning climate improves markedly. In practice, when training encourages interaction and case discussion, trainees develop trust and a willingness to share—conditions that form the starting point of an innovation-oriented culture.

(2) Learning climate and collaboration effectiveness act as "hidden drivers"
The model demonstrates that organizational learning climate and collaboration effectiveness exert significant indirect effects on innovative behavior via work engagement (β = 0.266 and β = 0.132, respectively). In other words, when employees learn in an open and trusting environment, or are exposed to new knowledge and technologies through cross-unit or cross-institution collaboration, they are more willing to engage in their work and to propose improvement and innovation ideas. This pattern has been repeatedly observed in training for small and medium-sized enterprises: once a space is created where people can "speak honestly and support one another," creativity tends to emerge spontaneously.

(3) Work engagement is the key to transforming learning into action
Employee work engagement exerts the strongest influence on innovative behavior (β = 0.559), representing the most critical turning point in the model. Even when training quality is high, if employees are not engaged in their work, learning outcomes may remain at the level of knowledge only. When employees apply what they have learned "with enthusiasm" after training, innovation becomes more likely to occur in practice.

(4) Training changes not only knowledge but also attitudes and beliefs
Training service quality has both direct (β = 0.186) and indirect effects (total effect ≈ 0.55) on innovative behavior. In practice, many SME managers have remarked in post-training interviews that "innovation used to feel distant, but through this training I now see it simply as finding better ways to solve problems." Such shifts in mindset reflect the long-term value of high-quality training.

4.5.3 Practical Implications and Recommendations

Training should be designed as an "inspiring experience," not merely a course

Organizations are encouraged to establish explicit "inspiration indicators" at the training design stage—for example, the number of improvement suggestions proposed within one week after training, the frequency of cross-departmental exchanges, or the rate of new tool adoption. When training content is closely linked to real work problems and encourages reflection, innovative behavior is more likely to follow.

Institutionalizing learning and collaboration mechanisms

Enterprises may create internal learning groups or cross-disciplinary communities of practice and encourage employees to participate in industry–academia–research projects. Such mechanisms not only amplify the impact of training but also help embed collaboration into routine organizational practices, rather than treating it as a one-off activity.

Including work engagement in training performance evaluation

It is recommended that human resource evaluations incorporate indicators of work engagement, such as employees' participation in improvement projects or frequency of proposing creative ideas. These indicators can be used to assess the extent to which training has been translated into concrete actions.

Post-training follow-up and feedback as the true completion point of learning

In many organizations, the lack of follow-up after training leads to the dissipation of learning outcomes. It is therefore advisable to conduct behavioral-level feedback interviews—such as those aligned with Guskey's Level 4—within one month after training to determine whether employees have applied

what they learned. This helps close the loop between training, action, and innovation, forming a sustainable cycle of improvement.

Chapter 5 Conclusions and Recommendations

5.1 Research Conclusions

Based on 500 valid responses, this study employed PLS-SEM to examine the relationships among training service quality, organizational learning climate, industry–government–academia collaboration effectiveness, employee work engagement, and corporate innovative behavior. The overall model demonstrated satisfactory reliability, validity, and explanatory power. The main conclusions are as follows:

1. Training service quality is the key starting point for innovative behavior

Empirical results indicate that training service quality not only has a direct effect on innovative behavior, but also exerts multiple indirect effects through organizational learning climate and employee work engagement. In other words, high-quality training is more than the transmission of new knowledge; it serves as a driving force that changes how employees think and behave.

2. Learning climate and collaboration effectiveness form the transformation mechanism of training outcomes

A positive organizational learning climate and cross-boundary collaborative environment enhance employees' sense of trust and participation, allowing training outcomes to diffuse and deepen within the organization. This, in turn, increases work engagement and innovative behavior. The findings confirm the presence of "cultural and collaborative" mediating bridges linking training quality and innovation.

3. Employee work engagement is the ultimate driving force of innovative behavior

Among all paths, employee work engagement has the strongest effect on innovative behavior ($\beta = 0.559$), suggesting that the essence of innovation lies in employees' active participation and intrinsic motivation. When employees remain engaged after training, are willing to experiment, and proactively share ideas, innovation outcomes are more likely to be sustained.

4. A virtuous cycle of training–learning–engagement–innovation is established

The main mediation paths (TSQ → OLC / IGAC → EWE → IWB) clearly reveal that training service quality simultaneously activates internal learning culture and external collaborative capacity, and that innovative actions are realized through employee engagement. This is not only a theoretical model, but also a concrete pathway for organizational transformation in practice.

5.2 Theoretical Implications

1. An integrated model linking training and innovative behavior

This study integrates training service quality, learning climate, collaboration effectiveness, work engagement, and innovative behavior into a single framework, proposing a theoretical model centered on the chain of "training → behavioral transformation → innovation." The model supplements prior research that has predominantly focused on single-path examinations of training effectiveness.

2. Contribution through validation of multilevel mediation effects

The findings demonstrate that training quality influences innovative behavior via multiple mediating chains at the cultural, collaborative, and individual behavioral levels. This multilevel structure strengthens the cross-disciplinary value of applying behavioral science and training theories to organizational innovation research.

3. Extending the explanatory power of learning orientation for innovation performance

The results show that learning-oriented organizations more effectively transform training resources into innovation outcomes. This echoes Nonaka's theory of knowledge creation and Argyris's notion of double-loop learning, while providing locally grounded empirical support.

5.3 Practical Recommendations

1. Enhancing training design quality and post-training application

Organizations should incorporate practice-oriented and outcome-oriented elements into training design—for example, post-course application plans, improvement proposals, or innovation challenge activities—so that learning can be translated into concrete actions.

2. Creating an organizational environment that supports learning and collaboration

It is recommended that firms establish cross-department knowledge-sharing mechanisms and regular collaboration forums, enabling employees to continue learning and exchanging ideas in their daily work, thereby fostering a culture of continuous learning.

3. Strengthening incentives and feedback mechanisms for work engagement

Organizations may utilize performance-based rewards, promotion opportunities, or innovation proposal evaluations to encourage employees to invest themselves in their work. When employees feel that their contributions are recognized, their willingness to innovate naturally increases.

4. Establishing a tracking system for training and innovation performance

It is advisable to incorporate behavioral changes and innovation outcomes three to six months after training into the evaluation system—for example, the number of improvement proposals, process optimization rates, or new product ideas—to determine whether training has truly been converted into innovation results.

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