

A Study on the Internationalization Development Model and Economic Effect Evaluation of Vocational Education Based on Cost-Benefit Analysis

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ABSTRACT The internationalization of vocational education has evolved from a single output model to a complex process involving multiple stakeholders, institutional transfer, cultural adaptation, and resource integration. Under increasingly economically rational policy and investment decisions, the economic efficiency and sustainability of internationalization models require quantitative assessment. Based on a cost-benefit analysis framework, this study constructs an evaluation system covering input and output indicators. Three typical models of vocational education internationalization are selected: project output, cross-border institutional cooperation, and standard foreign aid. Internationalization project data from 48 higher vocational colleges in 23 provinces and municipalities in China are collected to compare the cost structure and economic benefits of different models. Results show significant differences in cost recovery periods among the three models. The project output model shows the most evident short-term benefits; the standard foreign aid model has higher long-term return potential; and the cross-border institutional cooperation model faces the greatest cost pressure and slowest benefit release. Further analysis shows that project scale, cooperation depth, and host-country policy environment moderate economic benefits.

INDEX TERMS vocational education internationalization, cost-benefit analysis, development model, economic effect evaluation, resource allocation

I. INTRODUCTION

DRIVEN by both economic globalization and the deepening of international industrial division of labor, the internationalization of vocational education in engineering and science has become an important strategic choice for countries to improve their human resource competitiveness and participate in global education governance. This strategic alignment ensures the cultivation of high-caliber talents capable of mastering advanced manufacturing technologies and driving innovation within the increasingly interconnected global industrial landscape. From the export of the dual system model of Germany to the promotion of the TAFE system of Australia and the construction of Luban Workshops in China, the influx of vocational education resources and models has been an unprecedented international flow. This process involves not only the spread of educational philosophies and standards of teaching, but also the extension of the national industrial interests and international influence.

This study proposes economic impact assessment perspective, the internationalization development models of

vocational education. It introduces a cost-benefit analysis frame to quantify the input-output ratio of different models and try to understand the economy behind their sustainability. The research chooses three common internationalization paths of development, namely project-based output, cross-border institutional models and standard foreign aids models. It takes 48 projects on internationalization in higher vocational colleges in China as samples, to establish a system to collect internationalization project data about costs, including the cost of personnel, the cost of developing teaching resources, the cost of operations and management, and the cost of hardware investment and three indicators of output, which are the short-term benefits, the medium-term benefits, and the long-term benefits. The economic benefits of different models are compared and analyzed in identifying key factors that affect effectiveness. This research aims to complement existing socio-cultural studies with critical economic evidence regarding global engineering and science education, providing a theoretical foundation and practical guidance for precise decision-making in the high-quality development of vocational internationalization. By aligning

economic resource allocation with the technical demands of advanced manufacturing, this framework ensures that the global cultivation of industrial talent remains both financially sustainable and technologically sophisticated.

II. RELATED WORK

The cross-border flow of international vocational education and training (VET) has evolved from a single model transplantation to a complex process involving multiple actors, institutional environments and cultural logics. Toepper [1] conducted a comprehensive search, screening and analysis of empirical studies on VET transfer in the international community. Regel et al. [2] focused on the transfer of quality development methods in India as an example. With the rapid development of digital technology, the global vocational education field is facing digital transformation. Jiang et al. [3] sorted out and compared domestic (China) and international (outside China) studies on the application of digital teaching in vocational education to promote the exchange of ideas in order to meet the needs of digital transformation in vocational education. Borodiyenko et al. [4] found that international cooperation projects have had a significant impact on the development of vocational education in Ukraine. With the increase in the mobility of international students, vocational education teachers face the challenge of teaching students from diverse cultural backgrounds. Tran and Pasura [5] explored how teachers can acquire the skills to teach international students through informal professional learning in the international vocational education environment in Australia.

Vogelsang et al. [6] revealed that international VET transfer is a complex coordination process involving multiple levels and multiple actors. Iwacewicz-Orłowska [7] showed that international internships have a positive impact on students' vocational education. It not only improves students' professional practice skills and foreign language ability, but also enhances their cross-cultural understanding, adaptability and self-confidence. Fuchs [8] analyzed the specific practices of German multinational corporations in establishing and operating VET projects in specific emerging economies. Joncas et al. [9] called for VET policies and practices to recognize and respect the knowledge system and cultural rights of natives, and to ensure that they can participate and benefit from them on an equal footing. Based on the analysis of structured theory, Wang [10] revealed that the key to the success of the Luban Workshop brand lies in the realization of a virtuous interaction between the agency of actors and structural conditions. It has reference value for optimizing the construction of Luban Workshop and enhancing the international influence of Chinese vocational education. While existing research analyzes the internationalization of vocational education from the perspectives of process, participants, and diverse values, a core question remains unanswered as economic rationality increasingly becomes a key criterion for policy and investment decisions: what are the economic efficiency and long-term benefits

of the internationalization development model itself? This study aims to approach the topic from the perspective of economic effect assessment, focusing on the internationalization development models of vocational education. By introducing a cost-benefit analysis framework, it seeks to quantify the input-output ratio of different models and explore the economic logic of their sustainability. In order to supplement the socio-cultural dimensions of existing research with key evidence from the economic dimension, this study provides theoretical basis and practical guidance for promoting precise decision-making and high-quality development of vocational education internationalization.

III. METHODS

A. CONSTRUCTION OF THE ANALYSIS FRAMEWORK

Based on the basic principles of cost-benefit analysis, this study constructs an economic effect evaluation framework applicable to the internationalization development model of vocational education. The core of this framework is to identify and quantify the cost composition and benefit sources of different internationalization models, and to compare input and output on this basis [11].

The cost dimension was defined with reference to the cost-benefit model of the German Federal Institute for Vocational Education and Training. The model divides training costs into four categories: student-related costs, training personnel costs, material costs, and other costs. In light of the specific context of the internationalization of vocational education, this study adjusts the cost indicators to the following four categories: first, personnel costs, including salaries of dispatched teachers, salaries of overseas staff, and travel subsidies; second, teaching resource development costs, including translation and transformation of curriculum standards, textbook development, and construction of digital resources; third, operation and management costs, including project management, enrollment promotion, and cooperation coordination; and fourth, hardware investment costs, including the purchase of practical training equipment, construction of teaching venues, and establishment of remote teaching platforms.

The definition of the benefit dimension refers to the UNESCO's analytical framework for the return on investment in vocational and technical education and training. This framework emphasizes identifying benefits from the perspective of multiple stakeholders, including three levels: individual benefits, corporate benefits, and social benefits. In combination with the characteristics of the internationalization of vocational education, this study divides the benefit indicators into three categories: short-term benefits mainly include tuition revenue, training service revenue, government project funding, and other direct economic returns; medium-term benefits mainly include the subsequent consumption of international students, the remittances brought back by overseas employment of graduates, and the extended benefits of school-enterprise cooperation projects; long-term benefits mainly include the intangible value brought about by the

improvement of international influence, the derivative benefits of equipment exports driven by standard output, and the value of international partner networks.

Non-monetary benefits primarily target intangible value derived from enhanced international influence and the value of international partner networks—benefits that cannot directly generate cash flow. To address the quantification issue, this study introduces the Analytic Hierarchy Process (AHP). First, 12 senior experts, policymakers, and project leaders in the field of vocational education internationalization were invited to construct a non-monetary benefit evaluation index system encompassing five dimensions: “enhanced international reputation,” “export of standards systems,” “expansion of global networks,” “technology spillover effects,” and “strengthening of cultural soft power.” Subsequently, the weights of each indicator were determined through pairwise comparisons, and experts scored the degree of non-monetary benefit realization for each internationalization project (from 1 to 9 points), ultimately calculating the non-monetary benefit index for each project. This index serves as a moderating factor, combined with subsequent financial analysis results, to form a comprehensive evaluation of the project’s overall benefits.

In terms of input-output comparison, this study uses three core indicators: first, the cost recovery period, which is the time required for the cumulative income to reach the initial investment; second, the input-output ratio, which is the ratio of total income to total cost; and third, the net present value, which is the difference between the present value of income and the present value of cost after considering the time value of money [12].

B. RESEARCH SUBJECTS AND DATA COLLECTION

This study selected 48 higher vocational colleges from 23 provinces and municipalities in China as research subjects. The selection of colleges followed the following principles: First, balanced regional distribution, covering 18 colleges in the eastern region, 15 in the central region, and 15 in the western region; second, differences in the degree of international participation, including 26 colleges included in the national “Double High-Level” program and 22 colleges not included in the program; and third, diversity of internationalization models, ensuring sufficient sample support for all three development models.

The data collection work was carried out in three stages. The first stage was the pre-research stage, in which six universities were selected for in-depth interviews and questionnaire pre-tests to revise and improve the cost and benefit indicators. The second stage was the formal research stage, in which data on international projects carried out by various universities were collected through a combination of questionnaire surveys, financial data extraction and interviews with project leaders. The third stage was the data verification stage, in which key data were followed up by telephone and cross-validated to ensure the accuracy and consistency of the data [13-14].

A total of 48 questionnaires were distributed, and all 48 valid questionnaires were returned, resulting in a 100% response rate. A total of 156 international projects were collected, including 78 projects under the project export model, 42 projects under the institutional cross-border model, and 36 projects under the standard foreign aid model. Financial data covers personnel expenses, resource development expenses, operating expenses, and hardware expenses throughout the project cycle, as well as tuition revenue, service revenue, grant revenue, and derivative income.

C. DATA ANALYSIS METHODS

This study employs a combination of quantitative and qualitative analysis. Quantitative analysis primarily utilizes descriptive statistics and comparative analysis to calculate and compare the cost structure, benefit levels, and input-output indicators of different models. Descriptive statistics are used to present the mean, standard deviation, and distribution characteristics of each indicator, while comparative analysis is used to identify the differences in economic effects among the three models.

The cost recovery period is calculated using the cumulative net cash flow method. The input-output ratio is calculated using the ratio of the present value of total income to the present value of total cost. When calculating the net present value, this study did not use a uniform discount rate for all models, but set a differentiated discount rate based on the macroeconomic environment and country risk rating of the host country where the project is located. Specifically, referring to the country risk premium data released by the World Bank and the International Monetary Fund, and combined with the average government bond yield of the project country in the past five years, a discount rate of 3%-4% was used for projects operating in developed countries, a discount rate of 5%-8% was used for projects operating in developing countries, and a discount rate of 8%-12% was used for projects operating in high-risk countries, so as to more accurately reflect the differences in funding costs and risks faced by different projects[15].

To control for the impact of different project sizes and durations on the comparison results, this study also calculated unit output indicators, including per capita training cost, per unit project revenue, and annual return on investment, so as to establish a comparable basis between different types of projects.

Qualitative analysis was primarily based on in-depth interviews with 32 project leaders, employing thematic analysis to identify key factors influencing economic benefits. Interview content covered cost control strategies, revenue realization paths, challenges faced, and countermeasures during project operation. Through coding and categorization, moderating variables such as project scale, depth of cooperation, host country policy environment, and industry relevance were extracted to explain the inter-pattern and intra-pattern differences identified in the quantitative analysis.

IV. RESULTS AND DISCUSSION

A. COST STRUCTURE ANALYSIS OF THREE TYPES OF INTERNATIONALIZATION DEVELOPMENT MODELS

Data analysis of 156 internationalization projects from 48 institutions revealed differentiated cost structures across the three development models. Figure 1 illustrates the composition of the average annual cost for different project types.

Figure 1 shows that the annual total cost of the institutional cross-border model is the highest, reaching 9.071 million yuan, significantly higher than the 1.847 million yuan of the project output model and the 3.881 million yuan of the standard foreign aid model. In terms of cost structure, hardware investment costs account for the highest proportion in the institutional cross-border model, reaching 45.5%, which is directly related to the construction of facilities and equipment purchases for overseas branch schools or teaching sites. Personnel costs also account for a high proportion in the institutional cross-border model, reaching 27.2%, reflecting the continuous expenditure pressure on the salaries and benefits of overseas resident personnel.

The cost structure of project-based output model is relatively balanced, with personnel costs taking the highest proportion at 42.6% mainly manifested in travel subsidies and teaching fee for short-term dispatched teachers. Operational management costs 24.5% - mainly applied to project management albeit and student recruitment costs. It is worth to note that the hardware investment cost of the project based output model is relatively low accounting for only 15.4% due to the fact that the project based output model mainly relies on the existing teaching facilities of the partner to conduct training activities.

In the standard foreign aid model's cost structure, resource development costs account for 20.4%. The core of this model lies in systematically developing curriculum standards, teaching resources, and certification systems, which requires investment in early stages, such as translation and localization. Personnel costs account for 29.0%, including consulting and training fees for expert teams. Hardware investment costs account for 11.0%, which is relatively low, but mainly consists of a small amount of demonstration equipment donations. Further analysis of the time-varying trends of cost structures show that the cost fluctuations of the annual costs of the project output model are rather small with a rather stable characteristic. For the institutional cross-border model the investment in hardware is concentrated in the first stage, and the costs in the first two years are much higher than those in later years. In the typical foreign aid model, the development costs are typically invested in the early stages of the project and the later years mostly comprise the operational and maintenance costs of the project. This finding implies that temporal distribution characteristics of cost inputs need to be taken into account in the economic impact assessment of different models.

B. COMPARATIVE ANALYSIS OF THE ECONOMIC BENEFITS OF THE THREE DEVELOPMENT MODELS

Based on cost analysis, this study calculated and compared the economic benefits of the three models.

Table 1 presents the return levels and input-output indicators of the different models.

Table 1 shows that the model of project output has an average total revenue of 3.649 million yuan per year, input-output ratio of 1.98, the cost recovery period of 2.3 years, and net present value of 3.568 million yuan. This result shows that good economic benefits can be achieved by the project output model in the short period with the speed of cost recovery and the high rate of return on investment. Further analysis shows that direct revenue makes up a high proportion of this model, accounting for 78.5% which is primarily training service income as well as short term project funding.

The cross-border model for the institutions brought about an average annual total of 6.695 million yuan, the greatest absolute return among the three models. However, its return on investment (ROI) value was only 0.74 with a net present value of -4.125 million yuan, and it has a cost recovery period of 4.8 years. This finding reveals that although the cross border model can bring about the scalable profits, the high investment in hardware and continuous operating costs make it hard for its economic benefits to turn round in the short term. Some sample institutions' overseas branch campuses were faced with the dilemma of lower than expected levels of enrollment in the early stages of operation, which further extended the cost recovery period.

The results of the standard foreign aid model are the total revenue of 4.409 million yuan per year, the input-output ratio was 1.14, the cost recovery period was 4.2 years, and the net present value was 1.087 million yuan. The key feature of this model is that indirect benefits account for as much as 64.6%. These indirect benefits mainly come from equipment donations from industry enterprises obtained through standard output, processing revenue from overseas orders undertaken by on-campus productive training bases, and technical service and talent training cooperation funds paid by partner companies to prioritize the recruitment of graduates. Although the level of direct benefits is relatively low, the potential returns are high in the long run.

In terms of the time distribution of benefits, the benefits of the project-based output model are mainly concentrated during the project execution period, exhibiting a short-term and concentrated characteristic. The benefits of the cross-border institutional model increase year by year with the expansion of the student population, showing a slow upward trend. The benefits of the standard foreign aid model are the most delayed, often only gradually appearing after the standard is recognized by the host country.

This study further introduces a non-monetization benefit index for evaluation.

Although the net present value of monetization for the cross-border agency model is negative, its non-monetization

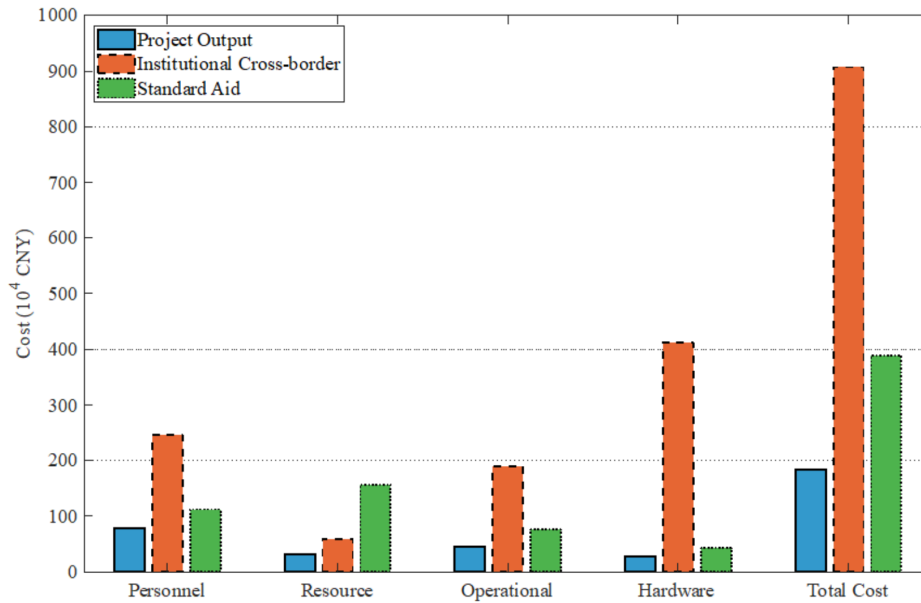


FIGURE 1. Average Annual Cost Structure of Three Types of Internationalization Development Models for Vocational Education

TABLE 1. Comparison of Economic Benefits of Three Types of Internationalization Development Models for Vocational Education

Benefit indicators	Project output mode	Cross-border model of institutions	Standard foreign aid model
Average annual direct income (ten thousand yuan)	286.5	542.8	156.3
Average annual indirect income (ten thousand yuan)	78.4	126.7	284.6
Average annual total income (ten thousand yuan)	364.9	669.5	440.9
Cost recovery period (years)	2.3	4.8	4.2
Input-output ratio	1.98	0.74	1.14
Net Present Value (RMB 10,000)	356.8	-412.5	108.7

TABLE 2. AHP evaluation results of the three models on the non-monetization benefit dimension

Non-Monetary Benefit Dimension	Weight	Project Export Model	Cross-Border Institution Model	Standard Foreign Aid Model
Enhancement of International Reputation	0.25	6.2	8.5	7.1
Export of Standards and Curricula	0.30	4.5	7.2	9.3
Expansion of Global Partnership Networks	0.20	5.8	8.9	6.5
Technology Spillover Effects	0.15	7.0	8.1	8.8
Strengthening of Cultural Soft Power	0.10	6.5	7.8	7.4
Non-Monetary Benefit Index	1.00	5.70	8.09	7.99

benefit index (8.09) is significantly higher than that of the project output model (5.70). This indicates that such projects have significant strategic value in enhancing international reputation and expanding global networks, but their high upfront investment has not been converted into monetary benefits in the short term. The non-monetization benefit index (7.99) of the standard foreign aid model is also very high, especially in the dimension of “standard system output” (9.3), reflecting its profound strategic influence. While the project output model performs best in terms of monetization benefits, its non-monetization benefits at the strategic level are relatively low. Combining the two and evaluating them through the “comprehensive benefit index,” it is found that the three models have different focuses in

strategic positioning: the project output model focuses on short-term financial returns, while the cross-border agency and standard foreign aid models focus on long-term strategic layout.

C. ANALYSIS OF KEY FACTORS AFFECTING ECONOMIC BENEFITS

Quantitative analysis revealed significant differences in economic benefits among the three models, but these differences were not entirely determined by the models themselves, but were moderated by multiple factors.

Based on in-depth interviews with 32 project leaders, this study identified key factors influencing economic benefits and summarized them from both positive and negative

perspectives. Table 3 presents the direction and degree of influence of different factors on economic benefits.

Project size is the most frequently mentioned influencing factor. Although the cost of training per student decreases significantly once the project reaches a certain size, this study further finds that this economies of scale are not infinitely extended. In cross-border education contexts, as the scale continues to expand, management complexity, cross-cultural coordination costs, and the cost of maintaining consistent quality increase non-linearly, potentially leading to “diseconomies of scale.” For example, an overseas branch of a vocational school in eastern China had 120 students in its first year, increasing to 560 in its fourth year, with the cost per student decreasing by 47%. However, when the school planned to expand enrollment to over 800 students, the interviewed project leader pointed out that due to the need for additional management levels, more complex faculty allocation, and multi-campus coordination, the expected decrease in per-student cost narrowed significantly, and even showed a rebound trend, indicating that the project had approached its optimal scale boundary.

The depth of cooperation is the second important positive factor. All 24 respondents stressed the importance of setting up long-term and stable partnerships with collaborating institutions or enterprises that may effectively minimize the cost of communication and coordination and enhance the efficiency of the operation of the projects. For example, following a sister school relationship with a technical college in an Asian country amongst countries in the Association for the Development of Education in Southeast Asia, one school’s achieved a tacit understanding of such areas as the articulation of curriculum, faculty exchange, and credit recognition, leading to a 32% reduction in the costs of operating the project as compared to the first stage. Host country policy support is also very important. 21 respondents said projects recognised or funded by the host country government have advantages in terms of student recruitment permits, teacher qualifications and revenue repatriation, to a much greater extent than institutional costs. For instance, a standard export project undertaken by a certain institution in a Central Asian country had its matching funds provided by the local government after being included in the key vocational education reform project of the country, and in effect, the pressure of initial investment was reduced.

The impact of industrial linkages is reflected in cost-sharing and benefit-sharing resulting from corporate participation. Nineteen respondents pointed out that international projects closely integrated with the overseas operations of Chinese companies can obtain support from enterprises in areas such as training equipment, internship positions, and part-time instructors, reducing the individual investment of educational institutions. One educational institution accompanied a Chinese-funded enterprise into the African market; the enterprise undertook some skills training tasks, while the institution was mainly responsible for standard setting and instructor training, forming a complementary cooperative

relationship.

Among the negative factors, cultural distance had the most significant impact. Eighteen respondents mentioned that conducting projects in countries with significant cultural differences requires additional investment in localizing curriculum content, adapting teaching methods, and navigating cross-cultural management, generally extending project durations. Policy stability was mentioned by 16 respondents; changes in host country policies could lead to project interruptions or adjustments, increasing uncertainty. Language barriers directly increase translation and communication costs, especially noticeable in standard output models.

V. CONCLUSION

This research is an empirical study assessing the economic impacts of three models of engineering and science vocational education internationalization using a cost-benefit analysis framework. By quantifying the financial and technical returns of international cooperation in manufacturing training, the study evaluates how different pedagogical approaches optimize the cultivation of high-caliber industrial talent. The results indicate considerable differences in terms of cost structure, return levels and input-output indicators between the project based export model, the cross border institutional model and the standard foreign aid model. The project-based export model has the easiest cost recovery period and the biggest input-output ratio and short-term economic benefits. The cross-border institutional model has the highest absolute return, but due to the large hardware investment and continuous operation costs, it is difficult for economic benefits to turn back to the positive in the short term, which results in a negative net present value. Although the standard foreign aid model has limited direct benefits, the indirect benefits have relatively high proportion, slightly suggesting its return in long term.

This study contains a preliminary analytical framework and empirical evidence to assess the economic effects of vocational education internationalization and therefore helps fill the gaps of existing research since the effects of globalization on vocational education have been neglected especially in the socio-cultural dimension along with the economic dimension. Its practical significance is to support decision makers in institutions and policy makers in the model selection, and contribute to the change of vocational education internationalization from “scale expansion” to “quality and efficiency”. Its theoretical contribution, therefore, is the introduction of cost-benefit analysis into the event of vocational education internationalization research to open broader research perspectives and analytical tools in the research field of vocational education internationalization.

There are various limitations of this study. First, the sample coverage is limited because even though it covers 48 institutions in 23 provinces and municipalities, it needs to improve its representativeness. Second, the data only covers a period of five years, so there is some uncertainty in calcu-

TABLE 3. Analysis of Factors Affecting the Economic Benefits of Internationalization of Vocational Education

Influencing factors	Direction of influence	Mechanism of action	Frequency of mention
Project Scale	positive	Economies of scale reduce unit costs, but beyond the optimal scale, increased management complexity and coordination costs can lead to diseconomies of scale.	26
Depth of cooperation	positive	Reduce coordination costs and improve efficiency	24
Host country policy support	positive	Reduce institutional costs and provide funding	21
Industrial linkages	positive	Companies participate in cost-sharing and provide internship positions.	19
Cultural distance	negative	Increased adaptation costs and extended development cycle	18
Policy stability	negative	Increased uncertainty risk	16
Language barrier	negative	Increased translation and communication costs	14

lating long term benefits. Third, the approaches to quantify indirect benefits still leave room for improvement since certain intangible values are hard to measure accurately. In future studies, the sample size and observation period could be enlarged to better capture the long-term economic benefits of internationalization in engineering and science vocational education. Refining the methods for quantifying technical returns from global manufacturing collaborations will further increase the understanding of how specialized industrial training contributes to high-quality economic development.

AUTHOR CONTRIBUTIONS

Ma Zhiyu designed, collected and analyzed the data, and drafted the manuscript. Ma Zhiyu conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Ma Zhiyu participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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