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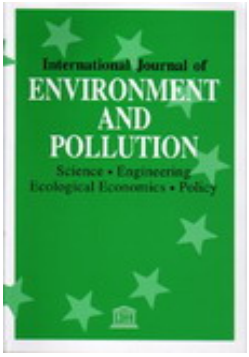

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An evaluation method of college students' innovation and entrepreneurship ability based on AHP method

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An evaluation method of college students' innovation and entrepreneurship ability based on AHP method

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Abstract: In order to overcome the problems of low efficiency and poor effect of evaluation, this study designed an evaluation method of college students' innovation and entrepreneurship ability based on analytic hierarchy process (AHP) method. Firstly, the structure of college students' innovation and entrepreneurship ability is analysed based on grounded theory and an evaluation index system is designed. Then AHP evaluation matrix is constructed to determine the reference data column. Finally, the correlation coefficient is calculated to determine the correlation degree, and AHP method is used to carry out the single ranking of indicators, so as to realise the effective evaluation of college students' innovation and entrepreneurship ability. Experimental results show that the evaluation accuracy of this method can reach 99.38%, the evaluation process takes only 22 s at most, and the satisfaction rate of ability evaluation is 99.0%, indicating that this method can effectively improve the evaluation effect.

Keywords: AHP method; evaluation matrix; correlation; hierarchical single ordering; innovation and entrepreneurship ability.

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1 Introduction

Innovation and entrepreneurship is a complex concept, which includes six kinds of abilities, such as independent learning ability, opportunity identification ability and management and communication ability. The concept of entrepreneurial ability of college students has the same characteristics as entrepreneurial ability (Li and He, 2020; Liu, 2022). As college students have the characteristics of advanced thinking, innovative

thinking and high knowledge level, their entrepreneurial intention, entrepreneurial ability and entrepreneurial activities have more abundant connotation (Tang, 2021). College students' entrepreneurial ability also emphasises to show the personality characteristics of college students, pay attention to the integration of innovation and specialty, emphasise the change of college students' thinking, consciousness and concept, so as to realise the development of college students' entrepreneurial ability (Shen, 2019).

The evaluation of college students' entrepreneurial ability is a comprehensive evaluation, which emphasises development and aims to cultivate talents with entrepreneurial ability for the society. The evaluation should not be limited to the evaluation of general knowledge and skills, but to prepare for future work and life (Liu and Liu, 2021). From the perspective of students, their understanding of entrepreneurship is generally simple and simple, and they believe that entrepreneurship is to find business opportunities, perfect business philosophy and management methods, innovative integration of skilled professional skills, and strong psychological quality have become the deep pursuit of college students. However, the entrepreneurial ability of current college students obviously cannot meet the current social requirements.

Therefore, relevant scholars have carried out research on it. In Liu et al. (2021), an evaluation method of college students' innovation ability based on game theory is proposed. In this method, a three-layer three-dimensional evaluation index is established, the coefficient of variation method is used to calculate the weight of the three-dimensional evaluation index, and the game theory is used to realise the evaluation of the innovation ability of college students. This method can effectively improve the evaluation effect of innovation ability, but the evaluation efficiency of this method is low because the evaluation process of game theory needs a lot of data support. In Lin (2020), an evaluation method of higher vocational college students' innovation and entrepreneurship ability based on fuzzy analytic hierarchy process is proposed. In this method, the dataset of innovation and entrepreneurship ability evaluation is obtained by data mining method, the weight of influencing factors of innovation and entrepreneurship ability evaluation is calculated by decision tree clustering method, and the evaluation results of students' innovation and entrepreneurship ability are calculated by fuzzy analytic hierarchy process. This method can effectively improve the evaluation efficiency, but the accuracy of the evaluation results of this method is poor because the fuzzy hierarchy analysis process cannot perform effective analysis according to the change of weights in real time. In Bai and Li (2021), a method of evaluating college students' innovation and entrepreneurship ability based on data mining is proposed. The method uses data mining technology to obtain the relevant data of the evaluation of innovation and entrepreneurship ability, establishes the evaluation index system combined with relevant elements, and then sets the index weight value by using the expert system to obtain the comprehensive evaluation set and the corresponding evaluation value, and determines the level of innovation and entrepreneurship ability of students. However, after the method is put into practical application, it is found to be time-consuming.

In view of the shortcomings of the above traditional evaluation methods, this paper designs a new evaluation method of college students' innovation and entrepreneurship ability based on AHP method. The specific ideas are as follows:

Firstly, on the basis of collecting relevant information, this paper analyses the core concepts that can reflect the essence of college students' innovation and entrepreneurship

ability, and establishes the structural framework of entrepreneurship ability according to the relationship between different concepts by using grounded theory.

Then, the evaluation index system is constructed, including three first-level indexes and 28 second-level indexes of entrepreneurial management literacy, entrepreneurial consciousness and personal ability.

Secondly, the mean method is used to carry out dimensionless processing on the evaluation indicators, so as to make the indicators more standardised, so as to fundamentally improve the efficiency of follow-up evaluation.

Finally, on the basis of calculating the absolute difference between the index sequence and the reference sequence in the object to be evaluated, the ultimate correlation coefficient and correlation coefficient between them are judged, and the comparative correlation sequence is formed. After the index weight is determined, AHP method is used to conduct hierarchical single ranking, and the final evaluation result is obtained according to the probability density of the sequence to be evaluated.

2 Evaluation method of college students' innovation and entrepreneurship ability

2.1 Construct the index system of college students' entrepreneurial ability

Firstly, the structural framework of college students' entrepreneurial ability is established based on grounded theory. This process is to establish a theory based on the empirical data, that is, on the basis of collecting relevant data, analyse the core concepts that can reflect the essence of college students' innovation and entrepreneurship ability, and then establish the relevant theoretical structure according to the relationship between different concepts. The specific process is as follows:

Step 1: Primary coding. This study codes the original data obtained from interviews around the composition of college students' entrepreneurial ability. Level of coding is also known as open coding, the researchers in the level of coding need as far as possible will itself as a research tool, objective open view to obtain raw materials, in the process of encoding avoid personal opinions to the influence of information, to take an objective attitude information, according to the data express the meaning and content of coding, wrong data excessive explanation and generalisation. Open coding is a process of analysing, conceptualising, and rearranging the original data obtained sentence by sentence (Bai and Li, 2021). To do this, first of all, to guide college students entrepreneurial guidance teachers and entrepreneurship of college students participation in depth interview, and the respondent audio information for text, word for word, his comments and opinions to the collection and analysis, with reference to strauss put forward the coding of the five basic principles to open source code and label, for the useful information, conceptualised coding is carried out to eliminate unclear or invalid information about confidence expression. Finally, a total of 24 conceptual genera are obtained (Yang et al., 2020; Shu, 2019).

Step 2: Secondary coding. In this study, 26 conceptual categories obtained from the first-level coding were analysed to find the relationship between each category, and four categories including entrepreneurial consciousness, personal traits, management knowledge and financial literacy were proposed to complete the second-level coding.

Step 3: Three-level coding. Three-level coding, also known as core coding, is the process of ‘coarsening" the existing conceptual categories, that is, classifying the existing category concepts into broader categories. This study analyses and integrates the four categories, and obtains three core categories: entrepreneurial consciousness, personal traits and entrepreneurial management ability. The relationships among the genera are shown in Table 1.

Table 1 Composition structure of college students’ innovation and entrepreneurship ability

Innovation and entrepreneurship ability	*Explain*	*Attribute content*
Entrepreneurial awareness	Entrepreneurial awareness	Entrepreneurial zeal
		Entrepreneurial awareness
		Entrepreneurial willpower
		Altruistic thought
Personal traits	Personal ability	Ability to seize opportunities
		Innovation ability
		Compressive capacity
		Leadership
		Innovation ability
		Compressive capacity
		Interpersonal skills
		Teamwork ability
		Learning ability
		Language ability
		Executive ability
		Professional knowledge
		Self-reflective capability
Entrepreneurial management ability	Management knowledge	Financial management
		Administrative management
		Marketing management
	Financial literacy	Legal literacy
		Customer classification
		Marketing ability

According to the above grounded theory of college students’ innovation and entrepreneurship ability structure, the corresponding ability evaluation index system is constructed, as shown in Table 2.

The formation of grounded theory model provides a reference for the design of evaluation index of college students’ entrepreneurial ability in the next step, and its element table evidence lays a foundation for the design of evaluation index (Duan, 2022; Wang and Du, 2021). These elements also need empirical evidence to determine their scientificity and rationality.

Table 2 Evaluation index system of college students' entrepreneurial ability

Level indicators	*Explain*	*Secondary indicators*
Entrepreneurial management literacy	Financial and management literacy	Financial management ability
		Legal literacy
		Administrative ability
		Marketing ability
Entrepreneurial consciousness	Seize entrepreneurial opportunities	Focus on customer needs
		Heightened Awareness
		Altruistic thought
	Entrepreneurial willpower	Entrepreneurial enthusiasm
		Endure hardships and be capable of hard work
		Compressive capacity
		Psychological regulation
	Objective and evaluation capability	Goal consciousness
		Ldea evaluation
Personal ability	innovation ability	Technological innovation ability
	Interpersonal skills	Ability to access resources
		Team relationship network
		Awareness of seeking help
		Team leadership
	Teamwork ability	Team communication ability
		Team consciousness
		Team execution
		Team organisation ability
	Learning ability	Establish connectivity
		Problem solving ability
		Ability to adapt to the environment
		Professional knowledge learning ability
	Self-awareness and self-efficacy	Self-Reflective Capability
		self-confidence

2.2 Dimensionless treatment of evaluation index

The mean method is used to implement non-dimensional processing of the evaluation index, so as to make the index more standardised, so as to fundamentally improve the efficiency of the subsequent evaluation of innovation and entrepreneurship ability. Assume that n data sequences form the following indicator matrix:

$$X = (x_1, x_2, ..., x_n) = \begin{bmatrix} x_1(1) & x_2(1) & \cdots & x_n(1) \\ x_1(2) & x_2(2) & \cdots & x_n(2) \\ \vdots & \vdots & \ddots & \vdots \\ x_1(m) & x_2(m) & \cdots & x_n(m) \end{bmatrix} \tag{1}$$

where m is the number of indicators. $i = 1,2,\ldots,n$. After the reference data column is determined, the reference sequence is constructed according to the maximum value of each evaluation index (Wu, 2021; Wang, 2019), which is denoted as follows:

$$x_0 = (x_0(1), x_0(2), ..., x_0(n)) \tag{2}$$

Then the index data is processed dimensionless. The non-dimensional dimensionalisation methods commonly used include mean method, normalisation method and transformation method (Chen, 2019). Among them, the normalisation method maps data to the range of [0,1] for processing. Its operation mode is relatively convenient and fast, but the format of data has high requirements. The transformation method is to establish the matrix according to the data characteristics and get the dimensional formula of the index through fast convergence. However, this method will destroy the original data matrix and it is difficult to maintain the original sparsity of data. Therefore, this study adopts the mean value method to carry out dimensionless treatment for indicators, and the specific process is as follows:

$$x_n' = \frac{x_i(k)}{\frac{1}{m}\sum_{k=1}^{m} x_i(k)} \tag{3}$$

where $x_i(k)$ represents the arithmetic mean of the kth indicator. The dimensionless index sequence can form the following matrix:

$$X' = (x_0'(1), x_0'(2), \ldots, x_0'(m)) = \begin{bmatrix} x_0'(1) & x_1'(1) & \cdots & x_n'(1) \\ x_0'(2) & x_1(2) & \cdots & x_n'(2) \\ \vdots & \vdots & \ddots & \vdots \\ x_0'(m) & x_1'(m) & \cdots & x_n'(m) \end{bmatrix} \tag{4}$$

Through the above process, the dimensionless processing of indicators is implemented to make the indicators more standardised, so as to fundamentally improve the efficiency of follow-up evaluation.

2.3 The evaluation is completed based on AHP method

Based on the calculation of the absolute difference between the index sequence and the reference sequence in the object to be evaluated, the ultimate relationship coefficient and correlation coefficient between them are judged, and the comparative correlation sequence is formed, which can improve the accuracy of the final evaluation. Then, after determining the index weight, the AHP method is used for hierarchical single ranking, and the final evaluation result is obtained according to the probability density of the sequence to be evaluated.

To this end, according to the dimensionless index sequence matrix obtained in the above section, the absolute difference between each index sequence and the corresponding element of the reference sequence in the object to be evaluated is calculated one by one, and the process is as follows:

$$\Delta = \left| x_0(k) - x_i(k) \right| \tag{5}$$

where $k = 1,2,\ldots,m$, $i = 1,2,\ldots,n$. Then the ability of innovation and entrepreneurship of college students is evaluated by AHP method. The characteristic of AHP method is to divide various processing processes in complex problems into interconnected ordered hierarchies, compare elements in the same hierarchy with each other according to the results of organised judgement, and carry out sorting processing according to their importance, so as to complete the final ability evaluation. The specific evaluation process is as follows:

Step 1: Determine the ultimate relationship coefficient between each index sequence and the corresponding element of the reference sequence in the object to be evaluated, namely:

$$\begin{cases} \partial_{\min} = \min_{i=1}^{n} \min_{k=1}^{m} \left| x_0(k) - x_i(k) \right| \\ \partial_{\max} = \max_{i=1}^{n} \max_{k=1}^{m} \left| x_0(k) - x_i(k) \right| \end{cases} \tag{6}$$

Step 2: Calculate the correlation coefficient between them, that is, calculate the correlation coefficient of every comparison sequence and the corresponding elements of the reference sequence respectively according to equation (6), and the process is as follows:

$$\zeta_i(k) = \frac{\partial_{\min} + \rho \times \partial_{\max}}{\left| x_0(k) - x_i(k) \right| + \rho \cdot \max_i \max_k \left| x_0(k) - x_i(k) \right|} \tag{7}$$

where ρ represents the resolution coefficient, and it satisfies $\rho \in [0,1]$. The smaller ρ is, the greater the coefficient difference between the index sequence and the reference sequence is, and the stronger the resolution is. Thus, the typical value of ρ is 0.5. An improved and simpler calculation method can be used to calculate the correlation coefficient by using the reference data column formed by the optimal value of each indicator. The process is as follows:

$$\zeta_i(k)' = \frac{\partial_{\min} + \rho \times \partial_{\max}}{\Delta + \rho \times \partial_{\max}} \tag{8}$$

Step 3: Calculate the average correlation coefficient between the index sequence and the reference sequence of each object to be evaluated, and form a comparative correlation sequence, which can be expressed as:

$$\gamma_{ki} = \frac{1}{m} \sum_{k=1}^{m} \zeta_i(k)' \tag{9}$$

Step 4: According to the scale of the judgement matrix, the m-order judgement matrix $X(x_i)_{m \times m}$ is established, and then the elements therein are multiplied as follows:

$$C = \prod_{k=1}^{m} \gamma_{ki} \times X(x_i)_{m \times m} \tag{10}$$

Step 5: Calculate the expected value of C as follows:

$$E[C] = \int_{-\infty}^{+\infty} C \times \vartheta \mathrm{d}F(C) \tag{11}$$

where $F(C)$ represents the distribution function and ϑ represents the probability density.

Step 6: The data obtained by $E[C]$ are processed to obtain the distribution of different evaluation indicators, and then the weight of each indicator is determined by combining the scale of the judgement matrix:

$$\omega_m = \frac{C \times \vartheta}{E[C]} \tag{12}$$

Step 7: According to the weight values of different indicators, AHP method is used to carry out hierarchical single ranking, and pairwise comparison is made between the weight elements of the same level and the weight elements of the higher level as the criterion. The final evaluation result of college students' innovation and entrepreneurship ability is obtained according to the probability density of the sequence to be evaluated. The process is described as follows:

$$\omega_m = \frac{\delta \times \omega_m \times \gamma_{ki}}{\varepsilon} \tag{13}$$

where ε represents the convergence degree of the evaluation process, and δ represents the equilibrium coefficient.

To sum up, this method firstly uses grounded theory to establish the structural framework of college students' entrepreneurial ability. Then the evaluation index system is constructed and the evaluation index is treated dimensionless by means of mean method. On the basis of calculating the absolute difference between the index sequence and the reference sequence in the object to be evaluated, the ultimate relationship coefficient and correlation coefficient between the two are judged. After determining the weight of the index, AHP method is used to carry out single hierarchy sorting, and the final evaluation result is obtained according to the probability density of the sequence to be evaluated.

3 Experiment and results

3.1 Experimental scheme

To verify the feasibility of Method of this paper, the following experiments are designed.

School W was selected as the experimental environment, 600 college students were randomly selected as evaluation samples for case analysis, and the innovation and entrepreneurship ability of college students was evaluated and analysed. The specific evaluation process was designed in the MATLAB environment as follows:

a Determine the comparative sequence and reference sequence of students' innovation and entrepreneurship ability.

b The evaluation indicators are dimensionless processed, and the difference between the influencing factor sequence and the reference sequence after dimensionless processing is calculated.

c Calculate the absolute value of the difference operation results to obtain the required gray absolute difference sequence.

d AHP method is used for the adaptive optimisation of the evaluation process to complete the evaluation of the innovation and entrepreneurship ability of college students.

In the experiment, the convergence degree of the evaluation process is 0.1, the equilibrium coefficient is 0.5, and the range of normalised treatment is [0,1].

3.2 Index and contrast design

The experiments were verified by the accuracy, time and satisfaction of the evaluation of innovation and entrepreneurship ability.

In order to enhance the explicability of experimental results, method of Liu et al. (2021) and method of Lin (2020) were compared to complete performance verification together with method of this paper.

3.3 Description of experimental results

3.3.1 Accuracy of innovation and entrepreneurship ability evaluation

First, the evaluation accuracy of different methods was verified, and the results were shown in Table 3.

Table 3 Evaluate accuracy comparison

Amount of data/GB	*Evaluation accuracy/%*		
	Method of Liu et al. (2021)	*Method of Lin (2020)*	*Method of this paper*
50	62.96	69.23	96.79
100	68.42	66.26	98.26
150	70.05	69.25	99.71
200	72.83	70.88	99.38
250	66.91	63.52	99.19
300	69.16	60.19	99.82

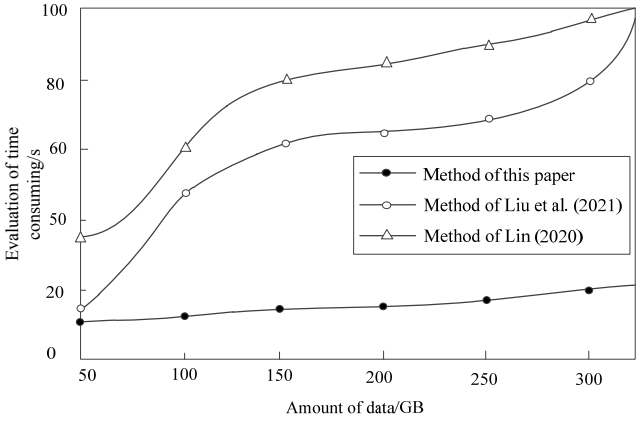
By comparing the data in Table 3, different methods have different accuracy in the evaluation of innovation and entrepreneurship ability. When the amount of data is 50GB, the evaluation accuracy of method of Liu et al. (2021), method of Lin (2020) and method of this paper is 62.96%, 69.23% and 96.79% respectively. When the amount of data is 200GB, the evaluation accuracy of method of Liu et al. (2021), method of Lin (2020) and

method of this paper is 72.83%, 70.88% and 99.38% respectively. Method of this paper always has a high evaluation accuracy, which proves that it can effectively improve the evaluation effect of innovation and entrepreneurship ability.

3.3.2 Ability evaluation time test

The comparison results of evaluation time of different methods are shown in Figure 1.

Figure 1 Evaluate the time comparison results



As can be seen from Figure 1, the evaluation time of different methods varies. When the amount of data is 200GB, the evaluation time of method of Liu et al. (2021), method of Lin (2020) and method of this paper is 63 s, 88 s and 14 s respectively. When the amount of data is 300GB, the evaluation time of method of Liu et al. (2021), method of Lin (2020) and method of this paper is 63 s, 88 s and 22 s respectively. The evaluation time of method of this paper is significantly less than that of the two comparison methods, indicating that method of this paper has efficient evaluation performance.

3.3.3 Evaluation satisfaction test

Verify different methods to evaluate satisfaction rate, and the results are shown in Table 4.

Table 4 Comparison of satisfaction rate of innovation and entrepreneurship evaluation

Evaluation of the number	*Evaluation satisfaction rate/%*		
	Method of Liu et al. (2021)	*Method of Lin (2020)*	*Method of this paper*
100	62.0	72.0	99.0
200	68.0	77.5	99.5
300	63.0	69.0	99.0
400	69.5	66.5	99.75
500	70.0	65.2	98.2
600	65.5	69.5	99.0

By analysing Table 4, it can be seen that, when the number of evaluation persons is 300, the evaluation satisfaction rate of method of Liu et al. (2021) is 63.0% and that of method of Lin (2020) is 69.0%. The satisfaction rate of method of this paper was 99.0%; When 600 people are evaluated, the evaluation satisfaction rate of method of Liu et al. (2021), method of Lin (2020) and method of this paper is 65.5%, 69.5% and 99.0% respectively. Method of this paper always has a high evaluation satisfaction rate, indicating that this method can realise the optimisation of the evaluation effect of new entrepreneurial ability.

In conclusion, the evaluation accuracy of this method can reach 99.38%, the evaluation process takes only 22 s at most, and the satisfaction rate of ability evaluation is 99.0%, indicating that this method can effectively enhance the evaluation effect of innovation and entrepreneurship ability.

4 Conclusion

This paper puts forward an evaluation method of college students' innovation and entrepreneurship ability based on AHP method, analyses the significance of the development of college students' innovation and entrepreneurship, and constructs the evaluation framework through grounded theory. Then AHP evaluation matrix is constructed and the evaluation results are obtained by hierarchical single ordering.

According to the experimental results, this method has a high evaluation accuracy, the highest evaluation accuracy can reach 99.38%. The global maximum value of the evaluation time of this method is 22 s, indicating that this method has high evaluation efficiency. The evaluation satisfaction rate of this method can reach 99.0%, indicating that this method can effectively enhance the effect of creative evaluation.

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