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Operational Mechanisms and Collaborative Optimization Paths of Industry-Education Integration Service Organizations in the Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract: In the context of high-quality development in the Guangdong-Hong Kong-Macao Greater Bay Area, industry-education integration service organizations serve as institutional hubs connecting the educational system with the industrial sector. These organizations play an increasingly critical role in optimizing regional education structures and facilitating the transformation of technological achievements. Drawing on multi-actor collaborative governance theory, this study constructs a four-dimensional analytical framework—platform functionality, collaborative mechanism, resource integration, and institutional embedding—and employs empirical testing using structural equation modeling (SEM) based on survey data to systematically examine the operational logic and performance mechanisms of service organizations. The findings reveal persistent challenges including goal divergence, communication inefficiencies, resource fragmentation, and institutional lag. Among the four factors, the collaborative mechanism has a significant positive impact on organizational performance, and government support, school-enterprise cooperation, and resource integration efficiency are identified as key pathways. Accordingly, this paper offers policy recommendations focused on institutional alignment, enterprise incentives, platform governance, and performance evaluation, aiming to provide both theoretical foundations and practical solutions for advancing regional education-industry integration.

Keywords: Industry-Education Integration; Service Organizations; Collaborative Governance; Institutional Mechanisms

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1.Introduction

As a national strategic region, the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) serves as a key platform for piloting China's modernization. Its pursuit of industrial upgrading and high-quality development urgently requires robust talent support and a transformation of the educational system. Against the backdrop of national strategies such as "Building a Strong Education Nation" and "Advancing Manufacturing Power," industry-education integration has become a vital lever for promoting structural reform in education and coordinated industrial development.

In recent years, both the central government and the Guangdong provincial authorities have issued a series of policies to support deepened industry-education integration. These include the National Implementation Plan for Industry-Education

Integration Pilot Projects and the 14th Five-Year Plan for Higher Education in Guangdong Province, which explicitly advocate for the construction of "multi-actor collaborative mechanisms" and emphasize the pivotal role of service organizations in coordinating resource allocation and institutional linkages (Yu, 2024; Xu, 2025).

However, in practice, industry-education service organizations still face considerable challenges in terms of role clarity, functional effectiveness, and institutional support. Some organizations struggle with ambiguous positioning, weak execution capacity, and dysfunctional operations, making it difficult to effectively match educational supply with industrial demand. Moreover, enterprises, universities, and government bodies often lack collaborative willingness, experience communication inefficiencies, and lack co-construction and sharing mechanisms—all of which severely impact integration outcomes and governance performance (Xie, 2025). These problems are particularly acute in the GBA, where the rapid growth in the number of organizations is not matched by the development of effective collaborative mechanisms, leading to resource redundancy and structural mismatches.

Current academic research on industry-education integration tends to focus on policy evaluation, governance models, and case studies. There remains a lack of systematic theoretical exploration into the core functions, governance logic, and development pathways of service organizations. In particular, research on the operational logic of these organizations under multi-actor collaborative frameworks—especially within the context of institutional innovation in the GBA—is relatively underdeveloped.

To address this gap, this paper takes industry-education integration service organizations in the Greater Bay Area as its research object, focusing on their functional logic and optimization pathways in a multi-actor collaborative governance context. By constructing a three-dimensional analytical framework encompassing platform functionality, collaborative structure, and institutional logic—and by integrating field surveys with questionnaire data—this study systematically investigates the internal mechanisms and external conditions through which service organizations enhance coordination efficiency. The goal is to provide theoretical insights and practical guidance for modernizing the regional education system and reforming talent development models.

2.Mechanisms by Which Industry–Education Integration Service Organizations Promote Regional Educational Synergy

Amid the strategic push for education modernization and industrial transformation in the Guangdong–Hong Kong–Macao Greater Bay Area (GBA), industry–education integration service organizations are transitioning from basic resource-matching platforms to collaborative governance entities. These organizations play an increasingly central role in aligning educational supply with industrial demand through four key operational dimensions: platform functionality, multi-actor collaboration, resource integration, and institutional embedding (Liu & Zhou, 2022; Zhuang & Zhou, 2023).

2.1 Platform Functionality: Embedding Educational and Industrial Systems

Service organizations act as hubs that aggregate vocational training infrastructure, academic programs, and enterprise engagement to bridge educational institutions with industry. For instance, vocational education platforms in Shenzhen and Guangzhou show a coupling coordination value above 0.7 between academic disciplines and regional industrial needs, illustrating strong platform functionality (Batista et al., 2024). This model supports cross-institutional curriculum co-design and accelerates the school-to-industry transition pipeline.

2.2 Multi-Actor Collaborative Mechanisms: Enhancing Governance Integration

Effective industry–education service organizations operate within multi-actor governance structures, where governments provide regulatory and financial support, enterprises contribute practical contexts, and universities deliver educational resources. These actors are linked via service platforms that institutionalize collaboration through joint committees and performance evaluation models (Liu & Zhou, 2022). Such arrangements reflect global trends in network governance, in which intermediary institutions mediate between actors with diverse interests and incentive structures.

2.3 Resource Integration Mechanisms: Optimizing Allocation and Innovation

Resource fragmentation remains a core constraint in regional educational ecosystems. Service organizations respond by creating integrated digital platforms that facilitate joint faculty appointments, shared laboratories, and collaborative research

(Yao & Li, 2023). Empirical evidence from the GBA confirms that these mechanisms increase innovation output and reduce duplication in infrastructure and staffing (Wu & Chen, 2023). Additionally, university–industry co-supervision models have been shown to enhance both student readiness and enterprise engagement (Zhuang & Zhou, 2023).

2.4 Institutional Embedding: Establishing Structured Support Systems

To ensure accountability and long-term sustainability, service organizations are increasingly embedded within institutional frameworks involving performance-based budgeting, service contracting, and credit rating mechanisms. In the Pearl River Delta, several municipalities have introduced triadic evaluation models covering process, outcome, and stakeholder satisfaction to ensure that integration platforms remain adaptive and outcome-oriented (Batista et al., 2024; Xie, Liu, & McNay, 2023).

3.Empirical Design and Data Analysis

To validate the proposed operational framework and examine the performance pathways of industry–education integration service organizations, this study constructs a structural equation model (SEM) grounded in theoretical insights. Using survey data from the Guangdong–Hong Kong–Macao Greater Bay Area, we quantify the impact of four latent variables—platform functionality, multi-actor collaboration, resource integration, and institutional embedding—on organizational performance.

3.1 Research Design and Variable Construction

Based on prior theoretical modeling (Zhuang & Zhou, 2023; Yao & Li, 2023), we designed a questionnaire to capture five core constructs:

1.Platform Functionality: Joint curriculum design, resource-sharing platforms, project coordination.

2.Multi-Actor Collaboration: Inter-stakeholder goal alignment, communication channels, collaboration frequency.

3.Resource Integration: Cross-sector mobility of human resources, shared equipment usage, data interoperability.

4.Institutional Embedding: Formalization of governance structures, performance-based incentives, policy responsiveness.

5.Organizational Performance (dependent variable): Indicators include talent matching rate, innovation conversion efficiency, and operational stability.

Each construct was measured with 3–5 items using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree).

Hypotheses:

H1: Platform functionality has a significant positive effect on organizational performance.

H2: Multi-actor collaboration has a significant positive effect on organizational performance.

H3: Resource integration has a significant positive effect on organizational performance.

H4: Institutional embedding has a significant positive effect on organizational performance.

3.2 Data Collection and Sample Distribution

The survey was conducted from November 2024 to February 2025 across five major cities in the GBA: Guangzhou, Shenzhen, Zhuhai, Dongguan, and Foshan. A total of 460 questionnaires were distributed, with 423 valid responses (valid response rate: 91.96%).

Table 1. Sample Composition and Demographics

Category	Percentage
Vocational colleges	41.4%
Enterprises	33.8%
Government agencies/service platforms	24.8%
Respondents with bachelor’s or above	>80%
Work experience > 3 years	61.7%
Valid response rate	91.96%

The questionnaire survey was conducted across five major cities in the GBA between November 2024 and February 2025. A total of 423 valid responses were collected from key stakeholders including educators, enterprise representatives, and

policymakers. The high percentage of educated and experienced respondents ensured both sample representativeness and analytical reliability.

3.3 Reliability and Validity Testing

Using SPSS 26.0 and AMOS 24.0, we conducted standard reliability and validity assessments:

Table 2. Reliability and Validity Test Results

Test	Result	Threshold	Evaluation
Cronbach's α (all constructs)	> 0.80	> 0.70	Strong consistency
KMO	0.924	> 0.80	Excellent sampling adequacy
Bartlett's Test of Sphericity	$p < 0.001$	$p < 0.05$	Suitable for factor analysis
Standardized factor loadings	> 0.70 (all items)	> 0.70	Good convergent validity

All reliability and validity metrics exceed commonly accepted academic thresholds. This confirms that the measurement model is both internally consistent and construct-valid, supporting the robustness of the SEM analysis.

3.4 Structural Model Fit

The SEM was tested using AMOS. Model fit indices are as follows:

Table 3. Structural Model Fit Indices

Fit Index	Value	Criterion	Evaluation
RMSEA	0.042	< 0.08	Good fit
CFI	0.945	> 0.90	Excellent fit
TLI	0.932	> 0.90	Excellent fit
GFI	0.901	> 0.90	Good fit
AGFI	0.881	> 0.80	Acceptable fit

The model shows excellent fit across all indices, confirming both the theoretical coherence and empirical robustness of the structural model (Liu & Zhou, 2022; Batista et al., 2024).

3.5 Path Coefficients and Hypothesis Testing

Table 4. Hypothesis Testing Results

Hypothesis	Path	β (Standardized)	p-value	Result
H1	Platform Functionality → Performance	0.284	< 0.01	Supported
H2	Collaboration → Performance	0.312	< 0.01	Supported
H3	Resource Integration → Performance	0.267	< 0.05	Supported
H4	Institutional Embedding → Performance	0.241	< 0.05	Supported

All hypothesized relationships are supported. The strongest impact is observed from multi-actor collaboration, emphasizing its strategic role in enhancing service organization effectiveness (Zhuang & Zhou, 2023).

3.6 Mediation Effect

Further mediation analysis revealed that collaboration partially mediates the effects of both institutional embedding and resource integration on performance:

Table 5. Mediation Effect of Collaboration on Performance

Pathway	Direct Effect (β)	Indirect Effect (β)	Total Effect (β)	p-value	Mediation Type
Institutional Embedding → Performance	0.241	0.185	0.426	<0.001	Partial Mediation
Resource Integration → Performance	0.267	0.141	0.408	<0.001	Partial Mediation

Collaborative mechanisms not only act as direct performance drivers but also play a critical mediating role between institutional/resource mechanisms and organizational outcomes. This highlights their centrality in governance architecture (Liu & Zhou, 2022; Wu & Chen, 2023).

4.Barriers Analysis and Policy Recommendations

Despite the central role of service organizations in driving industry–education integration within the Guangdong–Hong Kong–Macao Greater Bay Area (GBA), several barriers persist that limit their performance and sustainability.

First, many organizations suffer from strategic ambiguity, with unclear mandates and overlapping responsibilities with government agencies or academic institutions. This undermines autonomy and weakens innovation capacity (Yao & Li, 2023). Second, inter-organizational trust and collaboration are limited. Universities, enterprises, and governments often operate with conflicting priorities and incentive systems, leading to fragmented cooperation and the absence of shared governance frameworks (Liu & Zhou, 2022).

Third, resource fragmentation significantly reduces operational efficiency. There is a lack of unified digital systems or shared platforms that allow for efficient use of infrastructure, laboratories, and personnel across institutional boundaries (Wu & Chen, 2023). Fourth, institutional support structures are often weak. Many service organizations depend on temporary projects rather than performance-based long-term mechanisms. Without robust policy integration and continuous funding, they struggle to build sustainable impact (Zhuang & Zhou, 2023).

To address these barriers, targeted policy responses are essential. Table 6 summarizes key problems and their corresponding solutions.

Table 6. Major Barriers and Policy Recommendations

Barrier	Recommendation	International Practice
Strategic Ambiguity	Define clear mandates; introduce performance-based contracts; enable third-party governance	Southeast Asian vocational reforms (Ho et al., 2021)
Trust and Collaboration Deficit	Establish joint governance councils; launch co-training institutions; adopt shared equity/revenue models	EU vocational networks (OECD, 2022)
Fragmented Resources and Platforms	Build unified cloud-based systems; standardize inter-organizational protocols for labs/data/faculty	Korea/Singapore digital resource platforms (UNESCO, 2023)
Institutional Weakness and Instability	Secure long-term fiscal support; introduce triadic evaluation (process-outcome-feedback); adopt KPI-driven funds	European public–private education models (Steen & Winter, 2020)

These recommendations are supported by comparative international experiences. For example, Germany's dual-training system involves academic and enterprise co-supervision, enhancing applied skills and innovation (Deissinger & Rauner, 2022). The EU promotes co-governance in vocational education via funding tied to stakeholder collaboration and measurable results (Cedefop, 2021). South Korea's Educloud infrastructure enables real-time resource sharing across education providers and industries, improving efficiency and reducing redundancy (UNESCO, 2023).

To implement these reforms, GBA governments should first establish regulatory clarity by defining the operational boundaries of service organizations. Second, a stable financial ecosystem must be created through multi-year mandates and performance-linked grants. Third, collaborative infrastructure—including governance councils and cloud platforms—should be institutionalized. Finally, tripartite monitoring systems involving administrators, users, and evaluators can ensure accountability, responsiveness, and continuous learning.

Overall, addressing governance, trust, resource, and institutional challenges systematically will greatly enhance the impact, resilience, and sustainability of industry–education service organizations in the GBA.

5.Conclusion and Future Research

This study explores the operational mechanisms and optimization paths of industry–education integration service

organizations in the Guangdong–Hong Kong–Macao Greater Bay Area (GBA). Combining theoretical modeling with empirical data, the study reveals that platform functionality, multi-actor collaboration, resource integration, and institutional embedding all exert significant influence on the performance of service organizations.

The structural equation model demonstrates that collaborative governance mechanisms are the strongest drivers of organizational performance, both directly and through mediating effects. This suggests that integration success depends not only on resources and policy support, but also on the quality of coordination among universities, enterprises, and governments. In addition, institutional formalization, including performance-linked funding and shared governance frameworks, emerges as a key enabling condition for sustainable operation.

Nevertheless, structural barriers—including strategic ambiguity, weak inter-organizational trust, fragmented resource systems, and insufficient institutional support—continue to limit the full potential of service platforms. To overcome these challenges, the paper recommends four optimization pathways: clarifying strategic mandates, strengthening collaborative governance, building unified digital platforms, and embedding performance-based institutional mechanisms.

Looking ahead, future research may expand in several directions:

1.Sectoral Differentiation: Future studies could compare how service organizations function across different industries (e.g., manufacturing vs. digital services), to develop sector-specific operational models.

2.Longitudinal Studies: Time-series data could be used to analyze the evolution of organizational performance and governance maturity across policy cycles.

3.Digital Platform Analytics: Leveraging big data and AI, researchers can model real-time collaboration effectiveness using platform usage logs, knowledge flow maps, and stakeholder sentiment data.

4.Comparative International Studies: Comparative analyses of governance models in East Asia, Europe, and the GBA can enhance the generalizability and policy relevance of findings.

Ultimately, service organizations are not just intermediaries, but key enablers in the transformation of educational ecosystems. Their ability to bridge sectors, align resources, and institutionalize innovation will be critical to realizing the GBA's ambition of becoming a global hub for talent, innovation, and integrated development.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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