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Reconstruction of Undergraduates Evaluation Index System Majoring in Logistics Management Driven by Semantics

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ABSTRACT
Owning to the dual-first-level project for higher education in China, this paper analyzes the direction and key principles for undergraduates' education majoring in logistics management facing the national first-class majors cultivation. Taking the example of the original undergraduates' evaluation index system in Jiangxi province, this paper firstly finds out the shortcomings of the original undergraduates evaluation index system in Jiangxi province. Secondly, the index system after word frequency analysis of the interview records is achieved based on expert interview. Thirdly, depending on AHP method, a Likert five-level questionnaire is designed to collect 45 opinion data, both the information sensitivity method is used to filter out invalid samples, and Hadamard multiplier method is used to gather the opinions of all parties to construct a judgment matrix to weight the index system. Finally, undergraduates' evaluation index system majoring in logistics management driven by semantics is designed and comparison with the original index system is described.

Keywords: *Undergraduates evaluation index system, First-class-major cultivation, Semantic analysis.*

1. INTRODUCTION

The project of undergraduates' majors evaluation was initiated by Liaoning Province in China in 2014. As an important means to promote teaching and research for higher education through evaluation, it is of great significance for first-class-major cultivation. Jiangxi Provincial Department of Education started the first-round undergraduates' majors' evaluation in 2016, and sum of nearly 200 undergraduates' majors completed evaluation in 2019. The current undergraduates' majors' evaluation basically uses a set of general evaluation index system, moreover the first-level index and the second-level index were fixed, and only some observation points can be varied from different majors. Actually each major has its own personality and requirements. It is not appropriate to measure all types of majors by same ruler, which will inevitably lead to convergence of major construction.

Major of logistics management and engineering approved by the Ministry of education (including logistics management, logistics engineering, procurement management, and supply chain management) are established in China in 2000. As the emerging majors in China, such major is focusing on industry application, especially connecting with company's logistics technology and activities. It is common that major construction should support for talent training. If a comprehensive undergraduates' evaluation index system with logistics characteristics cannot be constructed, then the construction of logistics majors will inevitably converge with other majors, and the trained talents will inevitably not meet the needs of high-quality development of the logistics industry [1].

In the past, the standard for undergraduate cultivation in China was designed from the teachers, i.e., starting from the curriculum, then the courses design, and ending with the training goals [2]. The main purpose is to let teachers know what to teach and how to teach. The construction of the curriculum system is based on strict discipline planning, and the education model is deterministic, closed and static, which ignores the actual need of professional practice scenarios [3]. Therefore, the traditional cultivation based on positive education can only adapt to the needs of society, industry and the self-development of talents, but it is difficult to achieve "satisfaction" [4, 5].

After entrance to "Washington Agreement" in 2016, outcomes-based Education (OBE) has gradually become the core concept of higher education in China, moreover the design of undergraduate training goal has been transformed into a reverse concept, that is, let students know who they want to be? What should they learn? How to learn? (see table 1). Domestic scholars have carried out a series of reverse design for higher education, e.g. Zhang Jing et al. analysed the main content of campus connection plan in Infosys in India, analysed the main factors that its educational cooperation model can achieve great success, and proposed an IT professional training model by the reverse design concept [6]. Li Zhiyi et al. designed a syllabus based on the idea of reverse design around graduation requirements [7]. Based on the principle of reverse design, Jiang Dan determined the expected results of engineering courses and designed corresponding teaching reform programs [8]. Zhang Liping et al. used AHP method to construct a professional evaluation index system for higher vocational colleges [9].

Table 1. The difference of undergraduates' cultivation pre-and-after "Washington Agreement"

	Target design process	Goal	Characteristics
Before "Washington Agreement"	Top-down design (teachers-to-students)	Let teachers know what to teach and how to teach	Emphasizing knowledge
After "Washington Agreement"	Bottom-up design (students-to-teachers)	Let students know who they want to be? What should they learn? How to learn?	Emphasizing the actual needs from professional practice

Therefore this article is organized in four parts: the first part is the introduction, secondly the original undergraduates evaluation index system in Jiangxi province, thirdly the new undergraduates' evaluation index system majoring in logistics management is designed, finally a comparison with the original index system is described [10].

2. ORIGINAL UNDERGRADUATES EVALUATION INDEX SYSTEM

Jiangxi Province was the second province to carry out the undergraduates' majors' evaluation in China after Liaoning province firstly initiated this project in 2014. The goal of evaluation of the undergraduates' majors is to rank each kind of major in all the universities and select the good-quality listed majors to invest more resources to develop. As an important means to promote teaching and research for higher education, majors evaluation is of great significance for first-class-major cultivation. The first-round of undergraduate evaluation index system majoring in logistics management and engineering in Jiangxi Province is shown in Figure 1. It can be found there are six level 1 indicators and fourteen level 2 indicators, the total score is 110. Level 1 indicators include source of students, cultivation mode, teaching resources, undergraduate teaching achievements, teaching quality assurance, students and alumni performance and 10 points added is evaluated in terms of the features of the major in various universities. Owing that each major has its own personality and requirements, it is not appropriate to measure all the majors by the same ruler.

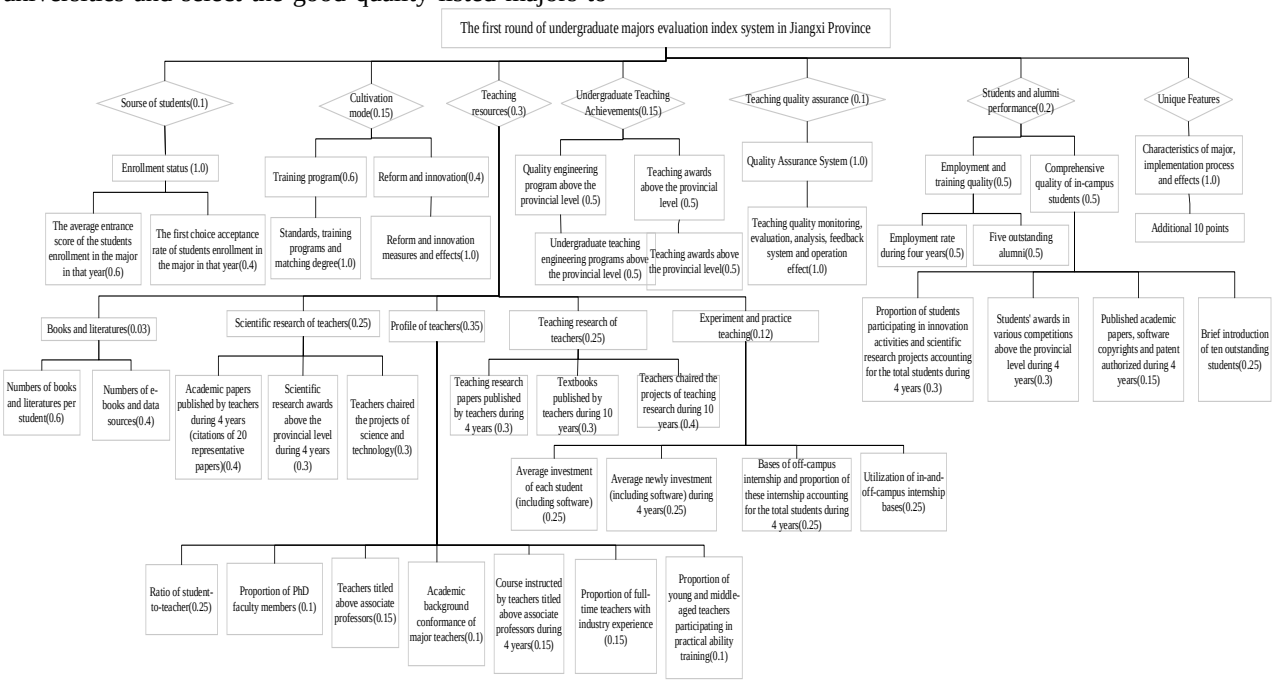

Figure 1 The first round of undergraduate majors evaluation index system in Jiangxi Province

3. INDEX REDESIGN OF UNDERGRADUATE EVALUATION MAJOR IN LOGISTICS MANAGEMENT DRIVEN BY SEMANTICS

Recently dual-first-class projects for higher education in China is proponed, accordingly the national first-class undergraduate major construction is the urgent task for all the universities. To face the national first-class undergraduate major construction, the requirements from the employer and students should be taken into consideration in priority. So the strategic direction of undergraduate major in logistics management is the core of evaluation index system. The strategic direction can be achieved by experts interviews. A method of word frequency analysis combined with AHP framework is conducted as follows.

Stage 1: Interview Design for Relevant Parties

The first step is to design interview topics for the related parties. The second step is to select 3-5 experts from each party for interviews. The third step is to use the word frequency analysis based on the interview records.

In the process of word frequency analysis, similar words are treated as the same word in order to facilitate statistics and ensure the integrity of the analysis result information [11]. Table 2 shows the results of the top two or three vocabularies ranked by word frequency in the interview activities.

From Figure 2 "employment rate", "employment benefits" and "employment stability" are the most mentioned vocabulary in terms of “reasons for major in logistics management”. While, “professional competence”, “communication skills” and “innovative thinking” are the frequent vocabulary attention from the employers.

Table 2. Word frequency statistics of interview from relevant parties major in logistics management

Problem description	Interview objects
Reasons for major in logistics management	Prospective students from high school
	Prospective students from social candidates
Expectations for undergraduates major in logistics management	Enterprises
	Government office
	Social organization
Relative advantages of the interviewer's major	Teachers and Students of Supply Chain Management
	Teachers and students in purchasing management
Advantages of major in logistics management affiliated with the university	Teachers and students major in logistics management in university
Advantages of major in logistics management affiliated with vocational colleges	Teachers and students major in logistics management in vocational colleges

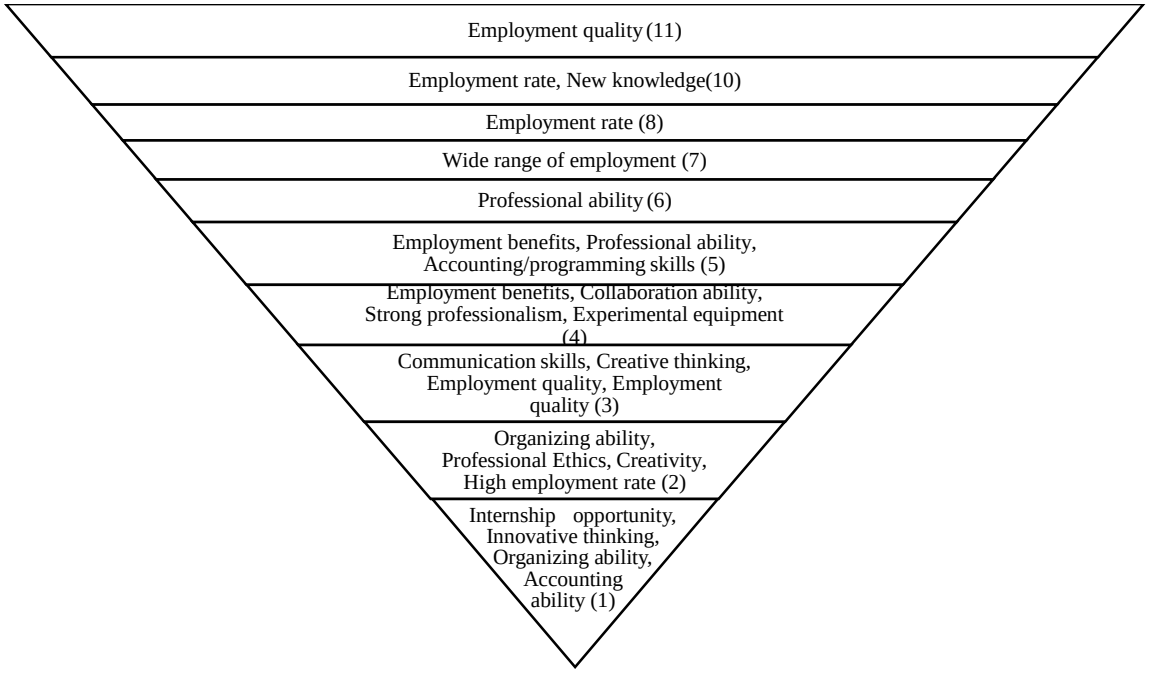

Figure 2 Vocabulary frequency (Note: Numbers represent vocabulary frequency)

Stage 2: Directions for Index Reconstruction

In order to adapt to social needs and maintain competitiveness, the cultivation direction of undergraduate major in logistics management should include professional ability, team ability (collaboration, communication and organizing ability), innovation ability and moral quality. On the other hand, 11 aspects including laboratory equipment, internship opportunities, curriculum system, employment rate and employment benefits are the target for the university. These elements can be attributed to the three strategic directions, i.e. improving student ability and quality, improving environment and resources and improving employment quality (Table 3). As a result, the reconstruction of the evaluation index system can be sourced from them.

4. REDESIGN THE EVALUATION INDEX SYSTEM MAJOR IN LOGISTICS MANAGEMENT

Therefore the strategic direction of undergraduates majoring in logistics management can be condensed into three first-level evaluation indicators, eight second-level evaluation indicators and twenty-three third-level indicators, as shown in Figure3.

Table 3. Focus and direction of undergraduate major in logistics management

Strategic Direction	Improve students' ability and quality					Improve teaching environment and resources				Improve the quality of employment	
Focus	profession ability	team ability	innovation ability	character quality	special ability	teachers quality	experiment equipment	practice opportunity	course system	employment rate	employment welfare

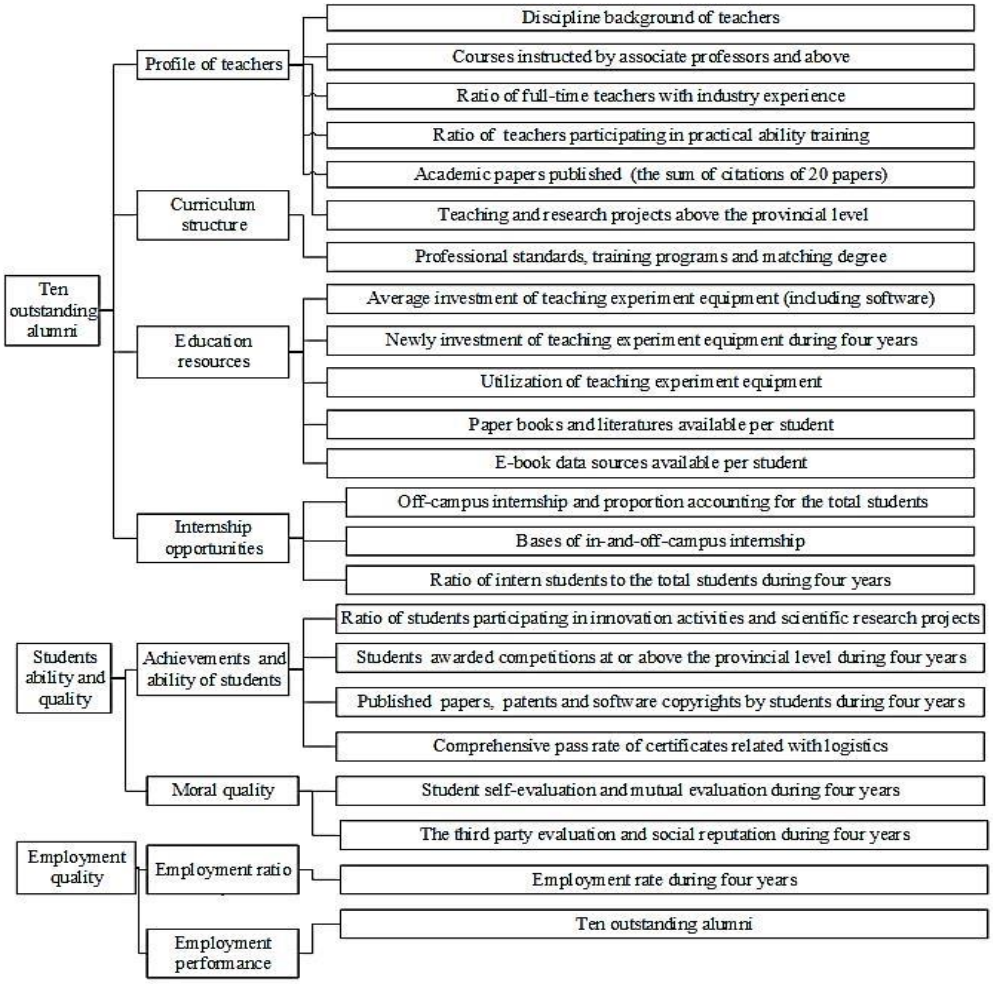

Figure3 Redesign the evaluation index system of logistics undergraduate major

5. WEIGHTS DESIGN OF EVALUATION INDEX SYSTEM

Stage 1: Calculation Method

After the initial indicator system is established, the weights of each indicator should be calculated. There are two kinds of indicator weighting, subjective weighting method (expert survey method, Delphi method, analytic hierarchy process, etc.) and objective weighting method (factor analysis method, entropy weight method, etc.). Analytic Hierarchy Process (AHP) combines the subjective and objective weighting, it is chosen to this paper to weight the initial index system [12, 13].

Depending on AHP weighting framework, the information sensitivity method is used to screen the questionnaire samples, and the Hadamard multiplier method is used to construct the judgment matrix [14]. Information sensitivity is the ratio of the standard deviation of a set of data to the mean, that is, the relative dispersion coefficient. It is used to measure the information content of a set of normal data. This paper defines the information sensitivity of the sample as the sample validity index Ci, and the validity interval of Ci takes [0.05, 0.95], that is, if the sample validity index is between 0.05-0.95, it is considered that the data sample is not an abnormal sample. The calculation formula of Ci is:

$$C_i = \frac{\sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left(x_{ij}-\frac{1}{n}\sum_{j=1}^{n}x_{ij}\right)^2}}{\frac{1}{n}\sum_{j=1}^{n}x_{ij}} \quad (1)$$

C_i: the sample validity of sample i;

X_{ij}: the score of sample i on the jth question;

n: the number of questions.

The Hadamard multiplier is an operation for multiplying the elements between matrices, such as formula (2). Compared with the summation method, this operation can strengthen the influence of smaller values on the result of the operation, and prevent the overall data from being damaged in actual problems. Excessive" optimism" , as shown in Table 4. The geometric mean of the Hadamard multiplier of the sample of expert opinions is suitable and convenient

to simplify the expert opinions and construct the judgment matrix.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1i} \\ \vdots & \ddots & \vdots \\ a_{j1} & \cdots & a_{ij} \end{bmatrix}$$

$$B = \begin{bmatrix} b_{11} & \cdots & b_{1i} \\ \vdots & \ddots & \vdots \\ b_{j1} & \cdots & b_{ij} \end{bmatrix}$$

$$Ha = A * B = \begin{bmatrix} a_{11}b_{11} & \cdots & a_{1i}b_{1i} \\ \vdots & \ddots & \vdots \\ a_{j1}b_{j1} & \cdots & a_{ij}b_{ij} \end{bmatrix} \quad (2)$$

a: representing the rating of expert A;

b: representing the rating of expert B.

Table 4. Examples of low-value strengthening effects of Hadamard multiplier

a_{ij}	b_{ij}	c_{ij}	$a_{ij}b_{ij}c_{ij}$	$a_{ij}+b_{ij}+c_{ij}$
4	4	4	64	12
3	4	5	60	12
2	4	6	48	12
…	…	…	…	…

Stage 2: Expert opinion Collection

The observation indicators are described by Likert five scale pattern, scoring rule is: "very important (5)"; "important (4)"; “general (3)"; "unimportant (2)"; "ignored(1)". Throughout the expert opinion consultation process, the principle of anonymity was observed, and online questionnaires were sent to experts related to logistics management in various universities and companies [15]. A total of 45 questionnaires were collected. 45 data sets were obtained, and there was no data default.

The questionnaire reliability test results are appropriate in terms of Cronbach’s Alpha coefficient is 0.93, expert authority coefficient value is 0.86, expert familiarity value is 0.85, and Kendall coefficient is 0.347. So the experts group has good validity, credibilty and coordination [16].

Stage 3: Data Sample Screening and Judgment Matrix

After calculating the validity of the sample, a total of 40 samples from 45 experts are excluded from the abnormal samples. According to Analytic Hierarchy Process, the scoring table reflects the expert's judgment on the importance of the comparison [17]. By applying the Hadamard multiplier to the expert score data and taking the geometric average, the comprehensive score of 23 indicators is obtained , as shown in Table 5.

As a result, the judgement matrix can be concluded according to layer B to layer C, and layer A to layer B respectively, e.g. table 6 is the judgment matrix of the indicators C1-C6 relative to indicator B1 from layer B; table 7 is the judgment matrix of the indicators B1-B4 relative to indicator A1 from layer A.

The consistency of the judgment matrix is calculated by formula 3. The consistency ratio is CR, when CR<0.1, the judgment matrix is considered to have satisfactory consistency. CI (Consistency Index) is the consistency index, and RI (Random Index) is the average random consistency index.

$$CR = \frac{CI}{RI} \quad (3)$$

The consistency test results of the judgment matrix at each level are shown in Table 8. The CR value of each matrix is less than 0.1, and the judgment matrix is consistent.

Stage 4: Weights of Indicator System

The weights of each indicator from the judgment matrix is shown in Table 9. Then the relative weight of each level corresponding to the upper level can be obtained by formula 4.

$$\beta_i = {\alpha_i}^A * {\alpha_i}^B * {\alpha_i}^C \quad (4)$$

β_i: absolute index weight,

${\alpha_i}^N$: weight of index i in N levels in the same relative weight index.

The new undergraduates evaluation index system is shown as Table 10.

Table 5. Comprehensive scores of all levels of indicators

Index No.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
overall ratings	4.577	4.394	3.758	3.600	4.358	4.244	2.780	3.383	3.324	3.539	3.055	3.633
Index No.	**C13**	**C14**	**C15**	**C16**	**C17**	**C18**	**C19**	**C20**	**C21**	**C22**	**C23**	**B1**
overall ratings	3.456	3.499	3.493	2.744	2.646	2.647	3.138	2.957	3.022	4.274	4.180	4.099
Index No.	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**A1**	**A2**	**A3**		

overall ratings	4.123	4.264	3.922	4.106	4.233	4.321	4.939	4.524	3.354	3.721		

Table 6. Judgment matrix of C1-C6 to B1

B1	C1	C2	C3	C4	C5	C6
C1	1	2	2	1	3	4
C2	1/2	1	3	1/2	1	2
C3	1/2	1/3	1	1/2	1/2	2
C4	1	2	2	1	1	3
C5	1/3	1	2	1	1	2
C6	1/4	1/2	1/2	1/3	1/2	1

Table 7. Judgment matrix of B1-B4 to A1

A1	B1	B2	B3	B4
B1	1	2	3	3
B2	1/2	1	1/2	1
B3	1/3	2	1	1
B4	1/3	1	1	1

Table 8. Consistency test results of judgment matrix

Index item	C1	C2	C3	C4	C5	C6	C8	C9	C10	C11	C12	C13	C14	C15
Matrix Consistency Index	CI=0.0449 CR=0.0362						CI=0.0416 CR=0.0371					CI=0 CR=0		

Index item	C16	C17	C18	C19	B1	B2	B3	B4	A1	A2	A3	C20	C21	C22	C23	B7	B8	B5	B6
Matrix Consistency Index	CI=0.039 CR=0.044				CI=0.0137 CR=0.0153				CI=0 CR=0			Pass the test by default, take 0							

Table 9. The normalization results of each indicators of judgment matrix

Index No.	C1	C2	C3	C4	C5	C6	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	
Weights	0.286	0.163	0.101	0.225	0.157	0.068	0.194	0.175	0.194	0.205	0.233	0.333	0.333	0.333	0.464	0.161	
Index No.	C18	C19	B1	B2	B3	B4	A1	A2	A3	C20	C21	B7	B8	B5	B6	C22	C23
Weights	0.207	0.168	0.355	0.145	0.355	0.145	0.500	0.250	0.250	0.500	0.500	0.667	0.333	0.500	0.500	0.33	0.67

Table 10. New undergraduates evaluation index system major in logistics management

First-level Index	Second-level index	Third-level index (observation points)
Teaching environment and resources (50%)	Profile of teachers (35.5%)	Discipline background conformance of teachers 28.6%
		Course instructed by teachers titled above associate professors during four years 16.3%
		Full-time teachers with industry experience 10.1%
		Young and middle-aged teachers participating in practical teaching ability training 22.5%
		Academic papers published by teachers during four years (citations of 20 representative papers) 15.7%
		Teachers have presided over teaching and research projects above the provincial level during 10 years 6.8%
	Curriculum structure (14.5%)	Professional standards, training programs and matching degree of each element 100%
	Education resources (35.5%)	Average investment of each student in terms of teaching experiment equipment (including software) 19.4%
		Newly investment in terms of teaching experiment equipment (including software) during four years 17.5%
		Utilization of existing teaching experiment equipment 19.4%
		Paper books and literatures available per student 20.5%
		E-book data sources available per student 23.3%
	Internship opportunities	Bases of off-campus internship and proportion of these internship accounting for the total students during 4 years 33.3%

	(14.5%)	Bases of in-and-off-campus internship 33.3%
		The proportion of intern students to the total number of students during four years 33.3%
Student ability and quality (25%)	Achievements and ability of students (50%)	Proportion of students participating in innovation activities and scientific research projects during four years 46.4%
		Students have won various competition awards at or above the provincial level during four years 16.1%
		Published academic papers, patent authorized and software copyrights by students during four years 20.7%
		Comprehensive pass rate of certificates related with logistics 16.8%
	Moral quality (50%)	Student self-evaluation and mutual evaluation during four years 50%
		The third party evaluation and social reputation during four years 50%
Employment quality (25%)	Employment rate (33.3%)	Employment rate during four years 100%
	Employment performance (66.7%)	Ten outstanding alumni 100%

6. COMPARISON OF THE EVALUATION INDEX SYSTEM MAJOR IN LOGISTICS MANAGEMENT

Compared with the first round evaluation index system of Jiangxi Province, new index system has obvious advantages, as shown in Table 11.

Firstly, the redesigned index system emphasizes the education center of students, such indicators as teaching resources and environment, employment quality, etc., which are closely related to students, and their weights have increased [18].

Secondly, the total indictors decreased from 33 to 23 indicators in order to facilitate the implementation of evaluation, especially the new index focus on outcomes, i.e. the performance of the students and social reputation of the major instead of the entrance records of the enrolments.

Thirdly, students' practical ability and internship are highlighted so that major cultivation can correspond to the needs of logistics industry and high quality development in our country [19].

7. CONCLUSION

The evaluation index system will lead the way of major cultivation. Since our education concept is changing from teachers to the students, the evaluation index should also adapt to this trend. This paper tries to redesign the undergraduates' evaluation index system in Jiangxi province for the coming evaluation. It is expected to check the effect for national first-class majors.

Table11. Comparison of old and new evaluation index system major in logistics management

	New evaluation index system	Old evaluation index system
Advantages	Measurement points are simplified to facilitate the implementation of evaluation. Evaluation factors closely related to students, and students become "protagonists". Highlight the observation of students ' " practical ability", in line with the characteristics of logistics major Design based on industry and professional development needs to meet industry development needs.	Comprehensive evaluation and strong versatility
Disadvantages	Evaluation is professional and specific, and its versatility is weak.	Measurement points are dense and complex, which is not convenient for the evaluation. The focus of attention is not clear, and the status of students is not prominent. Positive design does not meet needs of industry development.

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