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Quality Evaluation of Innovation and Entrepreneurship Education in Colleges and Universities Based on CIPP Model and AHP

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Abstract. Assessing the quality of education related to innovation and entrepreneurship in higher education institutions facilitates the identification and analysis of issues that arise during the process of developing these skills, as well as the advancement of the effectiveness of this process. Based on the CIPP model introduction, this paper attempts to build an index system from four perspectives: context evaluation, input evaluation, process evaluation and product evaluation. The analytic hierarchy process (AHP) is then used to determine the index weights, producing three primary and six subsidiary indicators that have a major influence on how well innovation and entrepreneurship education are taught at colleges and universities, among other things. Lastly, based on these viewpoints, enhancement strategies for the teaching of innovation and entrepreneurship in colleges and universities are suggested. To serve as a guide for enhancing the standard of entrepreneurship and innovation education in colleges and institutions.

Keywords. Innovation and entrepreneurship education; quality evaluation; CIPP; AHP

1. Introduction

Innovation and entrepreneurship education should undoubtedly be incorporated into the overall talent development process, according to the State Council's "Implementation Opinions on Deepening Innovation and Entrepreneurship Education Reform in Higher Education Institutions" (GUOBANFA [2015] No. 36) [1]. Higher education institutions not only have the function of creating a series of systems of knowledge but also can cultivate a group of innovative and entrepreneurial talents through the innovation and entrepreneurship education system, in order to continuously improve the innovation economy driving force. Evaluation is the process of evaluating objective objects based on predetermined standards and assigning values based on how well the object satisfies the subject's demands. Values and evaluation objectives form the cornerstone of innovation and entrepreneurship education. These are evaluated through the application of realistic and scientific methodologies in order to gather data and offer feedback for the advancement of innovation and entrepreneurship education as well as to continuously

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raise the bar for decision-making procedures and innovation and entrepreneurship education. Colleges and universities should strive to develop and enhance entrepreneurial consciousness, innovation spirit, and innovation and entrepreneurship as the ultimate aim of implementing innovation and entrepreneurship education evaluation. To that purpose, we must utilize indicators of the operation state of innovation and entrepreneurship education in colleges and universities, among other things, to assess the development and effectiveness of innovation and entrepreneurship education in each college and university. As a result, it provides management with information and comments on how to improve teaching methodologies, the environment in which innovation and entrepreneurship are taught, and the education of innovation and entrepreneurship [2-3].

Numerous studies have investigated the problems plaguing innovation and entrepreneurship education in China. Chen (2020) revealed that teachers lacked the experience and training required for entrepreneurship [1]. Xia (2021) argued that excessive theoretical teaching failed to provide students with practical skills [4]. Although these studies identify important issues, a comprehensive and systematic evaluation of the overall quality of entrepreneurship education programs is still lacking. To fill this gap, this paper introduces the CIPP evaluation model as an effective framework for assessing the context, inputs, processes, and outputs of innovation and entrepreneurship education in higher education. The CIPP model was originally proposed by Stufflebeam (1971) and has been widely used in educational program evaluation (Wei et al., 2019; Pang, 2021) [5-6]. However, there are relatively few studies using CIPP to evaluate the quality of entrepreneurship education. This study uses the CIPP model to create a more complete and objective evaluation system as well as a reliable evaluation tool to assist the ongoing improvement of innovation and entrepreneurship education in China's universities.

2. Overview of CIPP Model and AHP

2.1. CIPP Model

The CIPP model is a management-oriented model developed by Daniel L. Stufflebeam, a well-known American educational evaluator, based on the breakthrough of Tyler's behavioural goal-oriented mode [6]. There are four components to the CIPP model: first, Context Evaluation (CE), which is to determine the educational goals based on the needs of the evaluated target, to determine whether the educational goals reflect these needs, and thus to discover the differences with the actual results; second, Input Evaluation ((IE) is the evaluation of the conditions and resources needed to achieve the goals based on contextual evaluation, and the evaluation of the feasibility and usefulness of the educational program is its essence; third, Process Evaluation (PE) is the evaluation that monitors and checks the actual operation of the program, identifies problems, and provides effective feedback to decision makers; fourth, Product Evaluation (PE) is the evaluation that provides effective feedback to decision makers through the evaluation of the educational program. Product assessment (PE) is the process of gathering data pertaining to the outcomes in order to assess the true degree of the goals accomplished. A major advancement in the history of educational evaluation is the application of the CIPP model to the quality assessment of innovation and entrepreneurship education in

colleges and universities. This shifts the focus from evaluation for the sake of proof to improvement, from goal, result, and proof to decision, process, and improvement [7].

2.2. Analytic Hierarchy Process (AHP)

Early in the 1970s, University of Pittsburgh operations researcher Professor Satie proposed the analytic hierarchy process (AHP). This approach to methodical, hierarchical, qualitative, and quantitative analysis breaks the problem into a number of distinct objectives, which are then further broken down into a number of contributing factors. Depending on the complexity of the problem to be solved, the differentiation level can also be divided into several different levels. In order to link the problem to be solved to the influence weights of the various bottom-level influencing factors on the overall objective, the weights of the influencing factors in the various levels are determined using the fuzzy quantification method of qualitative indicators for the various influencing factors on the upper-level objectives [8]. AHP is a simple and efficient method for calculating indicator weights, which decomposes the elements to be decided into three levels: objective, criterion, and plan, and makes the final decision by fuzzy quantification of qualitative indicator information into simple and clear results of mathematical operations [9].

The Analytic Hierarchy Process (AHP) involves the division of the decision problem into a hierarchical structure consisting of the general objective, sub-objectives at each level, evaluation criteria, and specific alternative solutions. The prioritization of elements within each level is determined using the method of solving the judgment matrix's eigenvectors, which establishes the relative importance of each element in relation to the preceding level. Finally, the method of weighing and summing the final weights of each alternative solution with respect to the general objective is employed to identify the optimal choice [10].

3. Selection and Model Construction of Quality Evaluation Indexes of Innovation and Entrepreneurship Education in Universities Based on CIPP Model and AHP

Starting from the real-life insights of the CIPP education evaluation model, the evaluation indicators are designed around the school's actual situation and from four evaluation levels.

(1) Context Evaluation. The "C" in the CIPP model is Context Evaluation, which is a diagnostic evaluation of the implementation plan of innovation and entrepreneurship education in colleges and universities, and evaluates whether the goals set by the plan are indeed feasible. The focus of this evaluation is to clarify the basic information of the evaluated object, that is, the environmental foundation, and to evaluate whether all the conditions required for the implementation of the program are available and what deficiencies need to be adjusted and improved. The evaluation indexes mainly include top-level design, Safeguard mechanism and cultivation program, etc [11].

(2) Input Evaluation. Input evaluation, which comes after background evaluation, is represented by the letter "I" in the CIPP model. Focusing on whether the program is fully and successfully employed once the goals and concepts of innovation and entrepreneurship education are clearly defined, as well as whether the teachers and

financial inputs required for its implementation are comprehensive and sufficient. The evaluation indexes mainly include faculty input and funding. The evaluation indexes mainly include Faculty input and funding input [12].

(3) Process Evaluation. The "P" in the CIPP model is Process Evaluation, which is used to supervise and give feedback to the implementation of innovation and entrepreneurship education in colleges and universities. The main purpose is to correct and adjust the implementation process, improve and optimize the implementation process, formative evaluation and provide services for the implementation decision. The evaluation indexes mainly include teaching management, practice platform and Innovative entrepreneurial projects [13].

(4) Product Evaluation. The "P" in the CIPP model, also known as product evaluation, refers to the evaluation of the performance results associated with innovation and entrepreneurship education inside higher education institutions. In order to assess the efficacy of innovation and entrepreneurship education inside higher education institutions, an extensive dataset will be gathered encompassing a diverse array of individuals participating in the program. The data will then be analyzed to see if the adoption of innovation and entrepreneurship education accomplishes the desired goals or has other societal advantages. The primary assessment indices comprise student, enterprise, and school levels, among others [14]. Combining the above index elements into one, the evaluation system is shown in Table 1.

Table 1. Quality evaluation index system of university innovation and entrepreneurship education based on CIPP model

First-level indicators B	Second-level indicators C	Indicator Description
Context Evaluation B1	Top-level design C1	Integrating innovation and entrepreneurship education into the overall framework of the school's talent training program
		The concept and objectives are very clear
		Develop an implementation strategy to further the reform of entrepreneurship and innovation education
	Safeguard mechanism C2	Implementing "a handful of projects" and a "school system"
		Develop corresponding rules and regulations for innovation and entrepreneurship education
		Incentive mechanism and assessment methods for innovation and entrepreneurship education work
	Cultivation Program C3	Innovation and entrepreneurship education for all students
		Develop a relatively complete program to develop innovative and entrepreneurial capabilities
		Organic integration of professional education and innovation and entrepreneurship education
		Basic courses on innovation and entrepreneurship education included in the compulsory courses
Input Evaluation B2	Faculty input C4	Input from full-time and part-time innovation and entrepreneurship teachers
	Funding input C5	Innovation and Entrepreneurship Education Funding

(continued)

Table 1. *(continued)*

First-level indicators B	Second-level indicators C	Indicator Description
Input Evaluation B2	Funding input C5	Number of grants for innovative and entrepreneurial projects
Process Evaluation B3	Teaching Management C6	Number of innovative and entrepreneurial courses offered
		Establish a cumulative conversion system for innovation and entrepreneurship education credits
		Course Teaching Mode
	Practice Platform C7	Fixed on-campus innovation and entrepreneurship experiment and practice place
		Off-campus Innovation and Entrepreneurship Education Practice Base
		Using social resources to support the construction of innovation and entrepreneurship education practice platform
		Open the on-campus experimental practice platform to students
	Innovative entrepreneurial projects C8	Number of SRP Program
		Number of participants in the SRP Program
Product Evaluation B4	Student Level C9	Creative thinking and entrepreneurial awareness of students
		Student Innovation and Entrepreneurship Competition Awards
		Student Entrepreneurship Rate
	Corporate level C10	Enterprise evaluation of employment talent quality
		Partner companies promote the transformation of results
		Enterprise mentor, enterprise innovation and entrepreneurship base, enterprise funding input
	School level C11	teaching benefits teachers as well as students
		Social benefits (entrepreneurial alumni satisfaction, employer satisfaction, social reputation)
		ransformation of scientific research results of innovation and entrepreneurship education and application of innovation and entrepreneurship projects

Source: created by the author.

Based on the evaluation index system presented in Table 1, the assessment of high innovation and entrepreneurship education is established as the primary objective layer. This is further supported by four first-level indicators (B1-B4) serving as the criterion layer, and a comprehensive set of 11 indicators in the plan layer (C1-C11). Consequently, an evaluation system for assessing the quality of innovation and entrepreneurship education in higher education institutions is constructed. The evaluation hierarchy model is developed using the meta-decision yaahp software [2]. As seen in Figure 1.

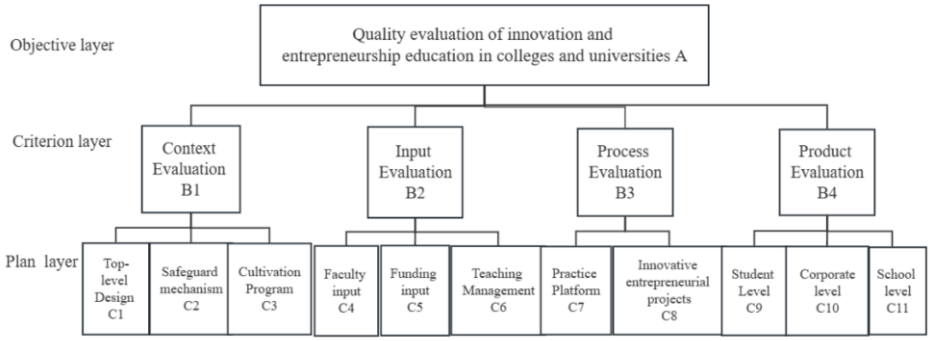

Fig.1. Hierarchical model for evaluating the quality of innovation and entrepreneurship education in higher education

Source: created by the author.

4. Analysis of the Process and Results of Quality Evaluation of University Innovation and Entrepreneurship Education Based on CIPP Model and AHP

4.1. Analysis of the Evaluation Process

Fourteen experts in the field of innovation and entrepreneurship education, who possess experience in overseeing or supporting such initiatives in colleges and universities, and possess knowledge about the overall landscape, achievements, and challenges in innovation and entrepreneurship education in higher education institutions, were requested to assess a questionnaire. The purpose of this assessment was to ascertain the relative importance of various evaluation criteria for determining the quality of innovation and entrepreneurship education in colleges and universities. A judgment matrix was then created, and a consistency test was carried out. The expert group consists of the head of the University Youth League Committee, the head of the Academic Affairs Department, the head of the Career Guidance Center of the Student Affairs Department, the head of the College of Innovation and Entrepreneurship Education (also known as the School of Entrepreneurship Education or Entrepreneurship College), as well as full-time teachers actively engaged in innovation and entrepreneurship education, along with other university leaders.

(1) Construction of judgment matrix model

The relative importance of the factors in Table 1 is judged as follows: citing the numbers 1-9 and their reciprocals as the scale, if the factor Bi is equally important as the factor *Bj* under objective A, assign a value of 1 to *Bi* and *Bj;* if you think Bi is more important than *Bj*, assign a value of 3 to Bi and 1/3 to *Bj*; if Bi is significantly more important than *Bj*, assign a value of 5 to Bi and 1/5 to *Bj.* If *Bi* is absolutely more important than *Bj, B*i is assigned a value of 9 and *Bj* is assigned a value of *1/9,* and if it is in the middle of the above two adjacent judgments, the scale value can be 2 or 4 or 6 or 8, and if Bi is not more important than *Bj,* the corresponding value of the above is the inverse of 1 [15].

(2) Hierarchical single ranking and its consistency test

Based on the judgment matrix, hierarchical single ranking determines the weights corresponding to the factors connected with this level in relation to the elements of the previous level. It serves as the foundation for grading each factor's significance at this level in relation to the one before it. The consistency index, or C.I., of the matrix must be determined in order to assess its consistency. It is defined as follows: (Note: The matrix's order is indicated by n).

$$C.I. = \frac{\lambda max - n}{n - 1} \tag{1}$$

where the maximum characteristic root of the matrix:

$$\lambda max = \frac{\sum (AWi)}{nWi} \tag{2}$$

In addition, Thomas L. Saaty proposed to use the average stochastic consistency index R.I. to correct the C.I. R.I. is a constant and the average stochastic consistency index of 1-9 matrix is shown in Table 2.

Table 2. Average random consistency index of the matrix

Number of steps	1	2	3	4	5	6	7	8	9
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Source: created by the author.

R.I. is merely formal for the order 1 and order 2 judgment matrix. We define the judgment matrix as follows: the judgment matrices of order 1 and order 2 are always the same. In cases when the matrix order exceeds 2, the random consistency ratio (C.R.) of the judgment matrix, denoted as the ratio of the consistency index (C.I.) to the average random consistency index (R.I.) of the same order, becomes applicable. When the consistency ratio (C.R.) is less than 0.1, the judgment matrix demonstrates an acceptable level of consistency. However, if the C.R. exceeds this threshold, it indicates that adjustments or modifications are necessary [16].

After combining the scoring results of 14 experts, the original comprehensive data were obtained, and the relative weights of each factor were calculated, and the judgment matrix and calculation results are shown in the table 3-7.

Table 3. Target layer Judgment matrix and weights

A1	B1	B2	B3	B4	Wi	
B1	1	4	4	5	0.5741	C.R.= 0.06721 λmax =4.1815
B2	1/4	1	3	2	0.2124	
B3	1/4	1/3	1	2	0.1227	
B4	1/5	1/2	1/2	1	0.0908	

Source: created by the author.

Table 4. Context evaluation B2 judgment matrix and weights

B1	C1	C2	C3	
C1	1	5	3	C.R.= 0.0332 λmax =3.0385
C2	1/5	1	1/3	
C3	1/3	3	1	

Source: created by the author.

Table 5. Input Evaluation B2 judgment matrix and weights

B2	C4	C5	Wi	
C4	1	5	0.8333	C.R.= 0.0000 λmax =2.0000
C5	1/5	1	0.1667	

Source: created by the author.

Table 6. Process Evaluation B3 judgment matrix and weights

B3	C6	C7	C8	Wi	
C6	1	1/4	4	0.1818	C.R.= 0.0000 λmax =3.0000
C87	4	1	8	0.7272	
C8	1/2	1/8	1	0.0910	

Source: created by the author.

Table 7. Product Evaluation B4 judgment matrix and weights

B4	C9	C10	C11	Wi	
C9	1	3	5	0.6370	C.R.= 0.0332 λmax =3.0385
C10	1/3	1	3	0.2583	
C11	1/5	1/3	1	0.1047	

Source: created by the author.

From the above judgment matrix and weights, we can get that C.R. is less than 0.1. Therefore, all judgment matrices pass the consistency test and prove that the results are reliable.

4.2 Analysis of Evaluation Results

Based on the relative weights of the factors in Tables 3 to 7 above, the synthetic weights were calculated, and the total ranking consistency ratio C.R. of each level was less than 0.1 after accounting with YaAHP software, so this evaluation result is acceptable.

Table 8. Evaluation index weights of innovation and entrepreneurship education quality in colleges and universities

First-level indicators B	Weights	Second-level indicators C	Weights
Context Evaluation B1	0.5741	Top-level design C1	0.3636
		Safeguard mechanism C2	0.0610
		Cultivation Program C3	0.1496
Input Evaluation B2	0.2124	Faculty input C4	0.1770
Input Evaluation B2	0.2124	Funding input C5	0.0354
Process Evaluation B3	0.1227	Teaching Management C6	0.0223
		Practice Platform C7	0.0892
		Innovative entrepreneurial projects C8	0.0111
Product Evaluation B4	0.0908	Student Level C9	0.0578
		Corporate level C10	0.0234
		School level C11	0.0095

Source: created by the author.

From Table 8, we can see that there are 3 first-level indicators, 6 second-level indicators, etc. that have a greater impact on the quality evaluation of innovation and entrepreneurship education at colleges and universities. The three first-level indicators such as B1 Context Evaluation, B2 input evaluation and B3 process evaluation have greater weights in the criterion level; outcome evaluation B4 has a lagging influence due to the evaluation of outcome performance and social benefits of innovation and entrepreneurship education, and CIPP evaluation shifts the purpose of evaluation from for proof to for improvement, from goal, result and proof to decision, process and improvement, so Product Evaluation B4 The weights are lower. Sorted according to the results of the weight of the program level, the secondary indicators with greater weight are six secondary indicators: C1 top-level design, C2 Safeguard mechanism, C3 Cultivation Program, C4 faculty input, C7 practice platform, and C9 student level.

5. Conclusion and Suggestions

The four CIPP model levels served as the basis for the formulation of the quality evaluation indexes in this study, which employed AHP to assess the caliber of collegiate innovation and entrepreneurship instruction. The quality evaluation system of college innovation and entrepreneurship education based on "CIPP+AHP" was established, adhering to the principles of combining process results, teaching practice evaluation, and objective subjective evaluation. It comprises 11 second-level indicators, such as top-level design, and four first-level indicators, such as context evaluation, input evaluation, process evaluation, and product evaluation of college innovation and entrepreneurship education. The scientificity and rationality of this evaluation index system are empirically analyzed and verified. According to the empirical results, the context evaluation is given the highest weight at the criterion level, suggesting that the school is superior in terms of its promotion of innovation and entrepreneurship in education policies and the quality of its well-established management department. However, Product evaluation has the lowest score, followed by process evaluation and input evaluation. It is clear that there is still room for further improvement in terms of funding input, teaching management, and innovation and entrepreneurship programs. At the plan level, the top-level design has the highest weight, followed by faculty input. Universities should expand the reform of innovation and entrepreneurial education, boost teacher involvement, and incorporate these subjects into the talent development programs of schools. However, the lowest weight is given to the school level in the evaluation of results, which suggests that during the implementation process, schools should concentrate on social benefits and bolstering the transformation of scientific research findings of innovation and entrepreneurship education. The following recommendations are offered in an effort to raise the standard of innovation and entrepreneurship education provided in schools:

(1) Strengthen the leadership mechanism and improve the top-level design

Universities should place a high value on teaching college students about innovation and entrepreneurship, bolster their leadership structures, put the "handful project" into action, and create a collaborative mechanism for this purpose that is overseen by the Academic Affairs Office and coordinated by the Department of Discipline and Science and Technology, the Finance Office, the Personnel Office, the Student Work Office, and other departments.

(2) Establishing rules and regulations and building a perfect guarantee system

Designing an optimal operational framework to facilitate the educational endeavours of college students in the domains of innovation and entrepreneurship necessitates the establishment of a dedicated task force. This specialized working group should be entrusted with the responsibility of orchestrating the provision of office facilities, ensuring an adequate allocation of personnel, and securing the requisite financial resources by including the funding for this initiative into the university's annual budget. Furthermore, it is recommended to motivate each unit to generate financial resources for the purpose of fostering innovation and entrepreneurship by employing diverse strategies. The creation of relevant rules and regulations has been undertaken to facilitate the effective support of institutionalization, specialization, and distinctive growth in the field of innovation and entrepreneurship education.

(3) Create "four fusions" and build a high-quality talent cultivation system

Universities should take a socially conscious approach to their work, incorporating the "four fusions" of thinking and creation, specialization and creation, industry and creation, and discipline as a guide. They should also review their talent training programs, provide courses on innovation and entrepreneurship, pay attention to the development of their faculty, enhance their teaching management and research capabilities, and foster the development of applied innovation and entrepreneurship talents. We will offer compulsory courses on innovation and entrepreneurship for all students, create a practical teaching system that integrates professional and innovation and entrepreneurship; develop an innovative practice section, where each student should obtain corresponding credits, build an innovative credit conversion system, open up the first and second classes, and effectively integrate the innovation and entrepreneurship curriculum and practice system.

(4) Establishing a part-time and full-time teaching team

Interdisciplinary teaching of "innovation and entrepreneurship" ought to be a core responsibility of all university faculty. They should also support full-time teachers who offer entrepreneurship education and coaching, and they should introduce management approaches for all kinds of part-time professionals and technicians. In order to foster an environment conducive to innovation and entrepreneurship, it is recommended that colleges and universities consider the inclusion of part-time instructors specializing in these areas. Additionally, efforts should be made to improve teacher preparation, allocate specific funding for training initiatives, and encourage young educators to engage in entrepreneurship training. Furthermore, the implementation of teaching reforms focused on innovation and entrepreneurship, as well as the establishment of partnerships with businesses for job placements, can contribute to the formation of a well-rounded innovation and entrepreneurship team. This team should ideally consist of both full-time and part-time staff members, operating within a well-structured organizational framework. A suitable structure and a mix of full-time and part-time teachers will make up the faculty.

(5) Focus on the construction of campus innovation and entrepreneurship culture

Universities should carry out diversified forms of innovation and entrepreneurship practice activities, raise the overall caliber of their student body, integrate innovation and

entrepreneurship education into campus cultural activities, club activities and social practice, and focus on cultivating market awareness, entrepreneurship, innovation ability and social responsibility necessary for employment competition. We will actively build a system of "college-level-school-level-provincial-level-national" innovation and entrepreneurship competitions to enhance the competitiveness of the school.

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