Performance Evaluation of Specialty Group Construction: AHP Analytic Hierarchy Model

Qiuyu Wang[1,2]

[1]Guangxi Vocational and Technical College, Nanning, China
[2]College of Innovation Management, Suan Sunandha Rajabhat University Bangkok, Thailand

qiuyuw411@gmail.com

Abstract. Taking the high-level professional groups of six universities in Guangxi as the research object, this paper explores and constructs the evaluation model of professional groups by using analytic hierarchy process. The study found that In terms of the weight of performance indicators, the highest weight is 0.0992 for the integration of industry and education, the training of technical and skilled talents, the construction of dual-teacher team and the service development ability index in the quality index, and the lowest weight is 0.0023 for the construction index of professional groups in the quantity index. The system can be used as an effective means for the education authorities to evaluate the development effect of specialty clusters comprehensively and objectively.

Keywords: Specialty Group; index system; Weight

1 Introduction

This paper introduces the new progress made in the connotation construction of modern vocational education system after the national vocational education conference. Specialized higher vocational education has entered the high-quality and value-added empowerment, school and 141 high-level professional group[11]. The selected project units should play a leading and radiating role. Local and school strengthen project self-management through performance self-evaluation, and form a pattern of "Double-high plan" construction leading the coordinated development of regional higher vocational schools[1]. Although the higher vocational colleges have made phased achievements, the indicators and standards of how to evaluate the high, special and strong groups of schools and majors in many schools are not clear, and the evaluation indicators of construction performance are scattered, lack of systematic logic, and cannot scientifically and reasonably evaluate construction performance. Therefore, based on the understanding of the basic principles and index classification of output performance indicators in the task book of the national "Double High Plan", combined with the characteristics of the construction of high-level professional groups, this paper investigates and analyzes the performance status of the overall output and effect expected to be achieved by some high-level professional groups in the region

Y. Kuang et al. (eds.), *Proceedings of the 2024 5th International Conference on Education, Knowledge and Information Management (ICEKIM 2024)*, Atlantis Highlights in Computer Sciences 22,
https://doi.org/10.2991/978-94-6463-502-7_31

during the construction cycle, and studies the construction of the performance evaluation index system of the construction of high-level professional groups in Guangxi[7].

2 Design of Performance Indicator System for High-level Professional Groups

2.1 Research Subjects

This study takes the construction projects of 12 high-level professional groups in the first batch of 6 higher vocational colleges in Guangxi Province as the research object, and compares and analyzes the development status, development level and internal characteristics of professional groups from different dimensions.

2.2 Research the Construction of the Index System

The logical model can be used as a tool to guide project design and development to a certain extent[3], following the four-level logical structure of input, output, effect and influence[4, 8].This paper constructs the performance evaluation index system of high-level specialty group from four aspects of project funds input, output, benefit and satisfaction, which is divided into four levels. A total of 1 first level indicator, 4 second level indicators, 6 third level indicators, and 29 fourth level indicators are set. See Table 1 below for details.

Table 1. Performance evaluation index system of high-level professional group construction[6, 9, 10]

First level indicators	Second level indicators	Third level indicators	Fourth level indicators
High level professional group performance evaluation indicators A	Indicators of financial investment B1	Investment and use of funds indicators C1	Capital availability rateD1
			Capital utilization rateD2
			The system constructionD3
			AccountingD4
			Provincial funds useD5
			Professional group of constructionD6
			Integrated development of industry and educationD7
	Output indicators B2	Quantity indicators C2	Technical skills trainingD8
			Construction of double-qualified teachersD9
			Service development capabilityD10
			Level of internationalizationD11

		Guarantee mechanism for sustainable developmentD12
		Integrated development of industry and educationD13
	Quality indicators C3	Technical skills trainingD14
		Construction of double-qualified teachersD15
		Service development capabilityD16
		Initial employment rate of graduatesD17
		The proportion of graduates employed in this province（%）D18
	Social benefit indicators C4	Monthly income of graduatesD19
		Percentage of self-employmentD20
Performance indicators B3		The added value of the student scale of the major group（Number of people）D21
		Total amount of social training（Number per day）D22
	Sustainable impact indicators C5	Influence of professional groupD23
		Service industry development abilityD24
		Social reputation of professional groupD25
	Customer satisfaction indicators C6	Student satisfaction（%）D26
Satisfaction indicators B4		Graduate satisfaction（%）D27
		Employer satisfaction（%）D28
		Parent satisfaction（%）D29

3 Determination of the Weight of Performance Evaluation Indicators for the Construction of High-level Professional Groups

In the early 1970s, Saaty T.L. put forward Analytic Hierarchy Process (AHP)[2],This method combines qualitative and quantitative analysis, fully reflecting the characteristics of systematization and hierarchy. It is mainly used for sorting and analyzing multi-attribute indicators. Therefore, when determining the weights of various indicators for high-level professional groups, this article uses AHP for calculation and analysis. It is divided into four steps, one is to determine the hierarchical structure, the first level is the highest level A, the second level is the criteria level B (the second level evaluation index) , the third level is the sub-criteria level C (the third level evaluation index) , and the fourth level is the scheme level D (the fourth level evaluation

index); Second, the construction of the judgment matrix, this paper adopts the 1-9 proportional scale method and the pairwise comparison method to construct the judgment matrix. After the matrix is formed, the λ_{max} of the judgment matrix can be calculated, that is, the maximum eigenvalue[5]. In constructing the judgment matrix, it is worth noting that a_{ij} represents the importance of the i-th and j-th indicators in the same hierarchy relative to a certain indicator in the previous layer. a_{ij} is taken based on a 1-9 scale table, where a_{ji} is the reciprocal of a_{ij}. The scale value a_{ij} is detailed in Table 2.; The third is to calculate the weight of each index and do consistency test; the fourth is to calculate the total ranking weight, that is, the lowest evaluation index for the highest index weight.

Table 2. Scale table

a_{ij}（Quantitative values）	signification
1	Index I is as important as index J
3	Index I is slightly more important than index J
5	Compared with index J, index I is significantly more important than index J
7	Index I compared with index j, the former is more important than the latter strongly
9	Index I compared with index j, the former than the latter is extremely important
2、4、6、8	The intermediate value of the two adjacent judgments above
$a_{ij} = \frac{1}{a_{ji}}$ $a_{ij} = 1,2,\cdots,9$ or $1,\frac{1}{2},\frac{1}{3},\cdots,\frac{1}{9}$	Index I and index J get a_{ij}, Index J and index I get a_{ji}.

3.1 Calculating Total Sorting Weights

When using analytic hierarchy process to calculate the weight of performance evaluation index of high-level professional group construction, the ultimate goal is to calculate the weight of evaluation index at scheme level to the highest level index. Therefore, firstly, it is necessary to calculate the weights of each evaluation index at the highest level and criterion level, criterion level and sub-criterion level, sub-criterion level and scheme level respectively, and do consistency check, and then calculate the total ranking weight.

In this paper, when determining the weight, five experts are invited to compare the indicators at the same level, and the corresponding judgment matrices are constructed according to the comparison results, and then the corresponding weights are calculated by using these judgment matrices.

Calculate the Weights of B1-B4 Evaluation Indicators of the Second Layer Relative to Those of the First Layer

Table 3. Judgement matrix H1 and corresponding weight W1 of the second layers B1-B4 relative to the first layer A

H1	B1	B2	B3	B4	weight W1
B1	1	1/5	1/7	1/3	0.0600
B2	5	1	2	3	0.4533
B3	7	1/2	1	3	0.3440
B4	3	1/3	1/3	1	0.1427

The maximum eigenvalues and corresponding eigenvectors of the judgment matrix H1 are calculated by using matlab mathematical software. See Table 3 for details.The specific calculation process (program) is as follows:

H1=[1,1/5,1/7,1/3;5,1,2,3;7,1/2,1,3;3,1/3,1/3,1]; [u,v]=eig(H1)

The results of computer output are as follows:

u =

0.1017 0.0295 + 0.0947i 0.0295 - 0.0947i -0.1803

0.7687 -0.8273 -0.8273 0.4617

0.5833 0.1395 - 0.5155i 0.1395 + 0.5155i -0.6525

0.2420 0.1432 - 0.0102i 0.1432 + 0.0102i 0.5732

v =

4.1237 0 0 0

0 -0.0345 + 0.7108i 0 0

0 0 -0.0345 - 0.7108i 0

0 0 0 -0.0547

The program for calculating weight vectors using the maximum eigenvalue of a matrix is as follows: w1=u(:,1)/sum(u(:,1))

The computer output results are as follows:

w1 =

0.0600

0.4533

0.3440

0.1427

From the output results of the above-mentioned computer, it can be seen that the largest characteristic root of the judgment matrix H1 is $\lambda_{max} = 4.1237$, so there is $CI = \frac{\lambda_{max}-n}{n-1} = \frac{4.1237-4}{4-1} \approx 0.0412$. Because of $n = 4$, $RI = 0.9$ is obtained by looking up the table, so $CR = 0.0458 < 0.1$, so the consistency test is passed, indicating that the normalized characteristic vector corresponding to the largest characteristic root of the judgment matrix H1 can be used as the weight vector. Therefore, the weight $w1 = (0.0600,0.4533,0.3440,0.1427)$of the second-tier evaluation indicators B1-B4 relative to the first-tier indicator A is obtained.

Calculate the Weight of the Third-tier Evaluation Index Relative to the Second-tier Index

Table 4. Judgment matrices H2 and corresponding weights W2 of the third layers C2 and C3 relative to the second layer B2

H2	C2	C3	W2
C2	1	1/7	0.125
C3	7	1	0.875

After calculation, the maximum characteristic root of H2 is $\lambda_{max} = 2$, $n = 2, CI = 0, RI = 0$, we get $CR = 0 < 0.1$,consistency test passed, Therefore, the weight of the third-layer evaluation indexes C2 and C3 relative to the second-layer index B2. $w2 = (0.125,0.875)$.See Table 4 for details.

Table 5. The judgment matrix H3 and corresponding weight W3 of the third layer C4 and C5 are relative to the second layer B3

H3	C4	C5	W3
C4	1	3	0.75
C5	1/3	1	0.25

After calculation, the maximum characteristic root of H3 is $\lambda_{max} = 2$, $n = 2, CI = 0, RI = 0$, we get $CR = 0 < 0.1$,,consistency test passed, Therefore, the weight of the third level evaluation indexes C4 and C5 relative to the second level index B3. $w3 = (0.75,0.25)$.See Table 5 for details.

Calculate the Weight of the Fourth Layer Evaluation Index Relative to the Third Layer Index

Table 6. The judgment matrix H4 and corresponding weight W4 of d1-D5 of the fourth layer are relative to C1 of the third layer

H4	D1	D2	D3	D4	D5	W4
D1	1	3	3	5	2	0.4065
D2	1/3	1	1	3	1/2	0.1428
D3	1/3	1	1	3	1/2	0.1428
D4	1/5	1/3	1/3	1	1/4	0.0589
D5	1/2	2	2	4	1	0.2490

After calculation, the maximum characteristic root of H4 is $\lambda_{max} = 5.0567$, $n = 5, CI = 0.0142, RI = 1.12$, we get $CR = 0.0127 < 0.1$,,consistency test passed,Therefore, the weight of D1-D5 of the fourth layer relative to C1 of the third layer. $w4 = (0.4065,0.1428,0.1428,0.0589,0.2490)$.See Table 6 for details.

Table 7. The judgment matrix H5 and corresponding weight W5 of the fourth layer D6-D12 are relative to the third layer C2

H5	D6	D7	D8	D9	D10	D11	D12	W5
D6	1	1/3	1/4	1/3	1/3	1/5	1/5	0.0403
D7	3	1	1/3	1	1	4	4	0.1620

D8	4	3	1	3	3	5	5	0.3384
D9	3	1	1/3	1	1	4	4	0.1620
D10	3	1	1/3	1	1	4	4	0.1620
D11	5	1/4	1/5	1/4	1/4	1	1	0.0676
D12	5	1/4	1/5	1/4	1/4	1	1	0.0676

After calculation, the maximum characteristic root of H5 is $\lambda_{max} = 7.7823$, $n = 7, CI = 0.1304, RI = 1.32$, we get $CR = 0.0988 < 0.1$, consistency test passed, Therefore, the weight of the fourth layer evaluation index D6-D12 relative to the third layer index C2. See Table 7 for details. $w5 = (0.0403, 0.1620, 0.3384, 0.1620, 0.1620, 0.0676, 0.0676)$.

Table 8. The judgment matrix H6 and corresponding weight W6 of d13-D16 at the fourth layer are relative to C3 at the third layer

H6	D13	D14	D15	D16	W6
D13	1	1	1	1	0.25
D14	1	1	1	1	0.25
D15	1	1	1	1	0.25
D16	1	1	1	1	0.25

After calculation, the maximum characteristic root of H6 is $\lambda_{max} = 4$, $n = 4, CI = 0, RI = 0.9$, we get $CR = 0 < 0.1$, consistency test passed, Therefore, the weight of the fourth-level evaluation index D13-D16 relative to the third-level index C3. See Table 8 for details.$w6 = (0.25, 0.25, 0.25, 0.25)$.

Table 9. The judgment matrix H7 and corresponding weight W7 of the fourth layer D17-D22 are relative to the third layer C4

H7	D17	D18	D19	D20	D21	D22	W7
D17	1	1/2	3	2	4	4	0.2484
D18	2	1	4	3	5	5	0.3814
D19	1/3	1/4	1	1/2	2	2	0.0966
D20	1/2	1/3	2	1	3	3	0.1566
D21	1/4	1/5	1/2	1/3	1	1	0.0585
D22	1/4	1/5	1/2	1/3	1	1	0.0585

After calculation, the maximum characteristic root of H7 is $\lambda_{max} = 6.0808$, $n = 6, CI = 0.0162, RI = 1.24$, we get $CR = 0.0131 < 0.1$,consistency test passed,Therefore, the weight of the fourth layer evaluation index D17-D22 relative to the third layer index C4.$w7 = (0.2484, 0.3814, 0.0966, 0.1566, 0.0585, 0.0585)$.See Table 9 for details.

Table 10. The judgment matrix H8 and corresponding weight W8 of the lowest layer D23-D25 are relative to the third layer C5

H8	D23	D24	D25	W8
D23	1	3	5	0.6370
D24	1/3	1	3	0.2583
D25	1/5	1/3	1	0.1047

After calculation, the maximum characteristic root of H8 is $\lambda_{max} = 3.0385$, $n = 3, CI = 0.0192, RI = 0.58$, we get $CR = 0.0331 < 0.1$, consistency test passed, Therefore, the weight of the fourth-level evaluation index D23-D25 relative to the third-level index C5 .$w8 = (0.6370, 0.2583, 0.1047)$.See Table 10 for details.

Table 11. The judgment matrix H9 and corresponding weight W9 of d26-D29 at the fourth layer are relative to C6 at the third layer

H9	D26	D27	D28	D29	W9
D26	1	1/2	1/4	2	0.1377
D27	2	1	1/3	3	0.2323
D28	4	3	1	5	0.5462
D29	1/2	1/3	1/5	1	0.0838

After calculation, the maximum characteristic root of H9 is $\lambda_{max} = 4.0511$, $n = 4, CI = 0.0170, RI = 0.9$, we get $CR = 0.0189 < 0.1$,consistency test passed, Therefore, the weight of the fourth layer evaluation index D26-D29 relative to the third layer index C6.$w9 = (0.1377, 0.2323, 0.5462, 0.0838)$.See Table 11 for details.

Calculate the Total Ranking Weight of the Fourth Tier Indicators to the First Tier Indicators

The calculation method of the weight of each evaluation index in the fourth layer to the index in the first layer is to sum the weights of each layer in turn, and the results are shown in Table 12.

Table 12. Weight of performance evaluation index and total ranking weight of high-level professional group construction

first-level indicators	second-level indicators	weight	third-level indicators	weight	fourth-level indicators	weight	Total sorting weight
High A	IndicatB1	0.0600	InvestmenC1	1	D1	0.4065	0.0244
					D2	0.1428	0.0086
					D3	0.1428	0.0086
					D4	0.0589	0.0035
					D5	0.2490	0.0149
					D6	0.0403	0.0023
					D7	0.1620	0.0092
					D8	0.3384	0.0192
	B2	0.4533	C2	0.125	D9	0.1620	0.0092
					D10	0.1620	0.0092
					D11	0.0676	0.0038
					D12	0.0676	0.0038
			C3	0.875	D13	0.25	0.0992
					D14	0.25	0.0992

first-level indicators	second-level indicators	weight	third-level indicators	weight	fourth-level indicators	weight	Total sorting weight
					D15	0.25	0.0992
					D16	0.25	0.0992
					D17	0.2484	0.0641
					D18	0.3814	0.0984
			C4	0.75	D19	0.0966	0.0249
					D20	0.1566	0.0404
	B3	0.3440			D21	0.0585	0.0151
					D22	0.0578	0.0149
					D23	0.6370	0.0548
			C5	0.25	D24	0.2583	0.0222
					D25	0.1047	0.0090
					D26	0.1377	0.0196
					D27	0.2323	0.0331
	B4	0.1427	C6	1	D28	0.5462	0.0779
					D29	0.0838	0.0120

4 Conclusion

Under the background of “Double-high plan” construction, this paper constructs the Performance Index System of Vocational Colleges by AHP method, and allocates the weight of the index to form a scientific and comprehensive performance evaluation system. From the index system, we can see that the importance of the two-level indicators ware output indicators, efficiency indicators, satisfaction indicators, investment indicators. The four-level indicators of the highest technical skills training, the integration of production and teaching development, the construction of a double-teacher teacher team are 0.0992, the lowest weight of professional group construction indicators is 0.0023. The performance system serves school development, enhances overall school operations, focuses on high-end industries, and most importantly, benefits student growth. Sound management mechanisms, like the one-level chief system, aid in implementing multi-level tasks. Leadership can shift to a responsibility and audit framework, while implementation involves hierarchical management with clear task lists at each level. Establishing a Performance Index system enhances professional group construction, promoting sustainability and achieving goals. Given its complexity, performance evaluation can be dynamically adjusted for optimal results. Finally, setting evaluation criteria for high-level professional cluster construction is crucial.

References

1. Chao-qun, C., Fu-xiang, H., & College, C. C. T. (2021). Performance Evaluationof the Construction of First Class Specialty Group in Higher Vocational Colleges in Hunan Province: A Case of Changsha Commerce& Tourism College. Vocational Education Research(09), 41-45.
2. Golden, B. L., Wasil, E. A., & Harker, P. T. (1989). The analytic hierarchy process. Applications and Studies, Berlin, Heidelberg, 2(1), 1-273.
3. Greenwood, R. G. (2005). Management by objectives. Peter F. Drucker: Critical Evaluations in Business and Management, 1(2), 153.
4. Min, L. (2009). Interpretation of Drucker's practical management thoughts. Xi nan cai jing da xue chu ban she.
5. Saaty, T. L. (2008). Decision making with the analytic hierarchy process. International Journal of Services Sciences, 1(1), 83-98.
6. Song, Z. (2020). The Construction of Professional Groups and Index System in Vocational Colleges in the "Double High" Construction. Vocational and Technical Education, 41(13), 12-16.
7. Wang Tingting, L. Z. (2021). Research on the construction of higher vocational professional groups under the background of "double high". Vocational Education Research
8. Wei, W. (2010). Study on Evaluation Model and Technique of Government Leaders' Performance. ke xue chu ban she.
9. Yang, X., Zhou, M., Yang, Z., & Tang, Y. (2022). Research on the Evaluation System for the Construction of Professional Groups in Higher Vocational Education under the Background of Double High Construction. Modern Commercial Industry(7), 38-39. http://doi.org/10.19311/j.cnki.1672-3198.2022.07.017
10. Yingkai, L., & Hui, C. (2022). Research on connotation analysis and evaluation of performance index system of higher vocational professional groups -- based on the background of "double high" construction. Liaoning Higher Vocational Journal, 24(04), 56-60.
11. Zheng, Y. (2022). Evaluation of the Development Level of Professional Groups in Double Higher Education Institutions: Model Construction and Application Analysis. Vocational and Technical Education, 43(01), 18-23.