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Rural E-Commerce Entrepreneurship Education in Higher Education Institutions: Model Construction via Empirical Analysis

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Abstract: Rural e-commerce entrepreneurship education (EE) in Higher Education Institutions (HEIs) can effectively enhance the development of the rural e-commerce industry and improve the motivation of students to start or be employed in rural e-commerce, but how to conduct effective evaluation is an issue that remains to be clarified. The research objectives of this paper are as follows: to establish a "student-centered" evaluation model for EE in HEIs, to integrate rural e-commerce professional education with EE, and to provide practical guidance for the evaluated HEIs. This paper constructs an evaluation model of rural e-commerce EE in HEIs. The research method combines Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation Method. The questionnaire method was used to obtain 384 valid data for the empirical analysis of the education of the Software Engineering Institute of Guangzhou. The study's results found that the final evaluation result of the school's rural e-commerce EE grade was good. The indicators at the level of educational support and feedback effectiveness scored relatively high, but those at the level of learning input and educational process scored low. Based on the findings, recommendations were made in terms of developing more open feedback channels, providing a full range of services, and social flexibility of the training program.

Keywords: entrepreneurship education; higher education institutions; fuzzy comprehensive evaluation method; rural e-commerce

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1. Introduction

Chinese rural online retail sales will reach 2.05 trillion yuan in 2021, an increase of 11.3% year-over-year [1]. As an expanding style of economic activity, rural e-commerce is also an efficient subject needing practitioners with exceptional practical skills [2,3]. In recent years, in the context of "mass entrepreneurship and innovation", the state has prioritized fostering Entrepreneurship Education (EE) in rural e-commerce for students. It has enacted a number of significant legislations to promote this initiative. The contradiction between the difficulty of student employment and the dearth of talent and skills among rural e-commerce teams must be resolved as soon as possible. Higher Instruction Institutions (HEIs) typically provide students with e-commerce education in rural areas. However, the practical abilities of many undergraduates majoring in e-commerce fall far short of the complex abilities that businesses require. Currently, a large number of students are dissatisfied with the EE services provided by their alma mater, and there is no common approach to evaluate the educational outcomes of HEIs. In EE courses for college e-commerce majors, theory is prioritized above practice. Some professional textbooks and instructional materials are severely lacking in depth [4]. Students majoring in e-commerce and related courses have limited options to enhance their professional abilities, inventiveness, and entrepreneurialism [5]. According to the China Undergraduate Employment Report, 56%

of 2017 undergraduates say their alma mater lacks entrepreneurial practice opportunities. In contrast, 45% say there is a shortage of EE courses [6].

EE programs in HEIs have undergone tremendous expansion globally since the first entrepreneurship course was offered at Harvard Business School in 1947 [7,8]. In recent decades, scholars at home and abroad have explored and researched EE in higher education from multiple perspectives [9,10]. Levie [11] and Nabi et al. [12] consider EE as a series of courses on the topic of entrepreneurship, new business management or starting a new business. Moreover, they emphasized that EE focuses on new business activities rather than existing ones. Rural e-commerce, as an emerging industrial activity, can open up new markets for agricultural products and provide new directions for employment and entrepreneurship for university graduates. In this way, combining EE in HEIs with the emerging rural e-commerce industry is only logical.

Academics generally agree that EE in HEIs can have a significant positive effect, whether on students' entrepreneurial attitudes and intentions [13,14], graduates' adaptability to employment and entrepreneurship [7,15], business start-up and development [16–18], or the development of regional economies [19,20].

While EE is flourishing in HEIs, there are essential questions that have yet to be answered or clarified. EE programs for the rural e-commerce sector can undoubtedly positively impact students, but how can students' entrepreneurial learning outcomes be judged? What indicators and research methods should be used? Furthermore, what is the applicability of the evaluation model proposed in the paper?

Based on these questions, the purpose of this study is as follows:

a. Develop a 'student-centered' model for evaluating EE and services in HEIs.
b. Provide practical guidance for evaluated HEIs.

This paper develops an evaluation index system for rural e-commerce EE based on George Kuh's learning input theory. The input theory consists of learning input, educational support, educational process, and feedback effectiveness as the primary indicators. In selecting the evaluation method, considering the "fuzzy" nature of the objectives and the practical experience of scholars, a combination of the Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation Method was used.

The authors chose Software Engineering Institute of Guangzhou, where they work, to conduct an empirical study to verify the applicability of the indicator system. The empirical analysis concludes that the HEIs' rural e-commerce EE is evaluated as good and suggests actionable guidelines. The paper's contribution aims to explore the whole process of the EE evaluation model, enrich the education evaluation index system for student subjects, and make practical suggestions for the schools in the empirical analysis.

There are two innovations in this study. On the one hand, it expands the attempt to assess EE for new business activities. As a dynamic and far-reaching new business activity, rural e-commerce has attracted substantial attention and progressive EE implementation in many HEIs. However, there is no widely used model for assessing rural e-commerce EE in HEIs for reference. On the other hand, learning input theory has an extended theoretical and practical application. It is a new attempt to reflect on EE efforts in HEIs by using students' learning experiences and judgments as an essential basis for model building and empirical research.

The remainder of the paper is divided into five sections. The literature review is discussed in Section 2. The theoretical model is built in Section 3, and the research hypotheses are presented. The research methodology and empirical findings are presented in Section 4. Section 5 examines our research's theoretical and practical ramifications and offers some suggestions. Finally, Section 6 summarizes the study's main findings and addresses the study's shortcomings.

2. Literature Review

The most prevalent research findings are those of industrialized nations, such as the United States, the United Kingdom, and Japan, which conducted EE research earlier. In contrast, emerging nations such as India and Nigeria have steadily prioritized research on EE in higher education institutions (HEIs) to improve the entrepreneurial environment.

2.1. Rural E-Commerce and Entrepreneurship Education

Kshetri was one of the first scholars to examine rural e-commerce in the early 1990s, followed by Ryuhei, the father of Japanese marketing. He also pioneered the study of rural e-commerce in Asia [21]. Rural e-commerce, they concluded, is a type of networking that connects numerous resources and, in the end, benefits rural commerce. Rural e-commerce, according to Li [22], is a result of the deep integration of agriculture and e-commerce, and its purpose is to bring agriculture and the market closer together. In reality, combining rural e-commerce with new technologies such as big data and cloud computing has evolved into a digital business model for the agricultural industry, with a continually changing and updating service model [22]. Many BRICS countries, including China, India, Russia, and Iran, attach particular importance to rural e-commerce's role in poverty eradication [23,24].

According to UNESCO, EE includes a variety of experiences and orientations that provide students with competence and perspective [25]. There is a consensus among academics that EE is an excellent method for fostering entrepreneurial attitudes and behaviors [26,27]. However, experts such as as Braun and Diensberg [28] and Hytti and Kuopusjarv [29] have argued that prior EE has not placed enough focus on establishing specialized entrepreneurial competencies. In recent years, some academics have conducted theoretical research on the confluence of rural e-commerce and entrepreneurship. For instance, Zhu [30] investigated the demand for inventive and entrepreneurial talent in the rural e-commerce sector. According to scholars such as Jiang [31] and Ye et al. [32], the effect of incorporating EE into professional e-commerce education can be realized by establishing and executing a curriculum framework for e-commerce students.

2.2. Evaluation of Entrepreneurship Education in Higher Education Institutions

With the increasing significance of entrepreneurship as a driver of economic growth. EE has been encouraged and integrated into school curricula in many countries [7,15,33] to compensate for the curriculum's deficiencies in addressing employment issues. Boldureanu et al. [13] and Ekpoh and Edet [34] found a favorable link between EE and students' career intentions in higher education institutions. According to Enu [35], Entrepreneurship programs in HEIs should be adaptable enough to overcome the perceived flaws in the current educational system. This places new demands on the innovativeness of schools' EE programs in addressing students' present and future needs and issues. Although the government and higher education institutions have developed numerous entrepreneurship programs and curricula to assist entrepreneurial activities, little is known about the efficacy of entrepreneurship program implementation [13].

The most influential HEIs evaluation system for EE is the Seven Elements of EE Program Evaluation, proposed by Richard Luecke [36], which uses factors such as courses offered, papers and publications published, impact on society, achievements of graduating alumni, innovation in the program itself, creation of new businesses by graduating alumni, and external academic connections. However, it was observed that the assessment of EE is often dominated by ex-post assessment designs such as the time-on-task theory [37], the quality of effort theory [38], the student engagement theory [39], the social and academic integration theory [40], the change assessment model [41] and the seven principles of effective teaching and learning at the undergraduate level [42], among six other classical theories. These HEIs are often assessed with a lack of acceptance of the EE process [43,44], which is in line with the observations of scholars such as Fauyolle [45] and Kailer [46].

Based on previous theoretical research, George Kuh developed a theory for assessing the effectiveness of the educational process [47]. George Kuh defines the theory of learnability as "a measure of the amount of time and experience students devote to effective educational activities and how they perceive the level of support provided by the school for their learning, which is essentially the result of the interaction between individual student behavior and it is essentially the result of the interaction between individual student behavior and the environment [47]". Moreover, its theoretical model is illustrated in Figure 1.

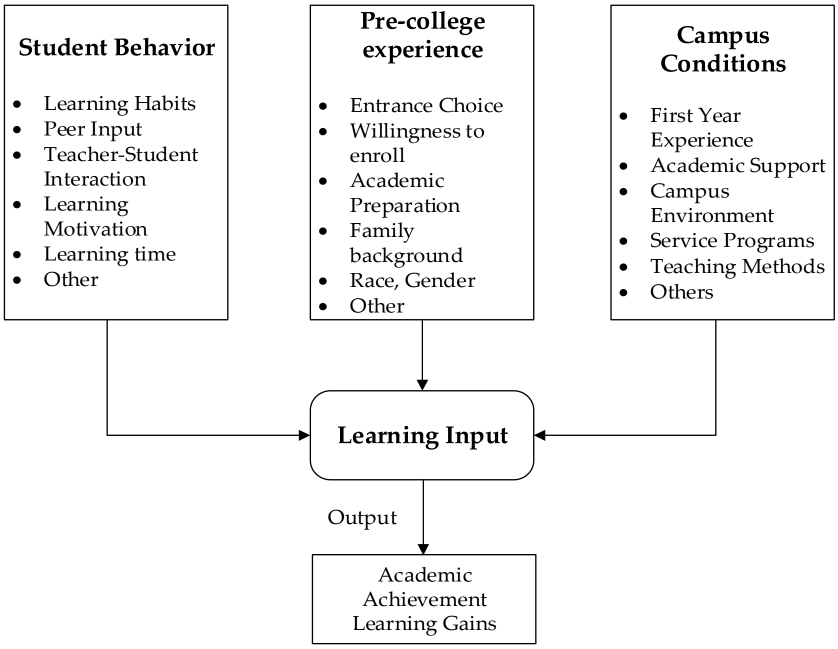

Figure 1. Diagram of a learning input theory model.

Nonetheless, as researchers such as Garavan and Barra [43] point out, there is a lack of study on the effects of these programs in the field of EE today. In assessment practice, outputs of entrepreneurial results, such as the conversion rate of entrepreneurship outcomes, student awards, and other external indicators, are frequently used as evaluation criteria at the government, school, and societal levels. The assessment, however, does not take into account the enhancement of students' consciousness, behavior, and abilities as a result of receiving EE.

3. Model Construction

3.1. Constructing Objectives

In the past, identifying indicators of outcome output type to reflect the "student-centered" evaluation concept was challenging and could not correctly reflect the actual condition of EE. On the one hand, the effectiveness of EE may be hampered by a time lag effect, i.e., the time between getting EE and establishing a firm is long [48]. It is too early to assess the success of HEIs that solely provide rural e-commerce EE regarding entrepreneurship behaviors and outcomes. On the other hand, students interested in receiving rural e-commerce entrepreneurship services focus on this paper's education and services. After all, students who compete in entrepreneurship competitions and win awards are a small minority that cannot fully reflect the high quality of this rural e-commerce EE.

This paper's evaluation model aims to create a "student-centered" education evaluated entrepreneurship index model. This model would examine and track the training objectives and effects of students receiving rural e-commerce EE from universities so that HEIs can improve their education and service programs over time.

3.2. Construction Principles

The following principles of the evaluation model were established based on the general principles of objectivity, comprehensiveness, and a combination of qualitative and quantitative analysis in education evaluation, as well as taking into account the motivation of student subjects in the educational process.

3.2.1. Systematic and Comprehensive

The selection of indicators and the construction of models are not isolated. However, they should have a holistic view, considering all dimensions and organically linking them to cover indicators from all perspectives of the student's education.

3.2.2. Developmental and Dynamic

The evaluation constructed in this chapter is conducted in rural e-commerce EE. These belong to the development of dynamic process evaluation, so the selection of indicators should also follow the developmental and dynamic nature so that the evaluation can reflect the actual situation of students in the learning process.

3.2.3. Hierarchy and Scientificity

Students' evaluation is closely related to hardware and software construction, theoretical and practical curriculum, teaching faculty, etc. In constructing model indexes, attention should be paid to the hierarchy of index selection to avoid the loss of scientificity due to the repetition of first- and second-level indexes.

3.3. Evaluation Index Construction

Based on the student's perspective, we combine the implementation of EE in HEIs while following the purpose and principles of evaluation index model construction. Based on learning input theory [47], this paper refers to the relevant index settings of the China College Student Survey (CCSS) [49], as well as the literature on education evaluation at home and abroad. Under the advice and guidance of the project expert group, we developed education evaluation indexes. The four dimensions of learning input, educational support, educational process, and feedback effectiveness comprised 16 evaluation indicators.

3.3.1. Learning Input

Referring to Professor George Kuh's principles of learning engagement theory [47], students were examined in terms of learning motivation, learning habits, and time commitment. Learning motivation is the intrinsic support to support students' acceptance of EE. In contrast, learning habits and time commitment reveal students' motivation and initiative to accept rural e-commerce EE.

3.3.2. Educational Support

Educational support is essential for rural e-commerce EE for students. Therefore, the educational support of the department mainly measures the software and hardware facilities, basic service facilities, entrepreneurship atmosphere, and policy support. The above factors are independent and intrinsically related, forming the evaluation index of the education guidance environment.

3.3.3. Educational Process

The previous education centered on teachers and teaching materials is not adapted to the characteristics of rural e-commerce EE and the development needs of students. However, the indispensable role of education faculty in cultivating students with innovation consciousness and entrepreneurial skills cannot be denied. The educational process evaluation consists of teachers, teacher–student interaction, course teaching, practical teaching, and assessment methods.

3.3.4. Feedback Effectiveness

As the object receiving education, students' feedback can directly show the effect of rural e-commerce EE. However, unlike the traditional output indicators of entrepreneurship papers and results, this paper evaluates four aspects: teaching tracking, feedback demand channels, entrepreneurship knowledge, and entrepreneurial employment skills.

4. Research Methodology and Empirical Analysis

4.1. Research Methodology and Principle

This paper evaluates the rural e-commerce EE of students of Software Engineering Institute of Guangzhou, using a mix of Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation Method, with the implementation phases shown in Figure 2.

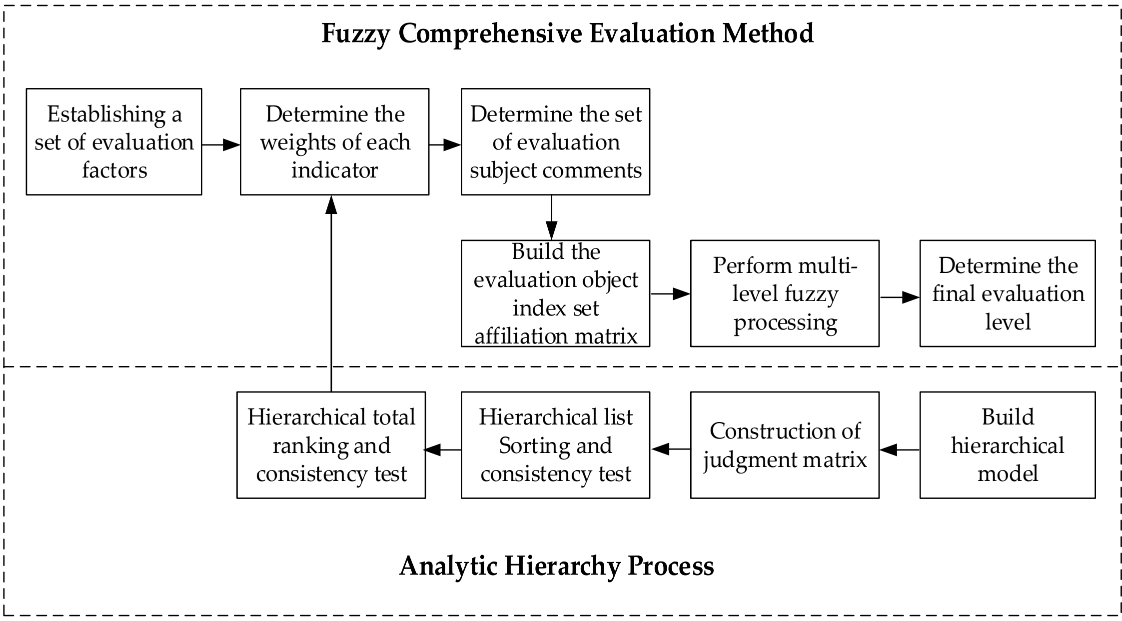

Figure 2. Schemes follow the same formatting. Implementation steps of Analytic Hierarchy Process combined with Fuzzy Comprehensive Evaluation Method.

The composite evaluation method is chosen for three reasons:

a. It is not enough to rely on qualitative analysis when evaluating the process of students' awareness, behavior, and competence enhancement in EE. Scholars such as Mimović P. and Krstić [50] and Zareinejad M. et al. [51] have also encountered such problems when evaluating in HEIs. When judging, some criteria are qualitative, and some criteria are quantitative. The AHP has been shown to be effective in combining qualitative and quantitative factors to make appropriate judgments.

b. The goal of the construction of the evaluation model is to evaluate the improvement of students' awareness, behavior, and ability in the process of receiving innovative education. It can be seen that the goal itself has the characteristics of fuzziness, which is challenging to be described by specific mathematical tools. For example, when students are asked to evaluate the teaching ability of teachers, the feedback may be "good" or "very good", with the line between the two being blurred. For this fuzzy phenomenon, fuzzy evaluation can be carried out using the theory and methods of fuzzy mathematics. Biswas [52] proposed two applications of fuzzy sets to student evaluation. Further, Chen and Lee [53] innovated the application of fuzzy evaluation.

c. The composite research approach is not the first of its kind by the authors; scholars such as Chen et al. [54], Chen [55], and Hu [56] have used this composite research approach to evaluate educational performance in practice and have achieved better feedback. However, we should also note that the use of this research method may have the following limitations: on the one hand, the system of indicators used in the AHP method needs to be supported by an expert system, and if the indicators given are not reasonable, the results obtained will not be accurate. On the other hand, when there are more elements, the consistency test may not pass.

The paper uses Analytic Hierarchy Process (AHP) to determine the weights of the evaluation indicators before constructing the index-set affiliation matrix of the Fuzzy Comprehensive Evaluation Method. Such a method can better solve the problems of factors that cannot be dealt with quantitatively in education evaluation and the unscientific formulation of evaluation index weights to produce quantitative evaluation results and improve the accuracy of evaluation.

4.2. Empirical Analysis

4.2.1. Establishing the Evaluation Factor Set

The '*U*' evaluation factor is set up in an index evaluation model. The model shows that the total target layer is the evaluation of rural e-commerce EE for HEIs students. We then use u_1, u_2, u_3, u_4 to represent the four dimensions of learning input, education support, educational process, and feedback effectiveness. These dimensions are then included in the criterion layer, respectively. Whereby $U = \{u_1, u_2, u_3, u_4\}$. Using uij to represent the indicator layer corresponding to each criterion layer, for example, u_{11}, u_{12}, u_{13} are used to represent the three secondary indicators of learning motivation, learning habits, and engagement time under the primary indicator of learning engagement. Similarly, the hierarchical structure of the index model for evaluating the quality of rural e-commerce EE of students in HEIs in Figure 3 can be obtained.

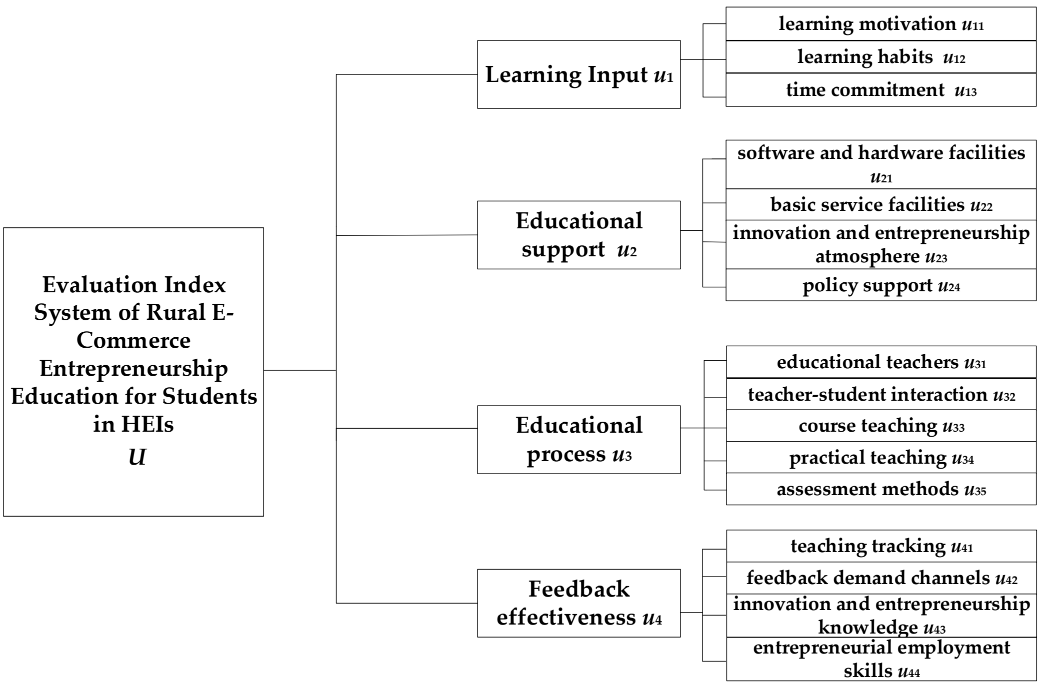

Figure 3. Evaluation index hierarchy chart.

4.2.2. Determining the Weights of Each Index

We employ AHP in this study to solve for the weights of 16 secondary indicators of u_{11}, u_{12}, u_{13}, u_{21}, u_{22}, u_{23}, u_{24}, u_{31}, u_{32}, u_{33}, u_{34}, u_{35}, u_{41}, u_{42}, u_{43}, u_{44} at respective criterion levels, as well as the four fundamental indicators of u_1, u_2, u_3, u_4.

1. Construction of judgment matrix

According to the expert group's comments, a two-by-two comparison of the evaluation factors was conducted, using the 1–9 scale method proposed by Professor Saaty as a reference [57]. The judgment matrix of the indicators are shown in Tables 1–5.

Table 1. Judgment matrix A of the second layer to the first layer U.

U	u_1	u_2	u_3	u_4
u_1	1	3	2	1/3
u_2	1/3	1	1/3	1/5
u_3	1/2	3	1	1/2
u_4	3	5	2	1

Table 2. Judgment matrix B_1 of the third layer to the second layer u_1.

U	u_{11}	u_{12}	u_{13}
u_{11}	1	1/2	1/3
u_{12}	2	1	1/2
u_{13}	3	2	1

Table 3. Judgment matrix B_2 of the third layer to the second layer u_2.

u_2	u_{21}	u_{22}	u_{23}	u_{24}
u_{21}	1	2	1/2	1/2
u_{22}	1/2	1	1/3	1/2
u_{23}	2	3	1	2
u_{24}	2	2	1/2	1

Table 4. Judgment matrix B_3 of the third layer to the second layer u_3.

u_3	u_{31}	u_{32}	u_{33}	u_{34}	u_{35}
u_{31}	1	2	3	1/2	3
u_{32}	1/2	1	2	1/3	2
u_{33}	1/3	1/2	1	1/2	2
u_{34}	2	3	2	1	3
u_{35}	1/3	1/2	1/2	1/3	1

Table 5. Judgment matrix B_4 of the third layer to the second layer u_4.

u_4	u_{41}	u_{42}	u_{43}	u_{44}
u_{41}	1	2	1/2	1/2
u_{42}	1/2	1	1/3	1/2
u_{43}	2	3	1	2
u_{44}	2	2	1/2	1

2. Calculation of eigenvectors and eigenvalues

We calculate the above judgment matrix eigenvectors W_i and use W_0, W_1, W_2, W_3, W_4 to denote the eigenvectors of judgment matrices A, B_1, B_2, B_3, B_4, respectively. After calculation, the results are as follows:

$W_0 = (0.832, 0.392, 1.150, 1.625)^T$

$W_1 = (0.491, 0.892, 1.617)^T$

$W_2 = (0.771, 0.484, 1.667, 1.078)^T$

$W_3 = (1.339, 0.805, 0.638, 1.792, 0.426)^T$

$W_4 = (0.698, 0.496, 1.389, 1.417)^T$

After finding the eigenvectors of each matrix, its maximum eigenvalue roots λ_{max} can be found accordingly. Using λ_0, λ_1, λ_2, λ_3, λ_4 to denote the maximum eigenvalue roots of the judgment matrices A, B_1, B_2, B_3, B_4, respectively, the following is obtained.

$\lambda_0 = 4.122$, $\lambda_1 = 3.009$, $\lambda_2 = 4.071$, $\lambda_3 = 5.191$, $\lambda_4 = 4.103$

3. Hierarchical single ranking and consistency tests

Since the judgment matrix was created artificially, a matrix consistency test is required to assess the matrix's reliability. As indicated in Equation (1) [57], the ratio of the difference between the maximum eigenvalue root λ_{max} and the order m of the judgment matrix to $n-1$ is introduced as a measure of the judgment matrix's divergence from consistency.

$$CI = (\lambda_{max} - n)/(n-1) \quad (1)$$

The smaller the *CI* value, the higher the degree of consistency of the matrix. When $CI = 0$, the judgment matrix is perfectly consistent. To measure whether the judgment matrices of different orders are satisfactorily consistent, Equation (2), which is the ratio *CR* of *CI* and the average random consistency index *RI* of the same order, is introduced to determine the random consistency ratio of the matrix [57].

$$CR = CI/RI \quad (2)$$

The *RI* values for orders 1–10 are shown in Table 6 [57].

Table 6. 1–10 th order *RI* coefficients.

Order	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	0.00	0.00	0.52	0.89	1.12	1.24	1.32	1.41	1.45	1.49

When $CR < 0.1$, the judgment matrix is considered to have satisfactory consistency; otherwise, the judgment matrix needs to be readjusted [57]. The above judgment matrix's index and random consistency ratio were obtained according to the formula shown in Table 7 below, and the listed judgment matrices passed the consistency test.

Table 7. Test on Judgment matrix consistency index.

	CI	***RI***	***CR***	**Test Results**
Judgment Matrix A	0.041	0.890	0.046	Less than 0.1, pass the test
Judgment Matrix B_1	0.005	0.520	0.010	Less than 0.1, pass the test
Judgment Matrix B_2	0.024	0.890	0.027	Less than 0.1, pass the test
Judgment Matrix B_3	0.048	1.120	0.043	Less than 0.1, pass the test
Judgment Matrix B_4	0.034	0.890	0.038	Less than 0.1, pass the test

4. Hierarchical total ranking and consistency test

The calculation of the hierarchical total ranking weights is shown in Equation (3) [57].

$$\sum_{j=1}^{n}\sum_{i=1}^{m} a_i b_j^i = 1 \quad (3)$$

The formula is the weight of the criterion level and the scheme level, and the hierarchical total ranking remains the normalized regular vector. Finally, there is a consistency test for the total ranking, as shown in Equations (4)–(6) [57].

$$\mathrm{CR}_T = \frac{\mathrm{CI}_T}{\mathrm{RI}_T} \quad (4)$$

$$\mathrm{CI}_T = \sum_{i=1}^{m} a_i CI_i \quad (5)$$

$$\mathrm{RI}_T = \sum_{i=1}^{m} \mathrm{a}_i RI_i \quad (6)$$

When $CR_T < 0.1$ the analysis results can be used for decision-making, otherwise, readjustment is required [57].

After calculation, the weights of each indicator can be derived in the criterion layer and the indicator layer. For the judgment matrix A, the weights of u_1, u_2, u_3, u_4 are 0.2081, 0.0981, 0.2875, 0.4063, respectively, representing the weight assignments of the indicators in the criterion layer. For the judgment matrix B_1, the weights corresponding to u_{11}, u_{12}, u_{13} are 0.1683, 0.2973, 0.5390, respectively. For the judgment matrix B_2, the weights corresponding to u_{21}, u_{22}, u_{23}, u_{24} are 0.1928, 0.1209, 0.4168, 0.2695. For the judgment matrix B_3, the weights of u_{31}, u_{32}, u_{33}, u_{34}, u_{35} are 0.2678, 0.1610, 0.1277, 0.3583, 0.0852, respectively. For the judgment matrix B_4, the weights of u_{41}, u_{42}, u_{43}, u_{44} are 0.1745, 0.1240, 0.3471, and 0.3544, respectively, representing the weight assignments of the index layer. After obtaining the weights of each indicator, the total hierarchical ranking weights can be calculated according to Equation (3), and the total hierarchical ranking is a normalized regular vector.

$$\begin{aligned}\sum_{j=1}^{n}\sum_{i=1}^{m} a_i b_j^i = \; & 0.2081 \times 0.1683 + 0.2081 \times 0.0981 + 0.2081 \times 0.4063 + 0.0981 \times 0.1928 + 0.0981 \times 0.1209 \\ & + 0.0981 \times 0.4168 + 0.0981 \times 0.2695 + 0.2875 \times 0.2678 + 0.2875 \times 0.1610 + 0.2875 \times 0.1277 \\ & + 0.2875 \times 0.3583 + 0.2875 \times 0.0852 + 0.4063 \times 0.1745 + 0.4063 \times 0.1240 + 0.4063 \times 0.3471 \\ & + 0.4063 \times 0.3544 = 1\end{aligned}$$

According to Equation (4), the total ranking has a calculated value of the consistency test is 0.0091. Its test result is much less than 0.1, which has a satisfactory consistency, indicating that this paper is reliable in dividing the weight assignments of each tier within the evaluation model of rural e-commerce EE in HEIs.

$$CR_T = \frac{0.2081 \times 0.005 + 0.0981 \times 0.024 + 0.2875 \times 0.048 + 0.4063 \times 0.034}{0.2081 \times 0.520 + 0.0981 \times 0.890 + 0.2875 \times 1.120 + 0.4063 \times 0.890} = 0.0091$$

5. Index weights summarization

This paper collates the weight assignments of the above indicators and obtains the total weights of each indicator. These weights were collapsed to obtain a model for evaluating rural e-commerce EE in HEIs, as shown in Table 8 below. The larger the weight assignment, the greater the relative importance of the indicator in evaluating the quality of rural e-commerce EE in HEIs.

Table 8. Evaluation model of rural e-commerce entrepreneurship education in HEIs.

Indicator Model	Criteria Level Indicators and Weighting	Indicator Level Indicators and Weighting	Comprehensive Weighting
Evaluation model of Rural E-Commerce Entrepreneurship Education for Students in HEIs U	Learning Input u_1 (0.2081)	Learning motivation u_{11} (0.1637)	0.0341
		Learning habits u_{12} (0.2973)	0.0619
		Time commitment u_{13} (0.5390)	0.1121
	Educational support u_2 (0.0981)	Software and hardware facilities u_{21} (0.1928)	0.0189
		Basic service facilities u_{22} (0.1209)	0.0119
		Entrepreneurship atmosphere u_{23} (0.4168)	0.0409
		Policy support u_{24} (0.2695)	0.0264
	Educational process u_3 (0.2875)	Educational teachers u_{31} (0.2678)	0.0770
		Teacher-student interaction u_{32} (0.1610)	0.0463
		Course teaching u_{33} (0.1277)	0.0367
		Practical teaching u_{34} (0.3583)	0.1030
		Assessment methods u_{35} (0.0852)	0.0245
	Feedback effectiveness u_4 (0.4063)	Teaching tracking u_{41} (0.1745)	0.0709
		Feedback demand channels u_{42} (0.1240)	0.0504
		Entrepreneurship knowledge u_{43} (0.3471)	0.1410
		Entrepreneurial employment skills u_{44} (0.3544)	0.1440

From the assignment of indicator weights in the criterion layer, the most crucial evaluation is feedback effectiveness, followed by the educational process, learning input, and educational support. Under the feedback effectiveness criterion layer, the entrepreneurial employment skills significantly impact education evaluation. On the one hand, the educational process criterion layer on the practical teaching indicators significantly impacts education evaluation. While, on the other hand, the learning input criterion layer based on the time commitment indicators significantly impacts education evaluation. Subsequently, the educational support criterion layer resulted in the entrepreneurship atmosphere indicators having a more significant impact on evaluating education.

From the total ranking results of the indicator layer, the four indicators of entrepreneurial skills, entrepreneurship knowledge, investment time, and practical teaching are more than 0.10, which are more critical in evaluating education than other indicators of the indicator layer.

4.2.3. Determine the Evaluation Object Rubric Set

Rubric set V is established, and the following four rubrics and scores were determined for each evaluation index in the evaluation model of rural e-commerce EE in HEIs: excellent, good, pass and failure, which were expressed by V_1, V_2, V_3, V_4, the rubric set was recorded $V = \{V_1, V_2, V_3, V_4\}$, and the specific evaluation criteria of each index were shown in Table 9. In order to improve the accuracy of the evaluation, this paper describes the specific evaluation criteria for each evaluation index of "excellent, good, pass, and failure" in the design education model.

Table 9. Evaluation criteria of rural e-commerce EE in HEIs.

Indicators	Evaluation Level			
	Excellent	**Good**	**Pass**	**Failure**
Learning motivation	Supported by consistent and stable internal motivation	Can be motivated by external motivation	Nt interested in learning	No active motivation to learn
Learning habits	High enthusiasm and initiative in learning	Willing to learn actively, but not consistently	General enthusiasm and initiative in learning	No active learning ideas
Time commitment	Average daily input time greater than 2 h	Average daily input time greater than 1 h	Average daily input time greater than 0.5 h	The average daily input time is less than 0.5 h
Software and hardware facilities	The hardware and software facilities are complete and actively open to students	Hardware and software facilities are relatively complete	Hardware and software facilities are perfect	Weak awareness of the construction of software and hardware educational facilities
Basic service facilities	Well-established basic service facilities with comprehensive coverage	Basic service facilities are relatively complete	Basic service facilities are complete	Basic service facilities are not well developed
Entrepreneurship atmosphere	The atmosphere of "mass entrepreneurship and innovation" is powerful	The atmosphere of "mass entrepreneurship and innovation" is relatively strong	School leaders, teachers, and students understand the situation of entrepreneurship	School leaders, teachers, and students ignore entrepreneurship
Policy support	Support in various aspects such as materials	Material and other support can be provided	Limited support in a single area	Nothing else
Educational teachers	Teachers have the rich practical experience and theoretical teaching skills related to rural e-commerce entrepreneurship	Teachers are profound in lesson preparation, rich in knowledge, and have theoretical experience related to rural e-commerce entrepreneurship	Teachers are in-class severe preparation and rich in knowledge	Teachers' class content is seriously disconnected from reality
Teacher-student interaction	Teachers are very focused on student-teacher interaction	Teachers pay more attention to student-teacher interaction	Teacher-student interaction is not obvious	Little to no teacher-student interaction

Table 9. *Cont.*

Indicators	Evaluation Level			
	Excellent	**Good**	**Pass**	**Failure**
Course teaching	The curriculum is scientific and reasonable, with solid practicability	The curriculum is reasonable and practical	The practicality of the curriculum is general	The curriculum is out of touch with reality
Practical teaching	Practical teaching accounts for a large proportion, and the model of collaborative education with enterprises is perfect	Practical teaching accounts for a large proportion, and the model of collaborative education with enterprises is relatively complete	The proportion of practical teaching is medium, and the practical effect of the model of educating people in collaboration with enterprises is average	The proportion of practical teaching is small, and the model of collaborative education with enterprises is not perfect
Assessment methods	There are various assessment methods and can be converted into credits and included in academic performance and comprehensive assessment	There are various assessment methods, and those who are particularly outstanding can be included in the student's comprehensive assessment for extra points	There are various assessment methods for students to participate in entrepreneurship courses and practice	The assessment method is single, mainly based on course examinations
Teaching tracking	Track students' teaching situation throughout the process and provide answers to questions	Track student teaching and provide regular Q&A	Only provide Q&A regularly	No teaching situation tracking
Feedback demand channels	Feedback channels are open, and students' opinions are taken seriously and closely interconnected with the HEIs, industry, and government	Feedback channels are relatively open, and students' opinions and suggestions are adopted to a certain extent	Feedback channels are available, but the follow-up progress is unclear	No feedback channel
Entrepreneurship knowledge	The entrepreneurship knowledge level is particularly significant	Moderately significant improvement in knowledge of entrepreneurship	The improvement of knowledge of entrepreneurship is generally significant	No improvement in knowledge of entrepreneurship
Entrepreneurial employment skills	Students' entrepreneurial and employment skills level has improved particularly significantly	Students' entrepreneurial and employment skills have improved more significantly	The improvement of students' entrepreneurial and employment skills is generally significant	Students' entrepreneurial and employment skills did not improve

4.2.4. Fuzzy Comprehensive Evaluation

In the range of each factor subset U_k (k = 1, 2, … , s), the fuzzy factor vector is determined according to the size of each factor $A_k = (a_{k1}, a_{k2}, \ldots, a_{kn})$, and the fuzzy operation is performed with the single-factor evaluation matrix R_k, wherein the single-factor evaluation matrix R_k is composed of r_{kij} (i = 1, 2, … , n; j = 1, 2, … , m), we can get:

$$A_k \circ R_k = B_k = (b_{k1}, b_{k2}, \ldots, b_{km})(k = 1, 2, \ldots, s) \tag{7}$$

The weight vectors of each indicator under the learning input criterion layer, educational support criterion layer, educational process criterion layer, and feedback effectiveness criterion layer are denoted by A, A_1, A_2, A_3, A_4, respectively, based on the weights of each indicator determined using AHP above.

A = (0.2081, 0.0981, 0.2875, 0.4063)

A_1 = (0.1683, 0.2972, 0.5390)

A_2 = (0.1928, 0.1209, 0.4168, 0.2695)

A_3 = (0.2678, 0.1610, 0.1277, 0.3583, 0.0852)

A_4 = (0.1745, 0.1240, 0.3471, 0.3544)

After the evaluation model has been constructed, the next part of this section describes how the empirical analysis was conducted to test the model's applicability better. To better obtain the relevant data, it was chosen to be carried out in Software Engineering Institute of Guangzhou, where the author works. This paper used a questionnaire to ask students of Software Engineering Institute of Guangzhou to rate the rural e-commerce EE provided by the school. A total of 400 questionnaires were distributed to students, from freshmen to seniors, in the Department of Finance and Economics, and 384 valid data were obtained after excluding questionnaires that were not fully scored and those with inconsistent answers. The evaluation questionnaire was based on Table 9. Evaluation criteria of rural e-commerce EE in HEIs: students were asked to rate each indicator as "excellent, good, pass, fail". Based on the aggregation of the collected evaluation results, the affiliation degree r_{kij} of each factor can be evaluated, and the single-factor evaluation matrix R_k of the set of evaluation indicators can be established. Software Engineering Institute of Guangzhou students' judgments on learning input factors is shown in Table 10.

Table 10. Evaluation table of learning input factors (unit: number of people).

Criteria Level Indicators	Indicator Level Indicators	Evaluation Level			
		Excellent	**Good**	**Pass**	**Failure**
Learning input u_1	Learning motivation u_{11}	188	107	87	2
	Learning habits u_{12}	185	137	40	22
	Time commitment u_{13}	107	199	78	0

Calculating the affiliation of the learning input factors and creating the learning input factor evaluation matrix R_1 yields.

$$R_1 = \begin{bmatrix} 0.4896 & 0.2786 & 0.2266 & 0.0052 \\ 0.4818 & 0.3568 & 0.1042 & 0.0573 \\ 0.2786 & 0.5182 & 0.2031 & 0 \end{bmatrix}$$

According to Equation (7), the single-factor evaluation matrix R_k is fuzzy-operated to obtain B_k. The learning input factor is used as an example, whereby the questionnaire data determine the learning input factor evaluation matrix R_1. The single-level evaluation result B_1 of the learning input factor can be obtained by fuzzy calculation.

$$B_1 = A_1 \circ R_1 = (0.1637, 0.2973, 0.5390) \circ \begin{bmatrix} 0.4896 & 0.2786 & 0.2266 & 0.0052 \\ 0.4818 & 0.3568 & 0.1042 & 0.0573 \\ 0.2786 & 0.5182 & 0.2031 & 0 \end{bmatrix}$$
$$= (0.3736,\ 0.4310, 0.1775,\ 0.0179).$$

According to the principle of full membership, the single-level evaluation result of the school's learning input factor is good.

Similarly,

B_2 = (0.4322, 0.3697, 0.1815, 0.0166)

B_3 = (0.3711, 0.4705, 0.1428, 0.0156)

B_4 = (0.4153, 0.4061, 0.1698, 0.0088)

Then the single-level evaluation results of the system performance, educational process, and feedback effectiveness factors are excellent, sound, and superior, respectively.

For the single-factor evaluation matrix R_k, the total evaluation matrix R of U is obtained as:

$$R = \begin{bmatrix} b_{11} & \circ & b_{1m} \\ \vdots & \circ & \vdots \\ b_{s1} & \circ & b_{sm} \end{bmatrix} \tag{8}$$

Then the total composite judgment result is:

$$B = A \circ R = \begin{bmatrix} A_1 & \circ & R_1 \\ \vdots & \circ & \vdots \\ A_s & \circ & R_s \end{bmatrix} \quad (9)$$

According to Equation (8) for the single-factor evaluation matrix R_k to obtain the total evaluation matrix R about U. Finally, according to Equation (9), the total evaluation matrix R is fuzzily synthesized with the indicator weight vector A of each criterion layer under the total target layer to obtain the final evaluation result B.

$$B = A \circ R = (0.2081, 0.0981, 0.2875, 0.4063) \circ \begin{bmatrix} 0.3736 & 0.4310 & 0.1775 & 0.0179 \\ 0.4322 & 0.3697 & 0.1815 & 0.0166 \\ 0.3711 & 0.4705 & 0.1428 & 0.0156 \\ 0.4153 & 0.4061 & 0.1698 & 0.0088 \end{bmatrix}$$
$$= (0.3956, 0.4262, 0.1684, 0.0134)$$

The final evaluation result of the scoring of rural e-commerce EE for students of Software Engineering Institute of Guangzhou can be obtained as good, according to the principle of maximum affiliation and the established evaluation criteria.

According to the criterion layer's single-level evaluation score, Software Engineering Institute of Guangzhou's rural e-commerce EE has a relatively higher system performance and feedback effectiveness but a lower score in terms of learning input and educational process. The results would indicate the capability of Software Engineering Institute of Guangzhou to nurture students as it can be seen that students have a higher level of recognition for the school's rural e-commerce EE and services compared to other areas. They are more satisfied with the overall quality of service and improved knowledge and skills. Despite these, the self-awareness of their learning investment is still lacking.

In the learning input criterion layer specifically, the indicator of time invested has a low index layer affiliation score. This lower score indicates that students invest less time in rural e-commerce entrepreneurship. In the educational support criterion tier, the indicator tier affiliation score for school support was low, indicating that the current support provided by the school is more limited than the later support system. As for the educational process criterion layer, a lower index stratum membership score of practical teaching and assessment methods indicated that a proportion of the school's practical teaching needs to be improved. In the feedback effectiveness criterion layer, the subordinate score of the teaching situation of the tracking indicator layer is low. The low scoring indicated that the feedback channel is relatively simple; thus, it would be suggested that the degree of emphasis on adopting students' opinions is low.

5. Discussion

This paper accomplishes the objectives of the study, which are to develop a 'student-centered' model for evaluating rural e-commerce EE in HEIs and to test the model's applicability in practice. The evaluation results suggest that the college's rural e-commerce EE has a solid overall score, with good, excellent, good, and excellent scores in learning input, educational support, educational process, and feedback effectiveness. We propose the following theoretical and practical implications based on the findings.

5.1. Theoretical Implications

In the course of our study, we found that many previous studies would prefer to evaluate the results obtained from education. However, our study emphasizes the evaluation of the whole process of education, which is in line with the studies of scholars such as Fauyolle [45] and Kailer [46]. Regarding the choice of subjects for educational evaluation, Rosa and Amaral [58] propose a Self-assessment Tool for Higher Education Institutions (HE Innovate), which takes HEIs as the subject of evaluation. Ruskovaara et al. [59] propose the Measurement Tool for Entrepreneurship Education (MTEE), which uses teachers as the subject of evaluation. This paper is based on the learning input theory [47] and places more emphasis on the role played by the educated subject in EE. Therefore, our study further expands the role of the whole process and student-centered EE evaluation models. We also found that EE encompasses a broader content range, and HEIs are less likely to integrate it with some professional education. This may make EE less relevant. We attempted to focus EE in HEIs on the field of rural e-commerce.

5.2. Practical Implications

The practical implications of this paper are to evaluate the education of Software Engineering Institute of Guangzhou and to suggest appropriate solutions for it. It also serves as a reference for the evaluation of more HEIs conducting rural e-commerce EE.

Firstly, it is suggested that HEIs such as Software Engineering Institute of Guangzhou should open up to a broader range of opinions. Then, they will be able to develop a more open feedback path for students based on the opinionated surveys. Henceforth, students interested in rural e-commerce entrepreneurship can give timely feedback on information related to the course. Such examples of the information would include innovation and entrepreneurship, feedback on teachers' performance, courses, and resources on campus. All this feedback would continue to improve the campus's incredible entrepreneurship atmosphere. Although the results indicate that the quality level of rural e-commerce EE in Software Engineering Institute of Guangzhou is promising, further construction can be strengthened. This strengthening is suggested around the indicators with low affiliation scores to improve the level of rural e-commerce entrepreneurship among students.

Secondly, to provide a full range of services for suitable projects interested in rural e-commerce entrepreneurship, the college should increase its investment in rural e-commerce EE. It should also provide entrepreneurial guidance, project incubation, business consulting, technology research and development, financing, and loan support based on the on-campus business park.

Finally, undergraduate training programs' social flexibility needs to be enhanced to address the current societal demand for skilled individuals with a broad understanding of rural e-commerce. Further development in rural e-commerce EE would be required. The development phases required are scale and efficiency, quantity and quality of training, and employment. Hence, we believe that the education contents should be optimized. Moreover, rural e-commerce employers should be invited to participate in developing training programs and hire off-campus business mentors.

6. Conclusions

Focusing on the evaluation of rural e-commerce EE in HEIs, this study constructs a model of educational evaluation indicators. Three questions are discussed, including how to evaluate students' EE learning outcomes, which indicators and research methods should be used for such evaluation, and how applicable the evaluation model is. Drawing on George Kuh's learning engagement theory, this study follows the principles of systematic and comprehensive, developmental and dynamic, hierarchical and scientific. It mainly involves the four dimensions of learning input, educational support, educational process, and feedback effectiveness, comprising 16 evaluation indicators. An evaluation method combining AHP and Fuzzy Comprehensive Evaluation Method is used to combine qualitative and quantitative analysis, determine the weights of each indicator and the opinion sets of evaluation subjects, and carry out empirical analysis on the rural e-commerce EE practices of Software Engineering Institute of Guangzhou, finally putting forward corresponding improvement suggestions.

The limitations of this paper are as follows: Firstly, there are some limitations in the evaluation method, and it is a more complex problem to determine whether the indicator weights given by the expert system are reasonable. The generalizability of the evaluation model needs to be further tested. Secondly, due to the limited survey sample in the empirical analysis, the findings cannot be generalized to all schools in Guangzhou. Thirdly, the evaluation and interpretation of the results represent the author's own views and experiences and should therefore be viewed with caution. In future research, the applicability of the evaluation indicators will also be adjusted according to the current state of development of rural e-commerce EE, and the scope of application of the empirical analysis will be further expanded.

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