Research Article

Research on the Evaluation Method of University Bi-Entrepreneurship Curriculum Based on IoT Integrated with AHP Algorithm

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The Internet of Things (IoT) is essential for the success and adoption of digital entrepreneurship in universities. The Internet of Things (IoT) is the integration of electronic objects, peripherals, cities, and other items and equipment with embedded software, electronics, actuators, network connections, and sensors that allow these things and equipment to share and gather data. The usage of IoT for university bi-entrepreneurship can equalize the playing field in many areas of the economy, creating options like as remote work at any time and from anywhere. Nowadays, universities are playing an essential part in the careers of students. In this regard, government departments provide considerable assistance in recruiting individuals and companies in a variety of ways, including funding and tax policies. However, many factors affect university students’ innovation and entrepreneurship education. Therefore, it is necessary to establish a quality evaluation system of innovation and entrepreneurship education, which can guide university students’ targeted innovation and entrepreneurship by improving the comprehensive ability and employability of these students. Therefore, this paper constructs an evaluation index system of university students’ innovation and entrepreneurship education quality, including several dimensions and several sub-indicators. On this basis, the analytic hierarchy process (AHP) algorithm is used to construct the judgment matrix, and the ranking weight of each comparison element is calculated according to the judgment matrix. The suggested system first constructs a hierarchical model to conceptualize the relationship between different elements and then builds a judgment matrix. After establishing the judgment matrix, the calculation methods of the characteristic root, square root, and idempotent relative weight are systematically checked. The experimental results reveal that the proposed evaluation system has a stronger impact on promoting university students’ creativity, entrepreneurship, and employment.

1. Introduction

When facing the challenge of a fast-changing, development education environment, such as what is happening significantly now throughout many universities with the Internet of Things (IoT), most of the universities launch a series of trials without first creating a robust and overarching strategy. The consequences of IoT for developing models must be looked at from the lens of university entrepreneurship, in which a corporation strives to utilize its current education skills in new, adjacent sectors for development. We contend that the Internet of Things, like many other high-impact technological advances, entails greater levels of risk than conventional and gradual upgrades to present university operations. In addition, IoT needs a strong and extensible architecture of the system that include a variety of sensors that are linked to the Cloud using wireless technology, and data are collected and processed to produce and act on data analytics. Furthermore, a Cloud link to a heart monitor combined with background analytics can notify healthcare call centers and patients of impending heart attacks. The necessity for disciplined architectural design is prevalent wherever there is a mix of software and hardware combined into a real-time warning system.

Under the background of increasing employment pressure, strengthening entrepreneurship and innovation
education for university students has certain application value, which is in line with the law of development of university students in China and is also an effective way to solve the employment of university students nowadays [1]. Innovation education solves the employment problem and boosts university students' innovation, independent learning, analysis, and problem-solving abilities, which improves their innovation ability. Innovation ability is fundamental to national development, especially university students’ innovation ability. However, the current innovation education in the university still stays a primary stage, and many indicators and systems are not very sound now, which is a problem that we need to improve at present. First, there is a lack of scientific innovation and entrepreneurship education concepts, and schools and students do not know enough about entrepreneurship education. Second, there is a lack of a reasonable entrepreneurship education curriculum system most of our universities and universities offer entrepreneurship education as elective courses. In addition, the curriculum and teaching methods are single, and most replace them with university students' career planning courses. Third, the teachers’ strength in entrepreneurship education is weak, and most of them teach entrepreneurship as a hobby [2].

Aside from the foregoing, our country’s university students’ capacity to adjust to culture, jobs, and entrepreneurship is lacking, whereas innovative and composite talents are in limited supply. Even though various agencies have implemented different preferential measures and policies to promote entrepreneurship and innovation education for university students, all types of universities and colleges have effectively cultured innovation. Additionally, the skilled staff training designs are intended to produce new entrepreneurial talents and abilities. It can be said that China’s innovation and entrepreneurship talents are still in their early stages of growth. Numerous issues regarding the growth of creative entrepreneurial talents must be investigated both in practice. How to assess and choose entrepreneurial and innovative skills is perhaps the most important issue in the entrepreneurship and innovation training mode. As a result, it is critical to develop a talent evaluation process for entrepreneurship and innovation.

Because of the aforementioned issues, this paper develops an evaluation index system for the reliability of innovation and entrepreneurship education provided to university students, which includes several dimensions and sub-indicators. The judgment matrix is constructed using the analytical hierarchy process (AHP) algorithm, and the ranking weight of each comparison element is calculated using the judgment matrix. The purpose of this paper is to draw a connection between entrepreneurship education in universities and the need for curriculum reform. It explicitly mentions unemployment levels in China while taking into account the execution of entrepreneurship education in universities to decrease the occurrence of youth unemployment and the significance of teacher education.

The key contribution of this research work consists of the following:

This study divided the quality assessment of innovation and entrepreneurship education into three dimensions: universities, students, and social groups to classify the assessment indexes [3]. Universities are the main body of innovation and entrepreneurship education. In this study, the indicators of schools in the quality assessment of innovation and entrepreneurship education are classified into entrepreneurship teachers, venues, and support. Innovation and entrepreneurship education in universities include talent cultivation, curriculum, and teaching methods [4]. On the other hand, entrepreneurship teachers include teaching methods, teachers’ innovation, entrepreneurship education teaching ability, assessment and evaluation of innovation, and entrepreneurship education. This study divides student indicators of innovation and entrepreneurship education quality into entrepreneurial practice, innovation and entrepreneurial effect, entrepreneurial status, and entrepreneurial satisfaction. Students’ entrepreneurial practice includes internships, competitions, and skills competitions in innovation and entrepreneurship [5]. In this study, social groups in innovation and entrepreneurship education are classified based on entrepreneurial effectiveness and satisfaction.

The organization of the rest of this paper is listed as follows: Section 2 discusses related work by international and national scholars. Section 3 presents the material and proposed methodology for this paper. Section 4 presents experimental work for the proposed model as well as its analysis. Section 5, the final section of this paper, contains the conclusion.

2. Related Work

2.1. Innovation Education Evaluation. Harvard University offered a course on entrepreneurship education in 1947, marking the beginning of innovative entrepreneurship education [6]. In the 1990s, American magazines such as Business Week and Entrepreneur and Success began to evaluate university entrepreneurship education programs once a year, in terms of the number of entrepreneurship courses, the rate of entrepreneurship among university students, and, the amount of financing for entrepreneurial enterprises [7]. Foreign scholars have studied the impact of innovative entrepreneurship education on the economy and society, as well as the time and opportunity costs for investors in educational institutions and educated people [8]. The authors of Ref. [9] argue that the consistency of entrepreneurship education in universities is low. Most evaluation criteria are specific to university entrepreneurship education, and there are no universal evaluation criteria for entrepreneurship education. In this regard, the scholar of [10] conducted a thorough investigation into the effectiveness of implementing entrepreneurship education courses based on the theory of planned behavior. It discovered that the most important outcome of entrepreneurship among students, but the conceptual change of students' attitudes and values, which leads to a
stronger entrepreneurial will and entrepreneurship. The third edition of the Oslo Manual of the Organization for Economic Cooperation and Development (OECD) represents research in the area of innovation measurement [11]. The handbook has made breakthroughs in the collection and interpretation of innovation data, but still has shortcomings, such as the difficulty of reflecting changes in process methods and organizations. In October 2018, the OECD released the fourth edition of the Oslo Manual. Several international research institutions are also conducting ongoing research on innovation assessment projects [12]. They have constructed innovation indicator systems mainly for global or cross-country innovation measures, such as the National Innovation Capacity Index, the Global Composite Innovation Index, and the World Knowledge Competitiveness Index, and have adopted different evaluation indicators or methods according to different evaluation objectives. From the research trend of foreign innovation and entrepreneurship education, the research content of innovation and entrepreneurship education evaluation not only includes the selection of evaluation indicators, the determination of evaluation methods, and the effectiveness of evaluation but also forms a more complete quality evaluation system.

Most of the literature in this field discusses the necessity of entrepreneurship education, realization path, development model, international and regional comparison, practice methods, and other dimensions [13]. There are fewer studies on the evaluation system and quality control of innovation and entrepreneurship education, among which there are fewer empirical studies. Due to the complexity of entrepreneurship education evaluation and other constraints, some research results are limited to exploring the necessity of innovation and entrepreneurship education evaluation, and innovation education evaluation indices and techniques have few quantitative investigations. There is no evaluation system to measure the quality of innovation and entrepreneurship education. First, research on innovation and entrepreneurship education evaluation is weak, and a scientific index system and representative research results are lacking. The assessment index system is naively quantitative, the evaluation material is not comprehensive, and the index weights are not scientific enough, which impacts the evaluation system of innovation and entrepreneurship education in university’s and universities [14]. Small sample coverage, lack of convincing research conclusions, mainly qualitative research, lacking of empirical research based on large sample data analysis, failure to build a scientific and reasonable index system, etc. are problems in China’s innovation and entrepreneurship education evaluation system research. The research on innovation and entrepreneurship education evaluation systems lacks theoretical depth, and the important issues are not adequate. This research builds a scientific and acceptable evaluation system of innovation and entrepreneurship education quality in China based on big sample data and three dimensions: development state, final results, and implementation method.

2.2. Research on Evaluation of Innovative Entrepreneurship Education

2.2.1. There Is Variability in Evaluation Indexes. There is a lag in innovative entrepreneurship education due to its impact, and some scholars believe that longitudinal evaluation should be conducted on innovative entrepreneurship education. The scholar of Ref. [15] believes that there is little consistency in innovative entrepreneurship education programs among universities and most of the evaluation criteria are for innovative entrepreneurship education in a particular university, and there are no universal evaluation criteria for entrepreneurship education. In this regard, the early work of Ref. [16] took five principles such as subjectivity, practicability, technological advancement, innovation, and team integrity as the principles for the construction of university students’ innovation and entrepreneurship evaluation system. Hence, the scholar of Ref. [17] measured innovation education in 8 domains.

2.2.2. Innovation and Entrepreneurship Indexes Are Hard to Validate. The scholars of Ref. [18] determine the innovation and entrepreneurship education assessment method, but hard to ensure it is effective. For this purpose, the work of Ref. [19] proposed that when domestic universities conduct research on innovation and entrepreneurship, they ignore the overall level design and do not effectively analyze the entrepreneurship education goals, which leads to the disconnection between theory and practice. Nowadays, there is no recognized definite assessment subject for the assessment of innovation and entrepreneurship education. Although most universities assess from the perspective of schools and students’ associations and society, there is still a problem of ignoring the demands of different assessment subjects in the assessment process.

2.2.3. Innovation and Entrepreneurship Education Evaluation Differs. The early work of Ref. [20] takes three aspects of school, students, and entrepreneurship projects as the main subjects of innovation and entrepreneurship education evaluation thus conducting the systematic evaluation. The author of Ref. [21] on the other hand, systematically evaluated four aspects of the entrepreneurship education environment, entrepreneurship teachers, entrepreneurship education curriculum, and entrepreneurship students according to students’ innovation and entrepreneurship reality. Similarly, the work of Ref. [22] evaluated four dimensions the target level, object level, teaching and research level, and resource level.

2.2.4. Factors. The global market economy, the shape, substance, and teaching methods of innovation education in different geographies and universities, and even individuals’ psychological states and circumstances affect innovation and entrepreneurship education. The researchers of Ref. [23] believe that as the global economy changes, so must our innovation and entrepreneurship education to produce
innovative individuals who are more flexible. The scholars in Ref. [24] note that the quality of entrepreneurship education and the assessment of innovation and entrepreneurship education is a complex process that is affected by individuals’ psychological and social status. Distinct researchers have different study themes, purposes, and opinions. Hence their evaluation indexes, procedures, and evaluation subjects will be different. This study seeks to perform an empirical study on the quality of innovation and entrepreneurship education of self-employed graduates in a city to increase the quality of higher education employment served by innovation and entrepreneurship education in a city.

Inspired by the work aforementioned, this research work draws a connection between entrepreneurship education in universities and the need for curriculum reform. It explicitly mentions unemployment levels in China while taking into account the execution of entrepreneurship education in universities to decrease the occurrence of youth unemployment and the significance of teacher education. This paper uses a hierarchical analysis algorithm to evaluate the quality of university students’ innovation and entrepreneurship education. AHP algorithm is a hierarchical, structured, combined qualitative, and quantitative decision-making method. The key steps are to construct the judgment matrix and to calculate the ranking weights of each element being compared from the judgment matrix. For our proposed education quality evaluation system, a hierarchical model is constructed to conceptualize the relationship between different elements, and then a judgment matrix is constructed. After constructing the judgment matrix, this system analyzes methods for calculating element weights, such as characteristic root, square root, and power. By comparing and studying the advantages and disadvantages of the above methods, an innovative improved algorithm combining the least squares method and the iterative power method with each other is proposed. The improved algorithm is verified by example to have better adaptability and also reduce the computational complexity.

3. Materials and Method

3.1. IoT for University Bi-Entrepreneurship Curriculum. This section expands on the idea of IoT use in entrepreneurship training and instruction in Chinese universities. First, this section describes and discusses IoT in the context of the chosen domain. Following that, it provides the Hierarchical Analysis of University Entrepreneurship Education. Finally, the revised AHP algorithm for the university’s Bi-Entrepreneurship program is discussed in this section.

The emergence of IoT technology provides an opportunity for universities and staff to solve limits and inadequacies in present entrepreneurship teaching and training programs. In general, IoT describes a network of intelligent devices capable of detecting, recording, and monitoring events or activities and sending the acquired data to another device or apps for analysis or action over the Internet or a network. IoT devices may have built-in processing capacity or may outsource computation to apps and devices in their surrounding environment.

3.1.1. Hierarchical Analysis (AHP Algorithm). The application of hierarchical analysis (AHP) first appeared in the field of operations research. In 1977, the first global conference on mathematical modeling was held in the United States. Professor Satie, a famous operations research scientist, published "Modeling of Unstructured Decision Problems—Hierarchical Analysis" [25], which proposed a new modeling method and introduced the mathematical approach to social problems for the first time. Since then, the vision has shifted from studying qualitative problems to studying quantitative problems. People started to pay attention to the hierarchical analysis method. Due to the advantages of simple operation, practicability, and systematics [26], hierarchical analysis has been gradually applied to a wide range of fields such as scientific management, multi-objective decision-making [27], economic development evaluation [28], and evaluation system construction [29]. The basic steps of the traditional hierarchical analysis method are shown in Figure 1.

(i) Establishing a Hierarchical Structure Model. Hierarchical analysis (AHP) focuses on the hierarchical relationships between elements. For the problem to be solved, the first step is to gradually hierarchize all elements and build a framework diagram. It is usually divided into three levels, wherein the first level is the highest level of the problem to be solved. The second level is the middle level, which is some criteria to be solved, and the last level the third level is some options or factors of the problem [30]. The general hierarchy diagram of AHP is shown in Figure 2.

(ii) Create a Comparison Matrix [25]. To determine the relative importance of the elements and to quantify the results of the comparison, the elements of each layer are compared in pairs. Typically, numbers 1 through 9 are used to indicate the importance of each of these two elements. While the number 1 indicates that the two elements are of equal importance and the importance will increase in increasing order of the number. Similarly, the number 9 indicates the comparison of two elements, one of which is very important. Finally, the comparison results are used to form a judgment matrix for analysis. Let the upper element and \( n \) elements. Based on the results of all comparisons of the relative importance of Bi to Bj, a judgment matrix \( B \) of influence elements is formed, which may be seen in the following equation:

\[
B = \begin{pmatrix}
1 & b_{12} & \cdots & b_{1n} \\
b_{21} & 1 & \cdots & b_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
b_{n1} & b_{n2} & \cdots & 1
\end{pmatrix}
\]

(iii) Calculate the Importance Weights between the Elements of Each Layer. Eigenvector is a nonzero vector that varies by a scalar factor whenever that transformation function is performed on it. The eigenvalues, on the other hand, were employed to compute the theoretical limit of the amount of data that could be conveyed through a communication
channel. This is accomplished by computing the communications channel’s eigenvectors and eigenvalues and then water filling on the eigenvalues. The eigenvalues are therefore essentially the gains of the channel’s basic phases that are recorded by the eigenvectors. If \( A_k \) is a linear function from a vector space \( W \) to a field \( F \), it may be determined using the following equation:

\[
A_k W = \lambda_{\text{max}} W.
\]  

In the above equation, \( \lambda_{\text{max}} \) is a scalar in function \( F \), recognized as the eigenvalue related with \( W \). Normalizing judgment matrix \( A_1, A_2, \ldots, A_n \) arranges the previous level’s element weights.

(iv) Check the Consistency of the Matrix. Consistency is the fundamental driver for achievement, which necessitates a huge commitment from the proposed work and entails continued work in repeating behaviors until you attain desired objectives. After calculating the weights of each matrix at each level, its consistency needs to be verified. Import the indicator \( CI \) calculated through the following equation:

\[
CI = \frac{\lambda_{\text{max}} - n}{n - 1}.
\]  

When \( = 0 \), the judgment matrix is perfectly consistent, but the actual situation is often not so perfect. The calculation result is usually \( > 0 \). At this time, the average random consistency index \( RI \) is needed. \( RI \) is used to check the satisfactory consistency of the judgment matrix, and its calculation formula can be represented as follows:

\[
RI = \frac{\lambda_{\text{max}}' - n}{n - 1},
\]

where \( \lambda_{\text{max}}' \) is the maximum eigenvalue of the matrix constructed above, and the average value is obtained. The Consistency Ratio (CR) is a statistic that measures the consistency of pairwise comparisons. As a result, consistency is intimately linked to the transitive property. If the value of CR is less than or equivalent to 10%, inconsistency is accepted, while subjective assessment must be revised if the CR is larger than 10%. After obtaining the CI and RI, the consistency ratio CR is calculated as follows:

\[
CR = \frac{CI}{RI}.
\]

According to the above equation, when \( CR < 0.10 \), it can be concluded that the consistency of the matrix is good. Otherwise, the comparison matrix should be adjusted appropriately until it satisfies \( CR < 0.10 \). At this time, the maximum eigenvalue \( \lambda_{\text{max}} \) of the comparison matrix is calculated and the corresponding eigenvectors are normalized to obtain the order of the weights of each layer [31].

(v) Sort the Entire Hierarchy. Calculate the weight of each sub-element in the last layer relative to the target problem to be solved. This step is the most important step in the whole hierarchical analysis method, and the calculation result directly affects the final judgment and selection. Assume that the weights of all elements in layer are \( a_1, a_2, \ldots, a_m \) and the weight of each element in that layer under that layer assumed
to be $b$. Then, the total ranking weights of the elements in layer $B$ are derived by referring to the formula in Table 1.

**Step 6** Verify the Consistency of the Final Weight Ranking Results. To verify the consistency of the final weight ranking results, let $CI$ be the one-time indicator of the total hierarchical ranking, and the formula for its calculation can be represented as follows:

$$CI = \sum_{i=1}^{m} a_{i} CI_{i}. \quad (6)$$

In the above equation, $CI$ is the consistency value of each matrix of the intermediate layer obtained from the above step. Let $RI$ be the random consistency index of the total hierarchical ranking and the formula for $RI$ be presented as follows:

$$RI = \sum_{i=1}^{m} a_{i} RI_{i}. \quad (7)$$

In the above equation, $RI$ is the random consistency index of each matrix of the intermediate layer obtained from the above step. The overall consistency index is calculated as equation (5).

From all these equations, it is clear that when the calculated $CR < 0.10$, it can be judged that the consistency of the hierarchical total sorting results meets the requirements. At this point, the computed results can be used to analyze and evaluate the problem to be solved.

### 3.2. Method

#### 3.2.1. Improved AHP Algorithm

Universities that do not carry out defined curriculum construction will be completely removed by the times, due to the rapid growth of the information community. The selection of rising education is a crucial stage for businesses to take when developing a Bi-Entrepreneurship curriculum. The AHP analytic hierarchy process is used to break down the items relating to the selection decision. The model for multilevel analysis has been developed. After establishing the significance of each factor at each level, a hierarchy ordering and stability test is conducted along with the creation of a judgment matrix. This paper obtains an AHP-based Bi-Entrepreneurship curriculum for the university selection method. The suggested AHP university Bi-Entrepreneurship curriculum is divided into three layers. As shown in Figure 3, these layers are comprised of the target, attribute, and solution layers. The target layer is made up of three different elements: school, student, and social group. When choosing a university curriculum, the attribute layer includes aspects such as form, venue, support, innovative practice, the effect of innovation, satisfaction, benefits, and prospects. Support, places, a type of education, practices, effectiveness, satisfaction, gain, and development are all aspects of the solution layer.

This paper employs an analytic hierarchy process (AHP) algorithm to build an evaluation indicator system of university students’ innovation and entrepreneurship education quality. Figure 4 shows a flow chart illustrating the multiple stages involved in conducting the AHP research.

(i) Step 1: the goal of this research is to create an evaluation method for the university Bi-Entrepreneurship curriculum to maximize benefits and prioritize the allocation of resources to individual practice throughout model implementation.

(ii) Step 2: the recommended algorithm’s second step is based on analysis. During this step, the problem is analyzed. Once the problem is analyzed, a hierarchical structure model is established, which typically includes the target layer, attributes layer, and solution layer.

(iii) Step 3: the judgment of each layer is very important, so in order to judge each matrix layer, our suggested model uses T.L. Saaty’s 1~9 scale to judge each matrix layer [30].

(iv) Step 4: the most crucial instrument for any judgment analyst to master is weighted ranking. The technique is highly efficient: it is the perfect tool available in terms of input effort involved data is expressed advantage received. By far the most powerful measure for one’s time and efforts available. Hence, step 4 calculates each layer’s ranking weights using square roots.

(v) Step 5: the consistency ratio indicates the consistency of the judgment matrix. A greater number indicates less consistency while a lower number indicates greater consistency. In general, the decision-maker’s answers are relatively consistent if the consistency ratio has been 0.10 or even less. When the consistency ratio exceeds 0.10, the research study must contemplate re-evaluating reactions during the pairwise comparisons that were used to generate the original matrix of pairwise comparisons. In our case, step 5 of the suggested algorithm checks the consistency of the Matrix judgment with formula (8), and if it is consistent, goes to step 5; otherwise, amend the Matrix judgment with formula (3) and go to step 3.

(vi) Step 6: finally, step 6 calculates the total ranking weight of each scheme.

#### 3.2.2. Modifying the Judgment Matrix

The judgment matrix method is a pairwise comparison-based multicriteria decision-aiding technique. Similar to AHP, pairwise comparisons among various criteria and various alternative solutions with respect to the criteria allow the decision-maker to express their desires. If the elements in the judgment matrix satisfy [32]: $a_{ij} > 0, a_{ij} = 1/a_{ji}, a_{ij} = 1 (i, j = 1, 2, ..., n)$ then the matrix $A$ is said to be a positive-inverse inverse matrix.

**Definition 1** (see [33]). Let the Matrix judgment $A = (a_{ij})_{n \times n}, i, j = 1, 2, ..., n, a_{ij} = a_{ki}a_{kj}$ then the Matrix judgment $A$ is a consistency matrix.
The consistency matrix has the following properties:

**Theorem 1** (see [34]). A sufficient condition for the Matrix judgment $A = (a_{ij})_{n \times n}$ is that the maximum eigenvalue $\lambda_{\text{max}} = n$ of $A$ with normalized eigenvectors $\bar{\omega} = (\bar{\omega}_1, \bar{\omega}_2, \ldots, \bar{\omega}_n)^T$ is the weight vector.

**Theorem 2** (see [35]). A sufficient condition for the matrix $A = (a_{ij})_{n \times n}$ to be completely consistent is that $a_{ij} = a_{ik}a_{kj} \forall i, j, k = 1, 2, \ldots, n$.

Positive and negative matrix $A$ is consistent according to Definition 1 and Theorem 2:

$$\forall i,j,k = 1,2,\ldots,n; a_{ij} = a_{ik}a_{kj} \quad (8)$$

For (8), the summation of the two sides with respect to $k$ is obtained in [30],

$$a_{ij} = \frac{1}{n} \sum_{k=1}^{n} a_{ik}a_{kj} \quad (9)$$

where (8) and (9) are necessary for positive and negative matrix $A$ consistency.

If (9) does not hold, then matrix $A$ is not consistent. Equation (10) is a precondition for determining the consistency matrix.

$$b_{ij} = \frac{1}{n} \sum_{k=1}^{n} a_{ik}a_{kj}, i < j, i = j, \frac{1}{b_{ij}}, i > j. \quad (10)$$

Using $B = (b_{ij})_{n \times n}$ as A’s correction matrix can improve its consistency; if $A = (a_{ij})_{n \times n}$ is the consistency matrix, then $B = A$.

### 3.2.3. Improvement of the Consistency Test

The strength of a consistent test for a repaired factually incorrect hypothesis grows to one as the number of information items tends to increase. Consistency in program evaluation is critical to ensuring that every applicant has the same expertise and is fairly treated. If we let $\omega$ be the normalized eigenvector corresponding to the largest eigenvalue $\lambda_{\text{max}}$ of matrix $A$, we
know from Theorem 1 that $\vec{w} = (\vec{w}_1, \vec{w}_2, ..., \vec{w}_n)^T$ is the weight vector of the hierarchical single ordering, as calculated in the following equation:

$$A\vec{w} = \lambda_{max}\vec{w}. \quad (11)$$

If the matrix $A$ is perfectly consistent, then its maximum eigenvalue $\lambda_{max} = n$. If $A$ is not perfectly consistent, then the maximum eigenvalue $\lambda_{max}$ of $A$ will be slightly larger than $n$; so, using the following equation:

$$\|A\vec{w} - \lambda\vec{w}\| = \|n\vec{w} - \lambda\vec{w}\| < \epsilon. \quad (12)$$

As the criterion to test whether the matrix $A$ satisfies the consistency criterion. According to Professor T.L. Saaty’s [29] consistency ratio $CR = \frac{CI}{RI} = \frac{\lambda_{max} - n}{n(n - 1)RI} < 0.1$, we can get the following equation:

$$|\lambda_{max} - n| < 0.1(n - 1)RI. \quad (13)$$

And $\|A\vec{w} - n\vec{w}\| = |\lambda_{max} - n| \cdot \|\vec{w}\| \leq |\lambda_{max} - n|$, and substituting (6) into the equation, we get the following equation:

$$\epsilon = 0.1(n - 1)RI. \quad (14)$$

It is obviously that we use the following equation:

$$\|A\vec{w} - \lambda\vec{w}\| < 0.1(n - 1)RI. \quad (15)$$

To determine whether the matrix’s consistency is satisfactory, the eigenvalues of $A$ can be omitted and only the sorting vector must be calculated which simplifies the operation and increases its running speed.

3.2.4. Matrix Consistency Test. To test the matrix consistency, we know that $A = \begin{bmatrix} 1 & 8 & 9 \\ 1/8 & 1 & 9 \\ 1/9 & 1/9 & 1 \end{bmatrix}$ and its normalized eigenvalue vector $\vec{w} = [0.829, 0.325, 0.034]$ by the square root method, where $\epsilon = 0.1(n - 1)RI = 0.116$, and $\|A\vec{w} - n\vec{w}\| = \|A\vec{w} - 3\vec{w}\| = 1.161 > 0.116$, which does not satisfy (8), so the consistency of the matrix is not satisfactory.

The matrix $A$ is corrected by (10) to obtain matrix $B$.

$$B = \begin{bmatrix} 1 & 17/3 & 30 \\ 3/17 & 1 & 51/8 \\ 1/30 & 8/51 & 1 \end{bmatrix}. \quad (16)$$

The normalized eigenvalue vector $\vec{w} = \frac{0.736}{0.372}$, and the test equation $\|B\vec{w} - n\vec{w}\| = \|B\vec{w} - 3\vec{w}\| = 0.013 < 0.116$, so the corrected matrix has satisfactory consistency, which is given as follows:

$$\vec{w}_j = \sum_{j=1}^{m} \vec{w}_j^c \omega_j^c. \quad (17)$$

In the above equation, $\vec{w}_j^c$ is scheme $i$’s attribute $j$ weight, $\omega_j^c$ denotes $j$’s weight, and $m$ denotes counts characteristics.

Compared with the original AHP algorithm, the new and improved hierarchical analysis (AHP) algorithm created in this paper avoids the process of re-survey, data collection, and Matrix judgment construction. In addition, it shortens the problem-solving time and saves human and financial resources due to the modification of the inconsistent Matrix judgment. Due to the improved consistency discrimination method, we can directly use the normalized eigenvectors and Matrix judgment to maximize the computation process of eigenvalues, thus avoiding the computation. A significant amount of practice demonstrates that the Matrix judgment that does not satisfy the consistency situation requires only one correction. If the consistency is still not satisfied after one correction.
4. Experimental Work and Analysis

4.1. Evaluation Index. A university is used as an example to more thoroughly study how hierarchical analysis algorithms are applied in the system of evaluating educational quality. The evaluation indexes are numerous, generally subject to multiple factors, and have multilevel characteristics. With the best decision scheme as the target layer, the overall structure of evaluation indicators is refined according to the specific situation, as shown in Figure 5.

4.2. Analysis Optimization Function. We use the previous paper to establish the consistency index function CI, solve for the weights, set the variable $p = 5$, set the initial interval to $[0, 1]$, the population size $n = 50$, the interval precision 0.001, the coding length $e = 10$, the maximum number of iterations 500, and record as AHP (1), load the great module in Python, and obtain the 267th generation population in the optimal values. According to the data processing results, the single ranking weights of threat indicators were 0.501, 0.086, 0.229, 0.138, and 0.046, and the optimal CI value was 0.0157. According to Section 3.3, the consistency test was performed with RI $(5) = 1.12$, and then CR $= 0.014 < 0.1$, which satisfied the consistency condition.

In order to obtain the optimal consistency ratio, we adjusted the search interval, coding length, interval precision, and other parameters: to adopt two-point hybridization, set the interval precision to 0.000 (1), corresponding to the coding length $e = 17$, and obtain the optimal value in the 224th generation population, which is denoted as AHP (3). The optimal value is obtained at the 224th generation population and is denoted as AHP (3). Based on $e = 14$, the initial interval is reduced to $[0, 0.5]$ and is denoted as AHP (4). The optimal value is obtained at the 294th generation population. The number of iterations is set to 1,000, 1,500, and 2,000, and the optimal values are obtained at the 325th, 1,396th, and 695th generation populations, which are denoted as AHP (5), AHP (6), and AHP (7), respectively. A single-point the optimal values were obtained at the 1,835th generation of the population, which were recorded as AHP (8), by adopting a single-point hybridization with interval precision of 0.000 1, coding length $e = 14$, and iteration number 2,000. By comparison, it can be concluded that the optimal consistency ratio, AHP (7), can be obtained at an interval precision of 0.000 1, coding length $e = 14$, iteration number of 2,000, and two-point hybridization, as shown in Figure 6.

4.3. The Importance of Evaluation Indicators. Figure 7 shows a comparison of index weights and total weights for C11, C12, and C13, respectively. This figure compares Matrix judgment of indicators corresponding to the university factor. According to this figure, C12 has a higher index weight than the other two, as well as the highest total weight when compared to the others.

Figure 8 shows a comparison of index weights and total weights for C11, C12, and C13, respectively. This figure compares Matrix judgment of indicators
corresponding to the student factor. According to this figure, C23 has a higher index weight than the other two, while C21 has the highest total weight when compared to the others.

Figure 9 shows a comparison of index weights and total weights for C11, C12, and C13, respectively. This figure compares Matrix judgment of indicators corresponding to the group factor. According to this figure, C33 has a higher index weight than the other two, while C31 has the highest total weight when compared to the others.

In summary of the above figures, this work compared the importance of secondary indicators in each indicator of schools, students, and associations. From Tables 2 to 4, we can see that the ranking of school indicators: entrepreneurial support > entrepreneurial places > the form of entrepreneurial education, and the ranking of student indicators: innovation Entrepreneurial practice > effect of innovation and entrepreneurship > entrepreneurial satisfaction, ranking according to community indicators: entrepreneurial income > development prospects > satisfaction.

4.4. Comparison with Other Methods. Figure 10 shows the comparison results of multiple methods. According to this figure, it is the result of the comparison between the GA AHP algorithm and other methods. The comparison illustrates the superiority of the AHP algorithm in optimizing the accuracy and consistency ratio of the feature vectors.
5. Conclusions

Currently, the utilization of IoT technology and devices has altered several industries, especially healthcare, commerce, and transportation. IoT systems and enabling technologies, like those in other sectors, have the potential to change university entrepreneurship course offerings. IoT technology can enable entrepreneurship professors and institutions to analyze students, adapt entrepreneurship courses, incorporate external resources and entrepreneurship ecosystem players into courses and incorporate learning experiences into courses. Keeping in view of the above, this research provides a quality evaluation system for innovation and entrepreneurship education to support university students in becoming more creative and entrepreneurial. In this research, innovation and entrepreneurship education are accurately evaluated. First, this work optimizes the existing evaluation indexes and builds a multi-dimensional and multi-sub-indicator evaluation index system for university students’ innovation and entrepreneurship education. Second, the hierarchical analysis is done after determining evaluation indices. We created a hierarchical model and a Matrix judgment for our suggested education quality evaluation system. Scaling approaches for Matrix judgment were examined, and the optimum scaling option was chosen by weighing its benefits and drawbacks. During the construction of the Matrix judgment, strategies for computing relative weights such as feature root, square root, and power were investigated. Numerical examples demonstrate the new algorithm’s flexibility and reduced complexity.
**Data Availability**

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

**Conflicts of Interest**

The author declares that he has no conflicts of interest.

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**References**

[1] A. Song, "Research on the design of quality evaluation index system of higher vocational innovation and entrepreneurship education," *Education sector: Higher Education Research*, vol. 11, no. 9, pp. 202-203, 2015.

[2] H. Wu, X. Liu, and W. Cai, "Quality evaluation of innovative and entrepreneurial talents cultivation in universities based on fuzzy comprehensive evaluation," *Journal of Hefei Union University*, vol. 23, no. 8, pp. 99-101, 2016.

[3] J. Zhang and F. Zhang, "An investigation on building an innovative entrepreneurship education system for University students," *Fujian Quality Management*, vol. 20, no. 3, pp. 64-65, 2016.

[4] X. Gao, W. He, and X. Yang, "Research on the construction of the evaluation index system of innovation and entrepreneurship education in Universities and universities--based on international innovative talent evaluation theory," *Science and Education Wenhuai Lent*, vol. 11, no. 2, pp. 215-216, 2015.

[5] W. Fan, Y. Ma, and C. Liu, "Analysis of factors influencing innovation and entrepreneurship education of graduate students--an empirical study based on SEM," *Heilongjiang Higher Education Research*, vol. 25, no. 7, pp. 199-200, 2017.

[6] M. Zhang, "Building a curriculum system of innovation and entrepreneurship education for University students in Xinjiang higher education institutions based on the new connotation of innovation and entrepreneurship education," *China Training*, vol. 16, no. 3, pp. 52-53, 2016.

[7] M. M. Xu and X. H. Fang, "Thinking about the path of innovation and entrepreneurship education for University students Education," *Modernization*, vol. 40, no. 24, pp. 53-54, 2016.

[8] J. Qin, "Research on the quality evaluation of entrepreneurship education in Universities and universities based on QFD," *Management Science and Engineering*, vol. 39, no. 12, pp. 163-168, 2009.

[9] W. Wei, "Types and influencing factors of entrepreneurship education evaluation in Universities and universities," *Viewpoint*, vol. 21, no. 3, pp. 45-49, 2011.

[10] L. Pei and C. Shen, "Research on the evaluation method of entrepreneurship education effectiveness," *Innovation and Entrepreneurship Education*, vol. 41, no. 12, pp. 11-14, 2012.

[11] H. Yang, "Research on the evaluation model of entrepreneurship education in higher education institutions based on CIPP," *Journal of Beijing University of Finance and Trade*, vol. 32, no. 2, pp. 8-14, 2016.

[12] F. Yanfei and X. Tong, "Research on the quality evaluation model and hair method of entrepreneurship education for University students," *Journal of Huazhong Agricultural University (Social Science Edition)*, vol. 29, no. 1, pp. 122–128, 2013.

[13] Q. Shi, A Preliminary Study on Building a Quality Evaluation System of Innovation and Entrepreneurship Education Based on Students’ Perspective: An Example of Practical Exploration, Changzhou Information Vocational Technology University, Changzhou, China.

[14] H. Wang and Y. Huang, "Research on the evaluation of entrepreneurship education and entrepreneurship education model in China’s universities," *China Adult Education*, vol. 22, no. 4, pp. 81–85, 2012.

[15] Z. Zhu and R. Gu, "A study on the quality evaluation of entrepreneurship education services in local universities based on DEA," *Journal of Yangzhou University (Agricultural and Life Science Edition)*, vol. 14, no. 2, pp. 37–42, 2013.

[16] S. Shen, ""The construction of evaluation system of entrepreneurship education in applied undergraduate universities," *Journal of Chifeng University*, vol. 28, no. 8, pp. 136-137, 2012.

[17] G. Li, "Research on fuzzy comprehensive judgment and control method for the quality of university students’ innovation and entrepreneurship education," *Business Modernization*, vol. 61, no. 9, pp. 170–175, 2004.

[18] B. Liu, "AHP-Based evaluation index system of university students’ employment and entrepreneurship education," *Journal of Dongbei Normal University (Philosophy and Social Science Edition)*, vol. 33, no. 6, pp. 227–232, 2012.

[19] D. Tao and D. Chen, "Research on the quality evaluation index system of entrepreneurship education in Chinese universities," *Science and Technology Management Research*, vol. 23, no. 5, pp. 84-86, 2010.

[20] Li Ge and Z. Liu, "Research on the evaluation index system of entrepreneurial ability in universities based on CIPP," *Journal of Northeastern University*, vol. 49, no. 7, pp. 377–382, 2014.

[21] H. Huang, "Performance evaluation of entrepreneurship education based on balanced scorecard," *Journal of Yueyang Vocational and Technical University*, vol. 50, no. 11, pp. 30–33, 2015.

[22] Li Yue and H. Wang, "The design of BSC-based quality assessment index system of entrepreneurship education in Universities and universities," *Technology Management*, vol. 19, no. 3, pp. 53–57, 2014.

[23] H. Su, "Performance assessment of entrepreneurship education in Universities and universities based on balanced scorescard," *Chongqing Higher Education Research*, vol. 11, no. 6, pp. 34–39, 2015.

[24] D. Jiang, "On the construction of the evaluation system of innovation and entrepreneurship education instruction in Universities and universities," *Innovation and entrepreneurship education*, vol. 37, no. 12, pp. 1–4, 2015.

[25] H. Yang, X. Wang, J. Zhang, Y. Ren, and F. Long, "Analysis of university infrastructure project management model based on hierarchical analysis," *Journal of Tsinghua University*, vol. 8, pp. 1119–1127, 2013.

[26] S. Jiang, "Construction and application of enterprise internal audit performance evaluation system based on hierarchical analysis method," *Science and Technology Management Research*, vol. 16, no. 5, pp. 202–206, 2012.

[27] Yu Lei, X. Zhang, and J. Yu, "Analysis of competitiveness of resource-based industrial clusters based on hierarchical
analysis,” *Hunan Social Science*, vol. 44, no. 5, pp. 142–144, 2012.

[28] Z. Shen, “Using hierarchical analysis to construct the performance evaluation system of state-owned enterprises,” *Audit Research*, vol. 2, pp. 106–112, 2013.

[29] J. Zhaoquan and G. Ye, “Research on supplier evaluation system of pharmaceutical companies based on hierarchical analysis method,” *Science and Technology Management Research*, vol. 47, no. 12, pp. 53–57, 2012.

[30] L. Qu, Li Yue, F. Kong, L. Zhao, and P. Sun, “Application of hierarchical analysis method in the preferential selection of rural domestic sewage treatment mode,” *China Population, Resources and Environment*, vol. 26, no. S2, pp. 112–115, 2012.

[31] T. Gan, “Research on distance learning quality assessment of universities based on decision tree classification algorithm,” *Modern Electronic Technology*, vol. 44, no. 9, pp. 171–175, 2021.

[32] D. Liang, Q. Zhou, and K. Wang, “Construction of digital resource service performance evaluation system based on hierarchical analysis method,” *Intelligence Science*, vol. 1, pp. 78–81, 2013.

[33] Y. Li, Qi Qiao, F. Chai, Y. Yao, B. Lu, and X. Hu, “Weight analysis of environmental risk evaluation indexes in industrial parks based on hierarchical analysis,” *Environmental Science Research*, no. 3, pp. 334–340, 2014.

[34] Z. Xu, “Study on the relationship between two types of scales in AHP,” *Systems Engineering Theory and Practice*, vol. 7, pp. 98–102, 1999.

[35] X. Deng, J. Li, H. Zeng, J. Chen, and J. Zhao, “Analysis of hierarchical analysis method of weight calculation and its application research,” *The Practice and Understanding of Mathematics*, vol. 07, pp. 93–100, 2012.