Wiley
Discrete Dynamics in Nature and Society
Volume 2024, Article ID 5583728, 15 pages
https://doi.org/10.1155/2024/5583728

WILEY

Research Article

Performance Evaluation of School Enterprise Collaborative Innovation and Practice of Innovation and Entrepreneurship Education Based on the Improved AHP Fuzzy Comprehensive Evaluation Method

Yingxia Yu ,[1] Haoyu Gu,[1] Bin Liang,[1] Xiuwen Chen,[2] Zemeng Chen,[3] and Lin Wang[1]

[1]*School of Civil Engineering and Architecture, Henan University of Science and Technology, Luoyang 471000, China*
[2]*The 3rd Construction Company Ltd. of China Railway Construction 15th Corporation, Chengdu 641418, China*
[3]*CCCC-SHEC Forth Engineering Co., Ltd., Luoyang 471013, China*

Correspondence should be addressed to Yingxia Yu; yingxiayu316@163.com

Received 7 December 2023; Revised 3 May 2024; Accepted 7 May 2024; Published 23 May 2024

Academic Editor: Anibal Coronel

Under the influence of the COVID-19, great changes have taken place in China's economic structure and market subjects and college students are facing difficulties in employment. By carrying out collaborative innovation between schools and enterprises, cultivating high-quality talents to meet social needs has become an important way to solve difficulties. Based on the input-process-output principle, a performance evaluation index system for collaborative innovation is constructed, which includes 3 primary indicators and 22 secondary indicators. The weights of each indicator are determined using improved AHP. A mathematical model for evaluating the performance of school enterprise collaborative innovation is established using the fuzzy comprehensive evaluation method. The evaluation value of the innovation and entrepreneurship education case project is 0.82, indicating that the overall operation is in good condition. The cooperation between schools and enterprises has created a favorable atmosphere and accumulated rich experience for carrying out innovation and entrepreneurship education. Good results have been achieved in talent cultivation and scientific and technological output, but there are also problems such as low conversion rates of scientific and technological achievements. Based on the evaluation results, the article proposes suggestions to improve the performance of collaborative innovation between schools and enterprises. The research results provide theoretical reference for the performance evaluation of school enterprise collaborative innovation and the practice of innovation and entrepreneurship education.

1. Introduction

With the rise of the knowledge economy in the world, industry-university-research cooperation has received widespread attention from countries around the world. In China, the "Outline of the National Medium and Long Term Education Reform and Development Plan (2010–2020)" pointed out the need to explore new collaborative models and promote close cooperation and resource sharing among universities, research and development institutions, and enterprises. In 2012, the Ministry of Education implemented the "2011 Plan," and collaborative innovation was elevated to the national strategic level. The 18th National Congress of the Communist Party of China pointed out that building an innovative country should adhere to the path of independent innovation and focus on the development of collaborative innovation [1–3]. On May 4, 2015, the State Council issued the "Implementation Opinions on Deepening the Reform of Innovation and Entrepreneurship Education in Higher Education Institutions," with the main tasks of improving the quality standards for talent cultivation, innovating talent cultivation mechanisms, and strengthening innovation and entrepreneurship practices. It emphasized the importance of implementing innovation and entrepreneurship education in various levels and types of schools [4]. The report of the 19th National Congress of the Communist Party of China pointed out that in order to achieve the connotative development of higher education, the connotative development of innovation and entrepreneurship education should become a key link [5]. The report of the 20th National Congress of the CPC stressed that we should adhere to the core position of innovation in China's overall modernization drive, focus on cultivating top-notch innovative talents, and accelerate the building of a world talent center and innovation highland [6]. The above programmatic documents point out the direction for universities to carry out collaborative innovation and entrepreneurship education between schools and enterprises. The sudden COVID-19 has made it difficult for college students to find jobs. It has become an important goal for colleges and universities to carry out entrepreneurship and innovation education to carry out collaborative innovation between schools and enterprises and cultivate new talents that meet social needs [7].

In collaborative innovation activities among industry, academia, and research, there have been both successes and failures, which has attracted the attention of scholars and managers to the evaluation of collaborative innovation performance [8]. Furong et al. [2] established a performance evaluation index system for industry university research cooperation and verified its practicality by analyzing the connotation of industry university research cooperation. Jing et al. [9] analyzed the influencing factors of technological innovation performance in industry university research cooperation and constructed an innovation performance evaluation index system that includes cooperative innovation environment, cooperative innovation investment, cooperative innovation output, cooperative innovation operation, and cooperative innovation effect. Meihua and Weiwei [10] established a performance evaluation index system for collaborative innovation between industry, academia, and research in agricultural enterprises and used the fuzzy integral method to evaluate the performance of collaborative innovation. Shanlin and Can [1, 11] constructed a performance evaluation index system for industry university research collaborative innovation projects, including explicit performance, implicit performance, and collaborative performance. Leiming et al. [12] used the analytic hierarchy process and entropy method to conduct a horizontal evaluation of 10 sample cities in Qingdao, combining subjective and objective weights to obtain a more reasonable evaluation model. Hongyun et al. [13] constructed a performance evaluation index system for collaborative knowledge innovation among industry, academia, and research and used LWD and LOWA operators for evaluation. Xiaochao [14] used the "input-output" indicator system as the research foundation and applied DEA analysis method to study the performance of industry university research cooperation in 22 cities in Henan Province. Guangliang et al. [15] built an innovation performance evaluation system based on 30 provinces in four major regions of China and used two-stage data envelopment analysis and Malmquist index methods to systematically analyze the status of industry university research collaborative innovation. Bangjun and Yanfang [16] constructed input and output indicators to evaluate the performance of industry university research collaborative innovation, determined their weights by factor analysis, and calculated the total factor scores and rankings of 30 provincial administrative regions in China based on provincial panel data. Zhaohui and Yongzhou [17] analyzed the mechanism of knowledge transfer in industry university cooperation, established an evaluation index system using the analytic hierarchy process and constructed an evaluation model using the fuzzy comprehensive evaluation method. Jingjing [18] theoretically constructed a theoretical model for improving the performance of industry university research collaborative innovation and analyzed the improvement path of industry university research collaborative innovation performance. Lu et al. [19] studied the influencing factors of collaborative innovation performance between universities and research institutes from the perspective of social networks. Qing and Chaohao [20] analyzed the elements of industry university research cooperation from the perspective of managers, proposed a performance evaluation system for industry university research cooperation innovation, and provided a comprehensive evaluation mathematical model based on fuzzy mathematics and interval mathematics.

The existing research on innovation and entrepreneurship education mainly focused on talent cultivation models and systems [21]. Pingzhang [22] led educational innovation with the concept of "exceeding limits" and integrated innovation and entrepreneurship education into the cultivation of innovative talents for graduate students. Guided by the concept of integrating science and education, Wei [23] explored the path of cultivating innovative talents through the deep integration of industry, academia, and research. The Automation major of Beijing University of Science and Technology established a system for strengthening the cultivation of three innovative abilities, and the practical results have been reported by mainstream media such as the official website of the Ministry of Education [24]. Xiang et al. [25] constructed a quality evaluation index system for innovation and entrepreneurship education in the field of health management in universities. Some scholars have also conducted research on artisan entrepreneurship and male entrepreneurship with military experience [26, 27]. Ullah et al. [28] studied the impact of the integration of green customers and suppliers on the green innovation performance of enterprises. Su et al. [29] studied the impact of servant leadership on employee service innovation behavior.

In summary, although the "2011 Plan" has emphasized the dominant position of universities in industry university research cooperation, the academic community mostly focuses on enterprises as the research object and center of research models for industry university research cooperation and pays more attention to the performance of enterprises. There is relatively little research on the performance of collaborative innovation in universities and even less research on combining collaborative innovation between schools and enterprises with innovation and entrepreneurship education. Based on the existing theoretical research on collaborative innovation among industry, university, and research institutions, combined with the laws and characteristics of school-enterprise cooperation, this article establishes a performance evaluation index system for collaborative innovation between schools and enterprises, focusing on universities. Based on the case of innovation and entrepreneurship education, this article combines the improved AHP and fuzzy comprehensive evaluation method to evaluate the performance of collaborative innovation between schools and enterprises. This article explores the path to improve the performance of collaborative innovation between schools and enterprises and provides theoretical reference for the evaluation of collaborative innovation performance between schools and enterprises and the practice of innovation and entrepreneurship education.

2. Construction of the Performance Evaluation Index System for School Enterprise Collaborative Innovation

2.1. Construction Principles. The establishment of an evaluation index system is the foundation of performance evaluation, which directly affects the objectivity and authenticity of performance evaluation. The establishment of a performance evaluation index system for collaborative innovation in school enterprise cooperation should not only follow the principles of systematicity, scientificity, foresight, independence, comparability, hierarchy, and operability [2] but also combine the current situation and specific practices of school enterprise cooperation to develop targeted evaluation indicators for the evaluation system and objects.

2.1.1. Combining Input, Output, and Process Indicators. Collaborative innovation in school enterprise cooperation refers to the investment of various innovative elements into cooperation and the realization of value appreciation through the process of collaboration and interaction. When establishing evaluation indicators, it is necessary to fully consider the influencing factors of the input, process, and output stages, reflecting the entire process of collaborative innovation. In the stage of collaborative innovation investment, in addition to considering the traditional investment of human, financial, and material resources from various parties in industry, academia, and research, evaluation factors such as university reputation and alliance experience should be added to reflect the leading role of universities in school enterprise cooperation. In the stage of collaborative innovation, evaluations are set up on the willingness and degree of action collaboration, resource matching, and sharing between the school and enterprise, fully reflecting the degree of collaboration between the school and enterprise in the collaborative innovation process and compensating for the lack of process performance evaluation indicators in traditional evaluations. In the stage of collaborative innovation output, on the basis of traditional technical innovation output indicators (such as the number of articles (including works) and the number of three patent authorizations) increase the evaluation indicators reflecting management innovation and enhance the level of collaborative innovation management.

2.1.2. Combining Explicit, Implicit, and Collaborative Indicators. Collaborative innovation between schools and enterprises, as a value creation activity centered on knowledge appreciation, requires the innovation subject to integrate various innovative resources and engage in in-depth communication and exchange on the basis of full collaboration. When evaluating performance, it is often not enough to only consider explicit performance that is easy to measure, such as technological achievements. It is also necessary to consider implicit performance and collaborative performance [1, 11]. When constructing the indicator system, this article takes into account implicit performance that is difficult to quantify, such as the degree of improvement in social reputation, the quality and level of research teams, as well as collaborative performance that reflects the degree of collaboration between innovation entities and the innovation process, such as communication and trust. Explicit, implicit, and collaborative performance indicators complement each other, reflecting the synergy of innovation entities at different levels and covering the output and process performance of collaborative innovation between schools and enterprises.

2.1.3. Combining Quantitative and Qualitative Indicators. Due to the ambiguity of qualitative indicator evaluation, the traditional performance evaluation places more emphasis on the use of quantitative indicators. However, in practice, there are more indicators that cannot be expressed quantitatively, such as social reputation improvement, organizational learning, and growth. These qualitative indicators are also important driving factors for school enterprise cooperation and are indispensable in performance evaluation. Most scholars [8, 9, 30, 31] suggest combining quantitative and qualitative indicators to construct a performance evaluation index system to reflect different information of cooperation and make performance evaluation more objective. This article, based on the characteristics of school enterprise cooperation and after weighing, determines 10 quantitative indicators such as the conversion rate of scientific and technological achievements, the number of scientific research funds, and 12 qualitative indicators such as alliance experience and university reputation when setting secondary indicators. By organically combining quantitative and qualitative evaluation indicators, a school enterprise cooperation collaborative innovation evaluation index system is constructed.

2.1.4. Combining Short-Term and Long-Term Indicators. Compared with traditional industry university research cooperation, collaborative innovation between schools and enterprises is a high-level form of industry university research cooperation, with broader and deeper cooperation content. On the basis of traditional industry university research cooperation focused on technological innovation, new product development, and other activities, both schools and enterprises pay more attention to long-term strategic coordination in order to have more in-depth communication and resource integration. Compared with traditional industry university research cooperation, it maintains for a longer time and is more manifested in collaborative research and joint establishment of entities. More and more scholars in performance evaluation are paying more attention to long-term indicators that play an important driving role in future performance [8, 30, 31]. This article combines long-term indicators (such as organizational learning and growth, social reputation, and improvement) with short-term indicators (such as city level and above achievement rewards and three types of patent authorizations) to comprehensively evaluate the long-term and short-term performance of school enterprise cooperation.

2.2. Performance Evaluation Index System. Based on the principles of constructing the abovementioned indicator system and referring to existing research results [3, 8–10], combined with the current practice and characteristics of collaborative innovation between schools and enterprises, and based on the input-process-output principle, a performance evaluation indicator system for collaborative innovation between schools and enterprises, including 3 primary indicators and 22 secondary indicators, has been constructed, as shown in Table 1.

3. Determination of the Weight of Performance Evaluation Indicators for School Enterprise Collaborative Innovation

3.1. Improved AHP. In the 1970s, American operations researcher T. L. Satty proposed AHP. AHP [1, 32] is a multi-objective decision-making method that combines qualitative and quantitative analysis and has been widely applied in many fields such as society, economy, and management. When using AHP for system analysis, human experience and judgment are used to classify various factors into levels and quantify them, and the advantages and disadvantages of decision-making schemes are ranked. A key step of AHP is to construct a judgment matrix with satisfactory consistency based on a certain discriminant scale. According to the eigenvector corresponding to the maximum eigenvalue of the matrix, the importance ranking vector and importance weight of each scheme are determined. However, in the actual decision-making process, it is often difficult to make decisions due to the judgment matrix not passing the consistency test, which brings great difficulties to the practical application of the AHP method. The fundamental reason for consistency check errors is the serious flaws in the traditional construction method of the judgment matrix. It solidifies the selected scale, causing previously differing candidate solutions to lose their differences during the comparison process. The judgment matrices constructed by the improved AHP [32, 33] using the scaling construction method are completely consistent, so there is no need for consistency testing and the sorting vectors are also easy to obtain. This improves the reliability of AHP decision-making and makes AHP easier to use. The steps for determining indicator weights using improved AHP are as follows:

Step 1: determination of scale values. Assuming there are n indicators, the subjective ranking determined based on the principle of undiminished importance is $x_1 \geq x_2 \geq x_3 \geq \ldots \geq x_n$. Two adjacent indicators x_i and x_{i+1} are compared, and the scale values t_i of x_i are determined according to the corresponding relationship of {equally important, slightly important, strongly important, obviously important, absolutely important} = {1.0, 1.2, 1.4, 1.6, 1.8}. The scale values $t_1, \mathrm{t}_2, \ldots, \mathrm{t}_{n-1}$ of all indicators can be obtained. According to the principle of importance transmission and equation (1), the relative scale value is calculated.

$$r_{\mathrm{ij}} = \begin{cases} 1, & i = j, \\ r_{\mathrm{ij}-1} t_{j-1}, & i < j, \\ \dfrac{1}{r_{\mathrm{ij}}}, & i > j. \end{cases} \tag{1}$$

In equation (1), r_{ij} is the scale value of the i-th indicator relative to the j-th indicator, $r_{ij} > 0$.

Step 2: construction of judgment matrix. Based on the relative scale value, the judgment matrix R is constructed.

$$R = \left[r_{\mathrm{ij}}\right]_{n\times n} = \begin{bmatrix} 1 & r_{12} & r_{13} & \cdots & r_{1j} & \cdots & r_{1n} \\ r_{21} & 1 & r_{23} & \cdots & r_{2j} & \cdots & r_{2n} \\ r_{31} & r_{32} & 1 & \cdots & r_{3j} & \cdots & r_{3n} \\ \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots \\ r_{i1} & r_{i2} & r_{i3} & \cdots & r_{\mathrm{ij}} & \cdots & r_{\mathrm{in}} \\ \vdots & \vdots & \vdots & & \vdots & \vdots & \\ r_{n1} & r_{n2} & r_{n3} & \cdots & r_{\mathrm{nj}} & \cdots & 1 \end{bmatrix}_{n\times n}. \tag{2}$$

Bring equation (1) into equation (2), the final judgment matrix is obtained.

$$R = \left[r_{\mathrm{ij}}\right]_{n\times n} = \begin{bmatrix} 1 & t_1 & t_1 t_2 & \cdots & \prod_{i=1}^{n-1} t_i \\ \dfrac{1}{t_1} & 1 & t_2 & \cdots. & \prod_{i=2}^{n-1} t_i \\ \dfrac{1}{t_1 t_2} & \dfrac{1}{t_2} & 1 & \cdots & \prod_{i=3}^{n-1} t_i \\ \vdots & \vdots & \vdots & & \vdots \\ \dfrac{1}{\prod_{i=1}^{n-1} t_i} & \dfrac{1}{\prod_{i=2}^{n-1} t_i} & \dfrac{1}{\prod_{i=3}^{n-1} t_i} & \cdots & 1 \end{bmatrix}_{n\times n}. \tag{3}$$

Table 1: Performance evaluation index system.

Target	Primary indicators	Secondary indicators	Unit
Performance evaluation of collaborative innovation in school enterprise cooperation	Input	Policy support intensity	Grade
		University reputation	Grade
		Number of municipal and above scientific research platforms	Individual
		Proportion of research funding from source enterprises	%
		Number of scientific research funds	Ten thousand yuan
		Alliance experience	Grade
		Number of scientific researchers	Individual
		Proportion of scientific research personnel with intermediate professional titles and above	%
	Process	Resource matching and sharing	Grade
		Willingness to cooperate and degree of action synergy	Grade
		Operating mechanism	Grade
		Communication and trust	Grade
		Respect for intellectual property rights	Grade
		Organizational learning and growth	Grade
	Produce	Rewards for achievements at or above the city level	Term
		The rate of technology transfer	%
		Number of patent authorizations	Term
		Improvement in the quality and level of research teams	Grade
		Number of articles (including works)	A piece of writing
		Promotion degree of collaborative innovation management	Grade
		Number of graduate students trained	People
		Improvement of social reputation	Grade

Step 3: calculation of indicator weights. Based on the judgment matrix and equation (4), the weights of each indicator are calculated.

$$\alpha_i = \frac{\sqrt[n]{\prod_{j=1}^{n} r_{\text{ij}}}}{\sum_{i=1}^{n} \sqrt[n]{\prod_{j=1}^{n} r_{\text{ij}}}}. \quad (4)$$

In equation (4), α_i is the weight of the i-th indicator, $\prod_{j=1}^{n} r_{ij}$ is the product of all elements in the i-th row of the judgment matrix R.

According to the abovementioned steps, the weight vector of the secondary indicator is represented by A_i $(i = 1, 2, 3)$, $A_i = (a_{i1}, a_{i2}, \ldots, a_{\text{in}})$. The first level indicator weight vector is represented by A, where $A = (a_1, a_2, a_3)$.

3.2. Calculation of Evaluation Index Weight. A survey is conducted on researchers, industry experts, and educators using a combination of online anonymous questionnaires and one-on-one questionnaires, collecting opinions from 40 experts nationwide. By summarizing and analyzing the questionnaire results, the ranking of each indicator and the scale values between adjacent indicators are determined. The ranking of the first level indicators is output = process > input, and the scale values between indicators are $t_1 = 1$, $t_2 = 1.2$. Based on the transitivity of importance, the judgment matrix R is determined according to equations (1)–(3).

$$R = \left[r_{\text{ij}}\right]_{n\times n} = \begin{bmatrix} 1 & 1 & 1.2 \\ 1 & 1 & 1.2 \\ \dfrac{1}{1.2} & \dfrac{1}{1.2} & 1 \end{bmatrix}. \quad (5)$$

According to formula (4), the weights of the primary indicators output, process, and input in the performance evaluation of collaborative innovation between schools and enterprises are 0.35, 0.35, and 0.30, respectively. The weight vector of the first level indicator is

$$A = (a_1, a_2, a_3) = (0.35, 0.35, 0.30). \quad (6)$$

The ranking of the secondary indicators of investment is policy support intensity = university reputation > number of municipal and above research platforms > proportion of research funds from source enterprises > number of research funds = alliance experience = number of research personnel > proportion of research personnel with intermediate professional titles or above. The scale values between indicators are $t_1 = 1$, $t_2 = 1.8$, $t_3 = 1.2$, $t_4 = 1.2$, $t_5 = 1$, $t_6 = 1$, and $t_7 = 1.4$. The ranking of the secondary indicators of the process is resource matching and sharing = willingness to cooperate and action collaboration > operating mechanism > communication, exchange, and trust = respect for intellectual property > organizational learning and growth. The scale values between the indicators are $t_1 = 1$, $t_2 = 1.2$, $t_3 = 1.2$, $t_4 = 1$, and $t_5 = 1.2$. The secondary indicators of output are ranked as follows: number of municipal and above achievement awards > conversion rate of scientific and technological achievements > number of three patent grants > quality and level improvement of scientific research teams > number of articles (including works) = level improvement of collaborative innovation management > number of graduate students trained = social reputation improvement. The scale values between indicators are $t_1 = 1.2$, $t_2 = 1.4$, $t_3 = 1.2$, $t_4 = 1.2$, $t_5 = 1$, $t_6 = 1.2$, and $t_7 = 1$. According to formulas (1)–(4), the weight vectors of the secondary indicator are as follows:

$$\begin{aligned} A_1 &= (0.22, 0.22, 0.13, 0.10, 0.09, 0.09, 0.09, 0.06), \\ A_2 &= (0.21, 0.21, 0.18, 0.14, 0.14, 0.12), \\ A_3 &= (0.22, 0.19, 0.14, 0.11, 0.09, 0.09, 0.08, 0.08). \end{aligned} \quad (7)$$

A_1, A_2, and A_3 are the secondary indicator weight vectors for input, process, and output, respectively. The weight of the performance evaluation indicators for school enterprise collaborative innovation in this article is consistent with the calculation results in references [2, 7, 9], which verifies the reliability and feasibility of the calculation results.

According to the weight calculation results, it can be seen that

(1) The output and process have a significant impact on the performance of collaborative innovation between schools and enterprises, with weights of 0.35, while the input weight is relatively small at 0.30, but the difference between the two is not significant. Further proof is that when evaluating the performance of collaborative innovation between schools and enterprises, the influencing factors of input, process, and output stages should be considered, fully reflecting the entire process of collaborative innovation between schools and enterprises.

(2) Among the 8 secondary indicators invested, the maximum weight of university reputation and policy support intensity is 0.22. University reputation, as a hidden resource, can provide universities with more competitive advantages in seeking external cooperation, thereby better carrying out innovation activities. Policy support can provide a good external environment for school enterprise cooperation.

(3) Among the six secondary indicators in the process, the weight of resource matching and sharing, cooperation willingness, and action synergy is relatively high at 0.21. This reflects the importance of both schools and enterprises fully leveraging their respective resource advantages and achieving collaborative innovation, while achieving the same goals and similar intentions.

(4) Among the eight secondary indicators of output, the number of awards for achievements at or above the municipal level and the conversion rate of scientific and technological achievements have a relatively high weight, with 0.22 and 0.19, respectively. This indicates that the output and marketization of high-

level achievements in school enterprise cooperation are receiving more and more attention, not just the quantity of scientific and technological achievements.

4. Performance Evaluation Model for School Enterprise Collaborative Innovation

The commonly used performance evaluation methods for school enterprise collaborative innovation include neural networks, factor analysis, and fuzzy comprehensive evaluation method [13, 14]. These methods provide some reference for the performance evaluation of school enterprise collaborative innovation, but each has its own advantages, disadvantages, and applicability. The training of neural networks requires a large amount of sample data, which is not easy to achieve in practice. The slow convergence speed of the network also greatly affects the efficiency of evaluation work, which is suitable for evaluating a single object. Factor analysis is the study of the internal dependencies between numerous variables using a few hypothetical variables to represent the basic data structure. It is suitable for dimensionality reduction processing of high-dimensional variables. The fuzzy comprehensive evaluation method mainly relies on the fuzzy mapping from the indicator set of the evaluated object to the evaluation set for evaluation. When sample data are difficult to obtain or there is a fixed expert review panel and the evaluation of experts is consistent, using fuzzy comprehensive evaluation is a better evaluation method. Collaborative innovation between schools and enterprises is a complex system engineering. According to the indicator system in Table 1, many qualitative indicators in the evaluation system are fuzzy, interrelated, and mutually constrained. Comprehensive weighing is required in the evaluation. The fuzzy comprehensive evaluation method is more suitable for evaluating the performance of collaborative innovation between schools and enterprises. The fuzzy comprehensive evaluation method is established on the basis of fuzzy mathematics and interval mathematics, which can organize the relationships between various indicators and quantitatively process qualitative indicators.

4.1. First Level Fuzzy Comprehensive Evaluation. According to Table 1, the performance of collaborative innovation between schools and enterprises is represented by U, and the first level and secondary evaluation indicators are represented by U_i and U_{ij}, respectively. Therefore, $U = \{U_1, U_2, U_3\}$ = {Input, Process, Output}, $U_1 = \{U_{11}, U_{12}, U_{13}, U_{14}, U_{15}, U_{16}, U_{17}, U_{18}\}$ = {Policy support intensity, university reputation, number of municipal and above research platforms, proportion of research funds from source enterprises, number of research fees, alliance experience, number of research personnel, proportion of research personnel with intermediate professional titles or above}, $U_2 = \{U_{21}, U_{22}, U_{23}, U_{24}, U_{25}, U_{26}\}$ = {Resource matching and sharing degree, cooperation willingness and action synergy degree, operating mechanism, communication and trust degree, intellectual property respect, organizational learning and growth}, $U_3 = \{U_{31}, U_{32}, U_{33}, U_{34}, U_{35}, U_{36}, U_{37}, U_{38}\}$ = {Rewards for achievements at or above the city level, the rate of technology transfer, Number of patent authorizations, Improvement in the quality and level of research teams, Number of articles (including works), Promotion degree of collaborative innovation management, Number of graduate students trained, Improvement of social reputation}.

If the evaluation level is represented by V, then V = {V1, V2, V3, V4, V5} = {Excellent, Good, Medium, Qualified, Unqualified} = {1.0, 0.8, 0.6, 0.4, 0.2}. By evaluating the secondary evaluation indicators shown in Table 1, the evaluation levels of each indicator are determined, and a fuzzy relationship between evaluation indicators and evaluation levels is established. The evaluation of indicator U_i is denoted as $M_{ij} = [m_{ijl}, m_{ij2}, m_{ij3}, m_{ij4}, m_{ij5}]$, and a fuzzy evaluation matrix M_i is constructed for indicator U_i.

$$M_i = \left[m_{ij1}, m_{ij2}, m_{ij3}, m_{ij4}, m_{ij5}\right] = \begin{bmatrix} m_{i11} & m_{i12} & m_{i13} & m_{i14} & m_{i15} \\ m_{i21} & m_{i22} & m_{i23} & m_{i24} & m_{i25} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ m_{in1} & m_{in2} & m_{in3} & m_{in4} & m_{in5} \end{bmatrix}. \tag{8}$$

In this article, $M_1, M_2,$ and M_3 are the first level fuzzy evaluation matrices for the input, process, and output of the first level indicators.

$$B_i = A_i \bullet M_i = (a_{i1}, a_{i2}, \cdots, a_{in}) \begin{bmatrix} m_{i11} & m_{i12} & m_{i13} & m_{i14} & m_{i15} \\ m_{i21} & m_{i22} & m_{i23} & m_{i24} & m_{i25} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ m_{\text{in}1} & m_{\text{in}2} & m_{\text{in}3} & m_{\text{in}4} & m_{\text{in}5} \end{bmatrix} = (b_{i1}, b_{i2}, b_{i3}, b_{i4}, b_{i5}). \tag{9}$$

In equation (9), A_i is the weight vector of the secondary indicator determined according to equation (4). B_i is the fuzzy comprehensive evaluation vector corresponding to the first level indicator U_i. In this article, B_1, B_2, and B_3 are fuzzy comprehensive evaluation vectors for the input, process, and output of the first level indicators.

4.2. Second Level Fuzzy Comprehensive Evaluation. Based on the determined first level fuzzy comprehensive evaluation vector B_i and the first level indicator weight vector A, a second-level fuzzy comprehensive evaluation model should be constructed.

$$R_{\text{target}} = A \bullet [B_1, B_2, B_3]^T = (a_1, a_2, a_3) \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{21} & b_{32} & b_{33} & b_{34} & b_{35} \end{bmatrix}. \tag{10}$$

In formula (10), R_{target} is the fuzzy comprehensive evaluation vector of target U, reflecting the comprehensive evaluation result of the collaborative innovation performance between schools and enterprises.

5. Case Analysis of Entrepreneurship and Innovation Education Practice

5.1. Project Overview. The Bridge and Tunnel Engineering Research Institute of a certain university in Henan Province has carried out extensive collaborative innovation between schools and enterprises in the field of bridge and tunnel engineering, in combination with the major construction needs of national high-speed railways and expressways. Good and stable cooperative relationships have been established with multiple state-owned enterprises, and the engineering practice base for cultivating innovation and entrepreneurship abilities of students majoring in civil engineering has been improved. Over the past 10 years, more than 40 collaborative innovation projects have been carried out between schools and enterprises, with some representative projects shown in Table 2. More than 100 students and over 1000 engineering and technical talents have been trained. It has set a model for universities to carry out entrepreneurship and innovation education. This article takes the project “Research on Key Technologies of Tunnel Construction under Complex Geological Conditions in Southwest Yunnan” as the research object and combines the improved AHP and fuzzy comprehensive evaluation method to evaluate the performance of collaborative innovation between schools and enterprises.

The China Laos Railway is one of the representative projects in China’s “the Belt and Road” strategy. The Yumo railway section in Yunnan Province is located in the southwest of Yunnan Province. Karst landforms are widely distributed in this area. Large deformation of soft rock, bedding bias, filling of karst cavities, water inrush, and mud inrush and other adverse geological conditions have serious impacts on tunnel construction. The school enterprise collaborative innovation project “Research on Key Technologies for Tunnel Construction under Complex Geological Conditions in the Southwest Yunnan Region” has provided technical support for the smooth implementation of the Yumo Railway section construction in Yunnan. Figures 1 and 2 show the on-site research and discussion of the research group members during the project implementation process. On December 3, 2021, the whole China Laos Railway has been opened to traffic. Figure 3 shows the scene where the members of the research team participate in the opening ceremony of the China Laos Railway online. More than 30 scientific researchers participated in the project, and each member of the research group and graduate student stayed on site for about 1 year. Based on the project, we have produced over 20 research papers, patents, and other achievements. We have trained 6 graduate students and over 100 engineering and technical personnel. The effect of innovation and entrepreneurship education is significant.

5.2. Fuzzy Comprehensive Evaluation. According to the indicator system shown in Table 1, 25 questions are designed, each of which is divided into 5 levels. A “one-on-one” questionnaire survey is conducted on a total of 40 participants in the project, including researchers, managers, technicians, and graduate students. Quantitative indicators are evaluated based on the experience of experts and combined with the numerical values of various indicators in the past three years, while qualitative indicators are evaluated by experts based on their own knowledge and experience. After organizing and summarizing the basic data obtained from the questionnaire survey, fuzzy comprehensive evaluation data is obtained. Table 3 shows the fuzzy

Table 2: Information table for school enterprise collaborative innovation projects.

Serial number	Entry name	Project cycle	Cooperation company
1	Research on construction technology of continuous beam-arch in high earthquake fault zone	2018–2022	China Railway 15th Bureau Group Co., Ltd.
2	Research on key construction techniques and applications of asphalt pavement in high altitude cold regions	2017–2019	China Communications Second Highway Engineering Bureau Co., Ltd.
3	Construction technology for prefabrication and assembly of segmental beams of ultrasmall curve radius and variable cross section urban light rail	2015–2017	China Railway 15th Bureau Group Co., Ltd.
4	Research on key construction techniques of water droplet steel structure main tower cable-stayed bridge	2014–2017	China Railway 15th Bureau Group Co., Ltd.
5	Key construction technology of cast-in-place box girder and variable section continuous box girder bridge with double girders juxtaposed on Zhengzhou – Jinan intercity railway	2014–2016	China Railway 15th Bureau Group Co., Ltd.
6	Key technologies for construction of deep water pile foundations and high pile platform-suspended box cofferdam in karst geology	2013–2015	China Railway 15th Bureau Group Co., Ltd.
7	Research and development of key Technologies for cable-stayed bridges with composite box girders with oblique single towers and waveform steel webs	2012-2013	China Railway 15th Bureau Group Co., Ltd.
8	Research and development of key technologies for the combination section of steel concrete mixed box girders of Weihe river bridge	2012–2014	China Railway 15th Bureau Group Co., Ltd.
9	Research and development of key technologies for large-span cable-stayed bridges in marine muddy areas	2018–2021	China Railway 15th Bureau Group Co., Ltd.
10	Research on construction technology of plateau frozen soil	2018–2021	China Communications Second Highway Engineering Bureau Co., Ltd.
11	Research on key technologies for tunnel construction under complex geological conditions in southwest Yunnan	2018–2021	China Railway 15th Bureau Group Co., Ltd.
12	Research on construction technology and safety risk control of Luoyang Longmen station comprehensive transportation Hub	2021-2022	China Railway 15th Bureau Group Co., Ltd.
13	Research and development of Composite disaster prevention and construction technology for deep buried karst gas outburst extra long tunnel	2021–2023	China Railway 15th Bureau Group Co., Ltd.
14	Research on safety assessment and disaster warning of geotechnical engineering	2021–2024	China Railway 15th Bureau Group Co., Ltd.
15	Research and development of construction technology for micropile foundation pit support of bridges in complex environments	2021–2023	China Communications Second Highway Engineering Bureau Co., Ltd.

Figure 1: Field investigation.

Figure 2: Topic discussion.

Figure 3: Opening ceremony of China Laos railway.

comprehensive evaluation data of the project “Research on Key Technologies for Tunnel Construction under Complex Geological Conditions in Southwest Yunnan.”

According to the data in Table 3 and formula (8), the first level fuzzy evaluation matrices $R_1, R_2,$ and R_3 for the input, process, and output of the first level evaluation indicators are determined.

$$R_1 = \begin{bmatrix} 0.15 & 0.45 & 0.25 & 0.15 & 0 \\ 0.25 & 0.60 & 0.05 & 0.10 & 0 \\ 0.25 & 0.60 & 0.10 & 0.05 & 0 \\ 0.30 & 0.55 & 0.10 & 0.05 & 0 \\ 0.35 & 0.50 & 0.10 & 0.05 & 0 \\ 0.40 & 0.55 & 0.025 & 0.025 & 0 \\ 0.35 & 0.60 & 0.025 & 0.025 & 0 \\ 0.25 & 0.60 & 0.10 & 0.05 & 0 \end{bmatrix},$$
$$R_2 = \begin{bmatrix} 0.30 & 0.60 & 0.05 & 0.05 & 0 \\ 0.40 & 0.55 & 0.025 & 0.025 & 0 \\ 0.15 & 0.45 & 0.30 & 0.10 & 0 \\ 0.35 & 0.60 & 0.025 & 0.025 & 0 \\ 0.25 & 0.65 & 0.05 & 0.05 & 0 \\ 0.30 & 0.60 & 0.05 & 0.05 & 0 \end{bmatrix}, \quad (11)$$
$$R_3 = \begin{bmatrix} 0.35 & 0.55 & 0.05 & 0.05 & 0 \\ 0.20 & 0.40 & 0.30 & 0.10 & 0 \\ 0.45 & 0.50 & 0.025 & 0.025 & 0 \\ 0.35 & 0.55 & 0.05 & 0.05 & 0 \\ 0.45 & 0.50 & 0.025 & 0.025 & 0 \\ 0.35 & 0.55 & 0.05 & 0.05 & 0 \\ 0.35 & 0.60 & 0.025 & 0.025 & 0 \\ 0.30 & 0.60 & 0.05 & 0.05 & 0 \end{bmatrix}.$$

According to formula (9), the fuzzy comprehensive evaluation vectors $B_1, B_2,$ and B_3 for the input, process, and output of the first level indicators are obtained.

$$\begin{aligned} B_1 &= A_1 \bullet R_1 = (0.2645, 0.5485, 0.1085, 0.0785, 0), \\ B_2 &= A_2 \bullet R_2 = (0.2940, 0.5695, 0.0863, 0.0503, 0), \quad (12) \\ B_3 &= A_3 \bullet R_3 = (0.3405, 0.5180, 0.0898, 0.0518, 0). \end{aligned}$$

According to formula (10), the fuzzy comprehensive evaluation vector R_{target} for the collaborative innovation performance of school enterprise cooperation is obtained.

$$R_{\text{target}} = A \bullet [B_1, B_2, B_3]^T = (0.2977, 0.5467, 0.0951, 0.0606, 0). \quad (13)$$

Table 3: Fuzzy comprehensive evaluation data table.

Primary indicators	Weight	Secondary indicators	Weight	Evaluation level				
				Excellent	Good	Medium	Qualified	Unqualified
Input	0.35	Policy support intensity	0.22	0.15	0.45	0.25	0.15	0
		University reputation	0.22	0.25	0.60	0.05	0.10	0
		Number of municipal and above scientific research platforms	0.13	0.25	0.60	0.10	0.05	0
		Proportion of research funding from source enterprises	0.10	0.30	0.55	0.10	0.05	0
		Number of scientific research funds	0.09	0.35	0.50	0.10	0.05	0
		Alliance experience	0.09	0.40	0.55	0.025	0.025	0
		Number of scientific researchers	0.09	0.35	0.60	0.025	0.025	0
		Proportion of scientific research personnel with intermediate professional titles and above	0.06	0.25	0.60	0.10	0.05	0
Process	0.35	Resource matching and sharing	0.21	0.30	0.60	0.05	0.05	0
		Willingness to cooperate and degree of action synergy	0.21	0.40	0.55	0.025	0.025	0
		Operating mechanism	0.18	0.15	0.45	0.30	0.10	0
		Communication and trust	0.14	0.35	0.60	0.025	0.025	0
		Respect for intellectual property rights	0.14	0.25	0.65	0.05	0.05	0
		Organizational learning and growth	0.12	0.30	0.60	0.05	0.05	0
Output	0.30	Rewards for achievements at or above the city level	0.22	0.35	0.55	0.05	0.05	0
		The rate of technology transfer	0.19	0.2	0.4	0.3	0.1	0
		Number of patent authorizations	0.14	0.45	0.5	0.025	0.025	0
		Improvement in the quality and level of research teams	0.11	0.35	0.55	0.05	0.05	0
		Number of articles (including works)	0.09	0.45	0.5	0.025	0.025	0
		Promotion degree of collaborative innovation management	0.09	0.35	0.55	0.05	0.05	0
		Number of graduate students trained	0.08	0.35	0.6	0.025	0.025	0
		Improvement of social reputation	0.08	0.3	0.6	0.05	0.05	0

According to the evaluation level set V = {Excellent, Good, Medium, Qualified, Unqualified} = {1.0, 0.8, 0.6, 0.4, 0.2}, the evaluation result value is between 1 and 0.2; the closer to1, the better the performance, and the closer to 0.2, the worse the performance.

$$S = R_{\text{target}} \bullet V^T = (0.2977, 0.5467, 0.0951, 0.0606, 0)(1.0, 0.8, 0.6, 0.4, 0.2)^T \approx 0.82. \quad (14)$$

The performance evaluation value of collaborative innovation in this school enterprise cooperation is 0.82. Similarly, the performance evaluation values of 3 primary indicators and 22 secondary indicators are calculated, as shown in Table 4. The fuzzy comprehensive evaluation values in this article are consistent with the calculation results in references [7, 9], which verifies the reliability and feasibility of the calculation results.

5.3. Analysis of Calculation Results

(1) The collaborative innovation performance evaluation value of the school enterprise cooperation project for the "Research on Key Technologies of Tunnel Construction under Complex Geological Conditions in Southwest Yunnan" project is 0.82.29.76% of the evaluation expert group judges the performance of the project as "excellent," while 54.67% believes it to be "good." The overall state of the school enterprise cooperation project is good. Both parties in school enterprise cooperation have the same goals and strong willingness to cooperate. They are able to fully leverage their respective advantages and make full use of existing resources. They can not only fulfill their respective responsibilities but also cooperate fully, ultimately achieving good collaborative innovation performance. The cooperation between schools and enterprises has created a favorable atmosphere for collaborative innovation, gradually entering a virtuous cycle and achieving good results.

(2) The evaluation value of the indicator for collaborative innovation input in school enterprise cooperation is 0.80, which has a relatively small contribution to the performance of collaborative innovation in school enterprise cooperation. In the secondary indicators, the alliance experience and the number of scientific researchers have higher evaluation values, with values of 0.87 and 0.86, respectively. This indicates that in the long-term collaborative innovation between schools and enterprises, the Bridge and Tunnel Engineering Research Institute has accumulated rich alliance experience, which can better manage cooperation activities, cultivate scientific research teams, and obtain high recognition from cooperative enterprises. The lowest evaluation value of policy support intensity is 0.72, indicating that the policy support system for collaborative innovation between schools and enterprises is not perfect enough, and the external environment for collaborative innovation between schools and enterprises needs to be optimized.

(3) The evaluation value of the collaborative innovation process indicator is 0.82, slightly higher than the evaluation value of the collaborative innovation input indicator. Analyzing the secondary indicators, it can be seen that the evaluation values of the willingness to cooperate and degree of action synergy, communication, and trust are relatively high, with values of 0.87 and 0.86, respectively. This indicates that both parties in school enterprise cooperation have a strong willingness to trust each other, communicate smoothly, and work together to ensure the smooth implementation of the project according to the predetermined plan. However, the evaluation value of the operational mechanism indicator is relatively low at 0.73, indicating that the operational mechanism of collaborative innovation between schools and enterprises still needs to be improved.

(4) The highest evaluation value of the indicators for collaborative innovation output is 0.83, and the evaluation values for number of patent authorizations, number of articles (including works), and number of graduate students trained are 0.88, 0.88, and 0.86, respectively. However, the rate of technology transfer is relatively low, with an evaluation value of only 0.74, indicating that some research achievements are not suitable for market demand and cannot be converted into expected product returns. Both schools and enterprises cannot achieve higher-level cooperation, which is also a common problem in collaborative innovation between schools and enterprises.

5.4. Suggestions for Improving Collaborative Innovation between Schools and Enterprises

(1) With the development of China's economy and the increasing awareness of cooperation and innovation between schools and enterprises, local governments at all levels have increased their input in collaborative innovation between schools and enterprises. However, the policy support system for collaborative innovation between schools and enterprises is still incomplete and requires a long period of accumulation. Local governments should establish and improve policies to encourage technology brokers

Table 4: Performance evaluation value table.

Evaluating indicator	Evaluation value
Input	0.80
Process	0.82
Output	0.83
Policy support intensity	0.72
University reputation	0.80
Number of municipal and above scientific research platforms	0.81
Proportion of research funding from source enterprises	0.82
Number of scientific research funds	0.83
Alliance experience	0.87
Number of scientific researchers	0.86
Proportion of scientific research personnel with intermediate professional titles and above	0.81
Resource matching and sharing	0.83
Willingness to cooperate and degree of action synergy	0.87
Operating mechanism	0.73
Communication and trust	0.86
Respect for intellectual property rights	0.82
Organizational learning and growth	0.83
Rewards for achievements at or above the city level	0.84
The rate of technology transfer	0.74
Number of patent authorizations	0.88
Improvement in the quality and level of research teams	0.84
Number of articles (including works)	0.88
Promotion degree of collaborative innovation management	0.84
Number of graduate students trained	0.86
Improvement of social reputation	0.83

and intermediary service institutions as soon as possible, improve the level of specialized services for school enterprise cooperation, and further implement the issue of special funds for school enterprise cooperation, fully leveraging the external environmental role of school enterprise cooperation and collaborative innovation.

(2) Due to objective reasons such as the incomplete market economy system, incomplete legal system, and late start of industry university research cooperation, the operational mechanism of collaborative innovation between schools and enterprises has not yet formed, which greatly hinders the improvement of the performance level of collaborative innovation between schools and enterprises. Under the guidance and coordination of the government, with universities and enterprises as the main body, macro control mechanisms, incentive mechanisms, technological achievement flow mechanisms, and distribution systems should been established to ensure the smooth implementation of collaborative innovation between schools and enterprises.

(3) As one of the main subjects of collaborative innovation between universities and enterprises, universities pay more attention to scientific research innovation and talent cultivation. Economic awareness and market concepts are not yet in place, and there is less market demand for results. In addition, the immature market environment for results transformation hinders the marketization of innovative results. Universities should further transform their thinking, grasp market changes and demands, and make innovative achievements more meaningful and promising in the market. At the same time, it is necessary to accelerate the establishment of information-based trading platforms with the government or associations as the main body, establish sound market trading mechanisms and technology market norms, and adopt measures such as technology transfer and joint redevelopment to accelerate the diffusion of innovative achievements.

6. Conclusion

Based on the characteristics of school enterprise cooperation and the input-process-output principle, the article constructs a performance evaluation index system for collaborative innovation in school enterprise cooperation. Using improved AHP, the weights of 25 evaluation indicators are calculated. The performance evaluation value of school enterprise collaborative innovation projects is calculated using the fuzzy comprehensive evaluation method. The comprehensive evaluation value of the entrepreneurship and innovation education case is 0.82, indicating that the project is in good condition as a whole. The evaluation values of seven secondary indicators are all above 0.86. This indicates that the effectiveness of entrepreneurship and innovation education is significant. However, the evaluation values of the three secondary indicators, including policy support, operational mechanism, and conversion rate of scientific and technological achievements, are relatively low. Therefore, we should optimize the external environment for school enterprise cooperation, establish and improve operational mechanisms, change concepts, and accelerate the marketization of innovation achievements to enhance the efficiency of collaborative innovation between universities and enterprises. The article innovatively combines the school-enterprise collaborative innovation performance evaluation with innovation and entrepreneurship education, providing a new perspective for this kind of research. The results of performance evaluation point out the direction for both the university and the enterprise to improve the efficiency of collaborative innovation, and provide a theoretical basis for the government to optimize the external environment and the implementation of policies. There are many factors affecting the performance of school-enterprise collaborative innovation. This article focuses on the evaluation results of innovation and entrepreneurship education cases, refers to the results of literature research, and puts forward suggestions to improve performance. Its limitation lies in that it only selects 3 first-level indicators and 22 second-level indicators to carry out performance evaluation research and innovation and entrepreneurship education practice based on the previous projects of the bridge and tunnel engineering research institute of a certain university in Henan province and draws corresponding conclusions. Due to the limitations of project conditions in the selection of evaluation indicators, it is only applicable to the evaluation of school-enterprise collaborative innovation and entrepreneurship education of engineering class but not to the performance evaluation of all school-enterprise cooperation projects. When applying the ideas and methods in this article to evaluate the performance of other projects, the evaluation indicator system should be adjusted according to the actual situation of the project. In future research, based on collecting more cases of school enterprise collaborative innovation, the focus should be on exploring the challenges encountered in carrying out innovation and entrepreneurship education through school enterprise collaborative innovation in order to provide more universal solutions for innovation and entrepreneurship education.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

We thank all authors for their assistance with this research. This work was supported by the National Natural Science Foundation of China (grant number U1604135); the Key Scientific Research Project of China Railway 11th Bureau Group Co., Ltd. (grant number 18-AII-02); the Key Scientific Research Project of China Railway 15th Bureau Group Co., Ltd. (grant number 2019C51); and the Henan Province Higher Education Teaching Reform Research and Practice Project (grant numbers 2021SJGLX131 and 2021SJGLX387).

References

[1] S. U. N. Shanlin, "The theory and application research of the performance evaluation of Industry University Research institution collaborative innovation projects," *JIANG Su: Nanjing University of Aeronautics and Astronautics*, 2017.

[2] J. I. N. Furong, "Luo Shougui. Researching on the performance evaIuation index system of industry-university-research institute collaboration," *Scientific Management Research*, vol. 27, no. 3, pp. 43–46, 2009, 68.

[3] Z. H. O. U. Xiaoyang and W. A. N. G. Yuyun, "A literature review on the performance evaluation of industry-university Collaborative Innovation," *Scientific Management Research*, vol. 34, no. 11, pp. 45–49, 2014.

[4] S. H. I. Weiping, "Current situation and countermeasures of innovation and entrepreneurship education empowering high quality development of vocational education—analysis of the winning results of the 2022 Vocational Education National Teaching Achievement Award with the theme of Employment and Entrepreneurship," *Chinese Vocational and Technical Education*, vol. 27, pp. 13–19, 2023.

[5] R. U. A. N. Pingzhang, D. O. N. G. Hui, and L. I. U. Xu, "Innovation and entrepreneurship education for all: why is it possible and how is it feasible," *Journal of East China Normal University*, vol. 41, no. 9, pp. 100–111, 2023.

[6] Y. I. N. Jinrong, W. U. Weidong, and Ren Congjing, "The difficulties, measures, and prospect of the lntension-type development of innovation and entrepreneurship education in universities–based on the exploration and practice of innovation and entrepreneurship education in zhejiang university for 20 years," *Research in Higher Education of Engineering*, vol. 3, pp. 150–154, 2023.

[7] Y. A. N. Ying and Y. A. N. Tao, "Analysis on collaborative mechanism of entrepreneurship and innovation education in universities based on synergetic theory," *Higher Education Exploration*, vol. 11, pp. 108–113, 2023.

[8] W. A. N. G. Hao and H. A. N. G. Yaoming, "A renew on the studies of industry-university institute collaboration performance evaluafion," *Scientific Management Research*, vol. 11, pp. 56–61, 2011.

[9] C. A. O. Jing, F. A. N. Decheng, and T. A. N. G. Xiaoxu, "Research on performance evaluation of technological innovation combined with industry, university and research," *Science & Technology Progress and Policy*, vol. 4, pp. 114–118, 2010.

[10] X. I. N. G. Meihua and W. A. N. G. Weiwei, "The performance evaluation on industry-university-research collaborative innovation of agricultural enterprises based on fuzzy integral method," *Hubei Agricultural Sciences*, vol. 56, no. 24, pp. 4911–4915, 2017.

[11] S. U. N. Shanlin and P. E. N. G. Can, "The performance evaluation index system research of I-U-R collaborative innovation project," *Scientific Management Research*, vol. 37, no. 4, pp. 89–95, 2017.

[12] L. I. Leiming, Y. U. Yue, and Liu Bingquan, "Study on industry-university-research collaborative innovation performance evaluation of Qingdao based on AHP-ENTROPR methed," *Scientific Management Research*, vol. 15, p. 49, 2014.

[13] L. U. O. Hongyun, L. I. N. Xiangyi, and W. A. N. G. Lei, "Evaluation on innovating of performance industry university

research collaborative knowledge innovation system," *Journal of Modem Infomtion*, vol. 35, no. 2, pp. 8–11, 2015.
[14] Y. A. O. Zhaochao, *Evaluation of the Efficiency of Industry university Research Cooperration in Henan Province*, North China University of Water Resources and Electric power, Zhengzhou, China, 2013.
[15] Z. H. O. U. Guangliang, Z. H. A. O. Congyu, and C. H. E. N. Yu, "Performance evaluation and spatial pattern analysis of industrv-universitv-research collaborative innovation in China—based on two-stage DEA and malmquist index," *Journal of Xinyang Normal University Natural Science Edition*, vol. 35, no. 2, pp. 217–223, 2022.
[16] W. A. N. G. Bangjun and W. U. Yanfang, "Evaluation research on performance of regional cooperative innovation based on factor analysis method," *Scientific Management Research*, vol. 38, no. 1, pp. 66–71, 2018.
[17] G. U. O. Zhaohui and L. I. Yongzhou, "Mechanism and performance appraisal on knowledge transfer in industry university collaboration," *Technical Economy and Management Research*, vol. 6, pp. 39–43, 2013.
[18] D. U. A. N. Jingjing, "Research on the path to improve the performance of industry university research collaborative innovation—a theoretical analysis framework," *Inner Mongolia Social Sciences*, vol. 35, no. 2, pp. 119–123, 2014.
[19] C. H. A. N. G. Lu, W. A. N. G. Xuli, and F. U. Zhengping, "The factors which influence collaborative innovation performance of universifies and academic insfitutions based on social network analysis," *Scientific Management Research*, vol. 39, no. 14, pp. 100–108, 2019.
[20] Y. A. N. Qing and Z. H. A. N. G. Chaohao, "Research on fuzzy comprehensive performance evaluation of enterprise-university-research institute cooperation innovation," *Technology and Economy*, vol. 26, no. 1, pp. 75–79, 2013.
[21] L. I. U. Xiuqing, G. E. Wenqing, and L. I. Bo, "Reform and practice of the new engineering talent training model based on ability based training," *China University Teaching*, vol. 11, pp. 30–37, 2023.
[22] R. U. A. N. Pingzhang, "Practical exploration of cultivating innovative talents for graduate students under the guidance of the beyond limit concept," *Degree and Graduate Education*, vol. 11, pp. 9–14, 2023.
[23] L. I. U. Wei, "Training path of the innovative talents in universities based on the strategy of strengthening the country with talents," *Modern educational management*, vol. 10, pp. 82–93, 2023.
[24] L. I. Qing, C. U. I. Jiarui, and Y. A. N. G. Xu, "Construction and implementation of automation enhanced cultivating system for creative-innovation-entrepreneurship competences," *Research in Higher Education of Engineering*, vol. 4, pp. 171–175, 2023.
[25] Z. H. A. N. G. Xiang, Z. H. A. N. G. Lin, and D. O. N. G. Linyu, "Research on construction of indicator system of quality Evaluation of innovation and entrepreneurship education for health service management specialty in universities," *Medicine in Society*, vol. 35, no. 7, pp. 81–86, 2022.
[26] R. Yi, S. Liu, and B. Lyu, "A bibliometric and visualization analysis of Artisan entrepreneurship," *Technology Analysis & Strategic Management*, pp. 1–15, 2023.
[27] W. A. N. G. Haojun, W. A. N. G. Ying, and L. Y. U. Bei, "Military experience and individual entrepreneurship-imprinting theory perspective: empirical evidence from China," *Sage Open*, vol. 13, pp. 1–17, 2023.
[28] S. Ullah, T. Ahmad, B. Lyu, A. Sami, M. Kukreti, and A. Yvaz, "Integrating external stakeholders for improvement in green innovation performance: role of green knowledge integration capability and regulatory pressure," *International Journal of Innovation Science*, 2023.
[29] W. Su, B. Lyu, H. Chen, and Y. Zhang, "How does servant leadership influence employees' service innovative behavior? The roles of intrinsic motivation and identification with the leader," *Baltic Journal of Management*, vol. 15, no. 4, pp. 571–586, 2020.
[30] S. Philbin, "Measuring the performance of research collaborations," *Measuring Business Excellence*, vol. 12, no. 3, pp. 16–23, 2008.
[31] U. Johanson, M. Mårtensson, and M. Skoog, "Measuring to understand intangible performance drivers," *European Accounting Review*, vol. 10, no. 3, pp. 407–437, 2001.
[32] H. U. A. N. G. Decai and Z. H. E. N. G. Herong, "Scale-extending method for constructing judgment matrix in the analytic hierarchy process," *Systems Engineering*, vol. 1, pp. 105–109, 2003.
[33] L. I. U. Xiaoyue, Y. A. N. G. Wei, and Z. H. A. N. G. Xuemei, "Rockburst prediction of multi-dimensional cloud model based on improved hierarchical analytic method and critic method," *Journal of Hunan University*, vol. 48, no. 2, pp. 118–124, 2021.