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STRATEGIES FOR HIGH-QUALITY DEVELOPMENT OF LOCAL VOCATIONAL COLLEGES UNDER "CHINA'S DOUBLE HIGH-LEVEL PLAN"

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Abstract: The Double High-Level Plan (DHP), a national strategy to enhance vocational education quality in China, faces persistent challenges in addressing regional disparities, particularly in underdeveloped provinces such as Yunnan. This study evaluates operational efficiency gaps between nationally designated DHP institutions and vocational colleges in Yunnan, aiming to propose actionable strategies for optimization. A dual-model Data Envelopment Analysis framework was applied to assess inputs, including financial allocation and human resources, alongside outputs such as facility utilization, talent cultivation, social services, and internationalization. Results reveal that Yunnan colleges demonstrate higher scale efficiency due to resource-constrained adaptation but exhibit significant deficits in technical efficiency, faculty qualifications, and international engagement compared to DHP institutions. Key challenges stem from fiscal limitations, industrial mismatch, and geographic marginalization. To address these issues, the study advocates cross-regional industry-education collaborations, curriculum digitalization, and incentive-driven faculty development initiatives. These findings contribute empirical insights for optimizing resource allocation and advancing equitable vocational education under the DHP framework, offering a reference for similar regional contexts globally.
Keywords: DHP; DEA; Vocational education efficiency; Regional disparities; Resource optimization

1 INTRODUCTION

The DHP, officially known as the "Construction Plan for High-Level Vocational Schools and Majors with Chinese Characteristics," represents a pivotal national strategy to elevate the quality of vocational education in China. Since its inception, the DHP has aimed to foster institutional competitiveness, optimize resource allocation, and cultivate high-skilled talent aligned with industrial demands. While existing studies have extensively evaluated the implementation efficacy of the DHP, challenges persist in addressing regional disparities in educational efficiency, particularly in underdeveloped provinces such as Yunnan. These disparities manifest in imbalanced resource inputs, suboptimal faculty structures, and lagging student outcomes, thereby undermining the equitable development of vocational education.

Prior research has predominantly focused on assessing the operational efficiency of DHP-designated institutions using methodologies like Data Envelopment Analysis and Tobit regression. However, few studies have conducted comparative analyses between nationally recognized "Double High-Level" institutions and regional vocational colleges, especially those in geographically and economically disadvantaged areas. This oversight limits the understanding of how structural constraints—such as fiscal inadequacy, industrial underdevelopment, and talent drain—shape the efficiency landscape of vocational education in regions like Yunnan.

To address this gap, this study employs a dual-model DEA framework (CCR and BCC) to evaluate the operational efficiency of 56 DHP institutions and 31 vocational colleges in Yunnan Province. By constructing a multi-dimensional indicator system encompassing financial inputs, human resources, facility utilization, and educational outputs, the research quantifies efficiency gaps across regions and identifies key bottlenecks. The findings reveal that while Yunnan's institutions exhibit relatively high scale efficiency due to forced adaptation to resource scarcity, they suffer from significant deficits in technical efficiency, faculty quality, and international engagement compared to their DHP counterparts.

This study contributes to the literature in three ways. First, it provides empirical evidence on the heterogeneous efficiency patterns between national and regional vocational institutions, highlighting the compounding effects of geographic marginalization and economic underdevelopment. Second, it proposes actionable strategies for optimizing resource allocation, enhancing faculty capacity, and leveraging regional advantages to foster sustainable development. Finally, the research offers policy insights for bridging regional educational divides and advancing the DHP's goals of equitable, high-quality vocational education.

By integrating quantitative analysis with contextualized policy recommendations, this work underscores the urgency of adopting a multi-dimensional innovation system to transform Yunnan's vocational education from a resource-dependent model to one driven by strategic collaboration, digital transformation, and institutional resilience. The implications extend beyond regional contexts, offering a reference for addressing efficiency disparities in vocational education systems globally.

2 LITERATURE REVIEW

Research on the DHP primarily focuses on evaluating its implementation effectiveness, identifying challenges, exploring future directions, and proposing optimization strategies.

Li Xianzheng conducted a literature review to examine the status and implications of developmental evaluation by integrating historical practices of vocational college assessments in China [1]. Tang Ni analyzed the operational efficiency and influencing factors of DHP institutions, proposing strategies to optimize resource allocation [2]. Lee, Boon L., and Johnes, Jill applied a network DEA model to evaluate teaching quality in UK higher education and offered policy recommendations [3]. Mao Jianqing et al. investigated how university funding structures affect academic output and identified theoretical optimal values to enhance productivity [4]. Zhou Fei explored the mechanisms through which vocational students' learning engagement influences their institutional identity, providing actionable recommendations to strengthen this connection [5]. Hu Dexin et al. employed social structuration theory to study development pathways, challenges, and improvement strategies for vocational colleges [6]. Zhou Jiansong et al. discussed approaches to elevate talent cultivation quality through high-level specialized program clusters, driving high-quality vocational education [7]. Yang Wenjie et al. examined the value orientation, practical dilemmas, and solutions for western China's vocational education under the DHP framework [8]. Du Yamin and Seo Wonchul analyzed input-output efficiency and management of R&D activities across Chinese universities, proposing enhancement measures [9]. Xue Wuzhao et al. evaluated static and dynamic efficiency of research activities at universities directly under China's Ministry of Education, suggesting optimization strategies [10]. Jiang Jiali et al. assessed research efficiency in Chinese universities and provided improvement recommendations [11].Existing studies share common objectives: evaluating educational quality and efficiency improvements, identifying implementation challenges, optimizing resource allocation and performance management systems to boost institutional efficiency and academic output, and exploring pedagogical and curricular innovations to enhance talent cultivation quality.

Scholars adopted diverse research methods. Li Xianzheng combined literature analysis with historical evaluation practices and value orientations in vocational education [1]. Tang Ni utilized Data Envelopment Analysis (DEA) and Tobit regression to quantify operational efficiency across 56 DHP institutions [2]. Lee and Johnes integrated network DEA with qualitative and quantitative data (e.g., UK Teaching Excellence Framework) [3]. Mao Jianqing et al. employed a two-way fixed-effects model to analyze funding-academic output relationships [4]. Liu Bin et al. applied the Delphi method to establish weights for a three-tier indicator system, enabling measurable comparisons [12]. Sun Hui et al. developed an evaluation index system aligned with China’s Vocational Education Quality Enhancement Action Plan to propose development pathways [13]. Ma Xinyue et al. used DEA to assess DHP institutions' operational efficiency. Yuan Ke et al. applied a progressive Difference-in-Differences (DID) method, using QS rankings and student satisfaction metrics to evaluate the impact of targeted funding [14]. Yang Yanyan et al. constructed a Balanced Scorecard-based index system spanning teaching, research, finance, and social performance [15]. Xie Qian et al. employed CiteSpace and SATI for bibliometric visualization, analyzing keyword and burst term patterns [16]. Du and Seo combined DEA–Malmquist models with scientific-statistical data to assess regional R&D efficiency [9]. Xue Wuzhao et al. applied three-stage DEA and Malmquist indices to evaluate research efficiency at ministry-affiliated universities [10]. Jiang Jiali et al. leveraged DEA to measure research efficiency nationwide [11]..Key methodologies include DEA for institutional/research efficiency evaluation, Tobit regression for factor quantification, and hybrid network DEA models integrating qualitative-quantitative data. These approaches enable comparative analyses, enhance scientific rigor, and provide robust evidence for policy formulation and technical guidance.

3 RESEARCH METHOD AND INDICATOR CONSTRUCTION

3.1 Research Method

The operational performance evaluation of higher vocational colleges is a complex process involving multi-dimensional inputs and outputs. Due to the numerous indicators and intricate interrelationships, conventional simplistic evaluation systems prove inadequate. Data Envelopment Analysis (DEA), a non-parametric analytical method utilizing linear programming, enables efficiency measurement in multi-input and multi-output models by incorporating multiple indicators, making it particularly suitable for this research. This study employs DEA models to evaluate the operational efficiency of 56 "Double High-Level" institutions and 31 higher vocational colleges in Yunnan Province. Specifically, the CCR model is adopted to assess overall efficiency, while the BCC model is further applied to examine efficiency differences under variable returns to scale. The CCR model assumes constant returns to scale for all decision-making units (DMUs), whereas the BCC model accounts for variable returns to scale, offering a refined efficiency evaluation framework.

By integrating both CCR and BCC models, this research aims to quantify operational efficiency disparities between nationally recognized "Double High-Level" institutions and regional vocational colleges in Yunnan Province. The CCR model facilitates preliminary identification of overall efficiency, while the BCC model reveals efficiency performance under varying scale conditions. This dual-model approach not only distinguishes effective from ineffective DMUs but also provides comprehensive efficiency assessment outcomes. The findings will inform educational policymaking, optimize resource allocation, enhance rational distribution of educational resources, and improve teaching quality. Furthermore, this study delivers scientific evidence and actionable recommendations for advancing vocational education development in Yunnan Province.

3.2 Indicator Construction

Based on the performance indicator construction method for DEA analysis proposed by Ma Xinyue et al.[14], and aligned with the core operational indicators of higher vocational colleges in Yunnan Province, this study establishes a comprehensive evaluation system encompassing input and output dimensions. Input indicators include annual per-student financial allocation under the financial investment dimension and the number of full-time teachers representing human resource investment. Output indicators are structured into five aspects: school facilities and equipment, measured by per-student value of teaching and research instruments and per-student land area to assess resource conversion efficiency and spatial allocation; faculty team development, reflected in the proportion of teachers with master's degrees or higher and dual-qualified teachers to evaluate academic structure optimization and industry-education integration; talent cultivation outcomes, integrating enrolled student scale, graduate employment rate, and student competition awards to systematically gauge talent development capacity, social adaptability, and innovation; social service contributions, represented by non-degree training participation to quantify vocational skill enhancement efforts; and international cooperation impact, measured by the scale of international students to reflect global educational influence. The system positions "facilities-faculty-talent cultivation" as the core competency layer, extending to "social services-international cooperation" as the external benefit layer, forming an integrated evaluation framework that deepens insights into vocational education's foundational role while highlighting its contributions to industrial advancement and global engagement(Table 1).

Table 1 Indicator Classification

Primary Indicator	Secondary Indicator	Unit	Label
Input of Financial Allocation	Average Annual Financial Allocation per Student	Yuan/person	X1
Input of Human Resource	Number of Full-time Teachers in School	Person	X2
Output of School Facilities and Equipment	Average Value of Teaching and Research Instruments per Student	Yuan/person	Y1
	Average Land Area per Student	m^2/person	Y2
Output of Faculty Team	Proportion of Teachers with Master's Degree or Above	%	Y3
	Proportion of Dual-qualified Teachers	%	Y4
Output of Talent Cultivation	Equivalent Scale of Enrolled Students	%	Y5
	Graduate Employment Rate	%	Y6
	Number of Student Competition Awards	Count	Y7
Output of Social Services	Non-degree Training Participants	Person/day	Y8
Output of International Cooperation	Scale of International Students	Person	Y9

4 DATA ANALYSIS

4.1 Comparative Analysis

Notably, multidimensional gaps exist between higher vocational colleges in Yunnan Province and DHP Vocational Colleges, with pronounced disparities in resource investment, faculty structure, and student cultivation outcomes. To systematically evaluate these gaps, the dataset was divided into two groups: DHP institutions and Yunnan-based colleges. Averages were calculated for each group, and a comparative analysis was conducted to quantify differences across key indicators, as illustrated in Figure 1 below.

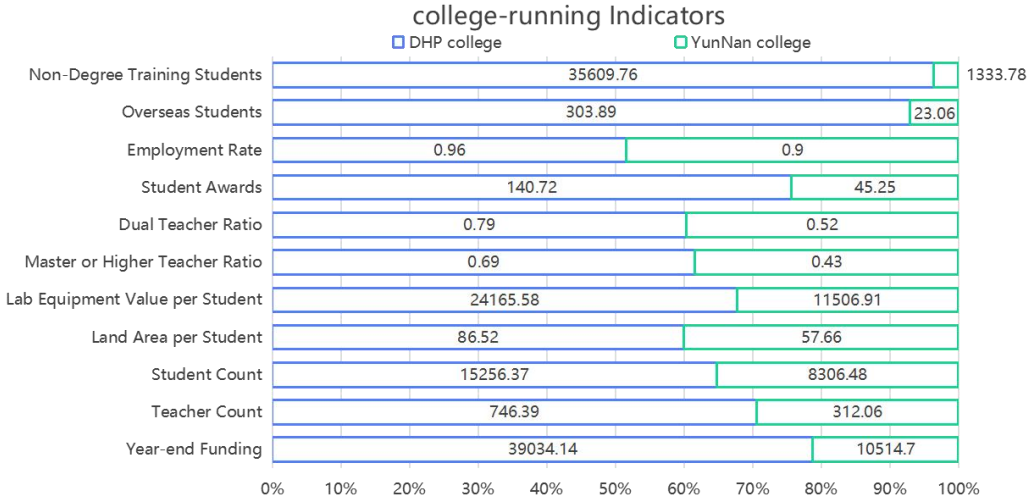

Figure 1 Comparative Analysis

In terms of resource investment, higher vocational colleges in Yunnan Province exhibited an annual financial allocation of 105.147 million yuan, equivalent to only 26.9% of the 390.3414 million yuan allocated to DHP institutions. This

insufficient fiscal support directly constrained infrastructure development: the per-student land area in Yunnan colleges was 57.66 m², 33.4% lower than the 86.52 m² in DHP institutions, while the per-student laboratory equipment value of 11,506.91 yuan represented less than half of the 24,165.58 yuan in DHP colleges.

Faculty-student ratio imbalances further exacerbated resource constraints. Yunnan colleges had 312.06 full-time teachers and 8,306.48 enrolled students, accounting for only 41.8% and 54.5% of the corresponding figures in DHP institutions, respectively. This imbalance, coupled with diluted per-student resources, significantly limited teaching and research capacity.

Regarding faculty structure, Yunnan colleges reported a 43% proportion of teachers with master's degrees or higher, significantly lower than the 69% in DHP institutions. The proportion of dual-qualified teachers in Yunnan (52%) also lagged by 27 percentage points compared to 79% in DHP colleges. These gaps reflect insufficient high-level talent reserves and weak industry-academia collaboration mechanisms, undermining pedagogical innovation and industry service capabilities.

In student cultivation outcomes, Yunnan colleges recorded 45.25 student competition awards, less than one-third of the 140.72 awards achieved by DHP institutions. The international student enrollment of 23.06 students in Yunnan represented a mere 7.6% of the 303.89 students in DHP colleges, while non-degree training participation (1,333.78 participants) was only 4% of the 35,609.76 participants in DHP institutions. These metrics highlight systemic challenges, including weak academic competitiveness, delayed internationalization, and ineffective social service functions. The graduate employment rate in Yunnan (90%) showed a relatively smaller gap compared to the 96% rate in DHP colleges.

4.2 DEA Analysis

Generally, categorize Data Envelopment Analysis (DEA) efficiency scores as follows: ≥0.8 indicates high efficiency, 0.5–0.8 denotes moderate efficiency, and <0.5 reflects low efficiency [14]. Using DEA-SOLVER Pro5.0, input-output indicators were processed to calculate comprehensive efficiency (technical efficiency), pure technical efficiency, scale efficiency, and returns to scale for institutions across five regions: Eastern, Western, Central, Northeast, and Yunnan. Results are summarized in Table 2.

Table 2 DEA Results

Region	Sample Total	Average TE	TE=1 Count	Average PTE	PTE=1 Count	Average SE	SE=1 Count
Eastern	46	0.66	17	0.99	28	0.67	11
Western	25	0.59	10	0.98	14	0.6	5
Central	11	0.71	5	0.98	7	0.72	4
Northeast	3	0.67	0	0.97	2	0.69	0
Yun Nan	21	0.79	10	0.96	13	0.82	10

Data analysis reveals that most institutions achieved a pure technical efficiency of 1, indicating that input-output effectiveness is well ensured under current management systems and practices. However, significant anomalies were observed in scale efficiency. Among all 85 higher vocational colleges, only 17 achieved scale efficiency of 1, while the majority, 81.2 %, operated below 0.9. This suggests that over 80 % of institutions suffer from excessive operational scale and need to downsize to improve efficiency.

In Yunnan, only 47.6 % of institutions achieved pure technical efficiency of 1, significantly lower than regions such as Eastern, Western, Central, and Northeast, where the rates exceeded 65 %, with Central reaching 71.4 %. This highlights Yunnan's shortcomings in management capabilities. Conversely, Yunnan exhibited the best performance in scale efficiency. Eleven out of 31 institutions achieved scale efficiency of 1, accounting for 35.5 %, far surpassing Central at 28.6 %, Eastern at 9.7 %, Western at 7.7 %, and Northeast with none. This contradiction underscores that while Yunnan institutions have relatively rational scale configurations, their management practices still lag behind national benchmarks, necessitating institutional optimization to bridge the efficiency gap.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The scale efficiency advantage observed in Yunnan's higher vocational colleges under DEA analysis is fundamentally a passive adaptation to the combined effects of its western geographic location and lagging economic development. As a southwestern border province, Yunnan faces structural challenges due to complex terrain, sparse transportation networks, chronic fiscal underinvestment, and weak capacity for educational resource aggregation. The regional economy, dominated by low-value-added traditional industries such as agriculture and tourism, with slow technological upgrading, constrains the demand hierarchy for vocational education. Institutions are compelled to prioritize low-skilled training programs, struggling to establish high-quality talent cultivation systems aligned with emerging industries. This dual collapse in economic foundation and educational investment results in Yunnan's annual funding amounting to less

than one-third of DHP institutions, while per-student laboratory equipment value is only half of the national benchmark. Severe hardware shortages force institutions to downsize operations to sustain basic efficiency.

Furthermore, the closed educational ecosystem in western China exacerbates competency gaps. Remote geographic positioning reduces talent attraction, with the proportion of teachers holding master's degrees or higher lagging 26 percentage points behind DHP institutions, and a 27% deficit in dual-qualified teachers. This faculty structure fracture perpetuates weakened pedagogical innovation and industry service capabilities. Concurrently, low technological sophistication in regional industries leads to superficial industry-education collaboration, limiting 校企 partnerships to basic internship arrangements rather than deep technical integration or customized training. The interplay of geographic marginality, low-end economic structure, and constrained educational investment creates a distorted pattern of "passively optimized scale but dysfunctional technical efficacy."

The efficiency dilemma of Yunnan institutions is further entrenched by regional development disparities and institutional stagnation. DHP institutions in eastern China leverage industrial agglomeration and policy-driven resource advantages to establish dynamic "disciplinary cluster-industry chain" coupling mechanisms. Their digital governance models and dense industry-academia networks efficiently convert abundant resources into technical skill outputs. In contrast, Yunnan institutions, constrained by homogeneous local industries and weak institutional innovation, remain trapped in a low-end equilibrium under comparable management frameworks. Outdated administrative practices result in underutilized laboratory equipment, curricula outdated against industry demands, and non-degree training participation at merely 4% of DHP levels, exposing atrophy in social service functions. This systemic inertia underscores the urgent need for policy interventions to recalibrate resource allocation, modernize governance, and foster adaptive industry-education ecosystems.

5.2 Recommendations

To advance the reform and development of higher vocational education in Yunnan, a multidimensional innovation system must be established, prioritizing the creation of an "Eastern-Western Collaboration + Local Characteristics" industry-education integration ecosystem. This involves constructing cross-regional industry-education alliances through national East-West cooperation mechanisms, implementing an innovative "1+1+N" collaborative model to align high-quality educational resources from Eastern DHP institutions with Yunnan's specialized disciplines. Virtual teaching and research platforms should be developed in fields such as green energy and cross-border e-commerce to enable interregional sharing of curricula and practical training resources, while synchronizing technical standards with talent cultivation mechanisms. Leveraging Yunnan's ecological assets and border location, provincial special funds should be allocated to cultivate distinctive discipline clusters in digitalized plateau agriculture and cross-border tourism services. Collaborative projects with enterprises along the China-Laos Railway and cross-border cooperation zones should develop "language + skills + commerce" interdisciplinary talent programs, forming an educational supply system aligned with Regional Comprehensive Economic Partnership (RCEP) industrial chains.

A "dual-track strategy of attraction and cultivation" is essential for faculty development. Competitive recruitment mechanisms for high-level talents should include relocation subsidies, research funding, and industry project linkages. To address structural shortages of dual-qualified teachers, an "engineer-in-residence" program should integrate corporate technical experts into campuses, with enterprise participation incorporated into social responsibility evaluations. A provincial dual-qualified teacher certification center, jointly developed with leading tech firms, should establish digital teaching competency standards and industry practice renewal mechanisms, directly linking certifications to promotions and performance-based salaries to foster continuous professional growth.

A "hardware-software synergy" model must be implemented. Provincial digital education funds should prioritize virtual simulation training systems and a unified "cloud vocational education" platform to enable cross-institutional resource sharing and equipment optimization. Flexible credit systems, including a "credit bank" and lifelong learning mechanisms, should allow skill certifications to convert into academic credits. Seasonal "peak practice + off-peak theory" schedules could expand non-degree training participation to over 20% of DHP levels within three years. Concurrently, smart training base efficiency evaluations should ensure equipment utilization rates exceed 85%.

A dynamic "incentive-constraint balance" framework is critical. Funding growth mechanisms should link vocational education investments to fiscal revenues, ensuring annual per-student allocations increase by ≥8%, supplemented by provincial vocational education bonds for border infrastructure. Enterprises engaged in industry-education integration should receive education surtax reductions and preferential land-use quotas to incentivize participation. Third-party monitoring systems must evaluate institutional performance using metrics such as international student enrollment and technology transfer income, issuing warnings and corrective mandates to underperforming institutions to enforce accountability.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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