The Evaluation of Scholarship for Undergraduate Based on AHP

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***Abstract*—In this paper, we use AHP to study the evaluation of scholarships for undergraduate. From so many datas of survey in our school, we build hierarchy model, then construct pair comparing judgment matrix, at last get the weight of each index. In the end put forward rational proposal in view of current realization condition.**

Keywords-Evaluation of Scholarship; AHP; Undergraduate; Judgment Matrix

I. INTRODUCTION

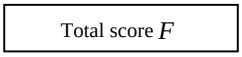
As China's economic developed, more and more students go into college after they graduate from high school. Scholarship distribution is an important thing to undergraduate every year.It's not only personal honor, but also impact the employment after they graduate directly. Scholarship including: national scholarship: at most about 8000 RMB every student every year; National Encouragement scholarship: at most about 5000 RMB every student every year; school scholarship: at most about 1000 RMB every student every year, and so on. So how to distribute the money is related to the interests of each student. This paper discuss the evaluation of scholarships by Analytic Hierarchy Process (AHP).

II. ANALYTIC HIERARCHY PROCESS

Analytic Hierarchy Process (AHP) is a structured technique for helping people deal with complex decisions. Rather than prescribing a "correct" decision, the AHP helps people to determine one. Based on mathematics and human psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. The AHP provides a comprehensive and rational framework for structuring a problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. It is used throughout the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education.

A. Build Model

We build the model by the survey to the undergraduate in Hebei University of Science and Technology. The hierarchy structure model is shown in Figure 1.



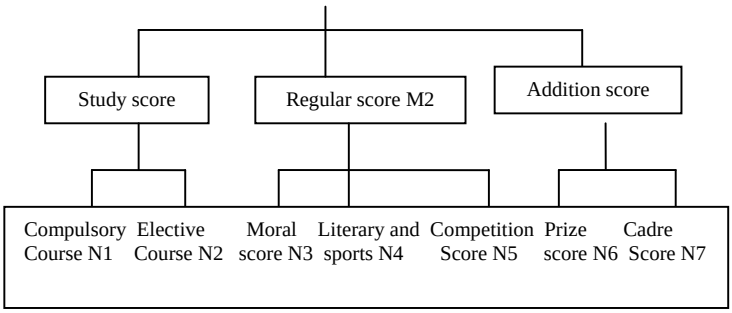


Figure 1 The Hierarchy Structure Model

B. Construct Pair Comparing Judgment Matrix

According to the result of survey, construct pair comparing judgment matrix A:

F	A1	A2	…	An
A1	a11	a12	…	a1n
A2	a12	a22	…	a1n
…	…	…	…	…
An	an1	an2	…	Ann

Where aij=1/aji （$i \neq j$）（$i, j = 1,2,\cdots,n$）.In the above matrix the value of aij is 1,2,…,9 based on 1-9 measures, define in table 1.

Table1 IMPORTANCE MEASURES

Deciding scale	Definition
1	ai's effect is the same with aj's
3	ai's effect is a little bigger than aj's
5	ai's effect is bigger than aj's
7	ai's effect is bigger than aj's clearly
9	ai's effect is bigger than aj's definitely
2,4,6,8	The ratio of ai's effect to aj's is between the opposition the above adjacent layers
1.1/2,…,1/9	The ratio of ai's effect to aj's is the opposite with the above aij

Determine aij according to the result of survey. Build judgment matrix is shown in Table 2.

TABLE2 JUDGMENT MATRIX

F	M1	M2	M3	*W*
M1	1	5	6	0.707
M2	1/5	1	3	0.201
M3	1/6	1/3	1	0.092

$$\begin{bmatrix} 1 & 5 & 6 \\ 1/5 & 1 & 3 \\ 1/6 & 1/3 & 1 \end{bmatrix} \longrightarrow \begin{bmatrix} 0.7317 & 0.7895 & 0.6 \\ 0.1463 & 0.1579 & 0.3 \\ 0.1220 & 0.0526 & 0.1 \end{bmatrix}$$

$$\longrightarrow \begin{bmatrix} 2.1212 \\ 0.6042 \\ 0.2746 \end{bmatrix} \longrightarrow \begin{bmatrix} 0.707 \\ 0.201 \\ 0.092 \end{bmatrix}$$

$$Hw = \begin{bmatrix} 1 & 5 & 6 \\ 1/5 & 1 & 3 \\ 1/6 & 1/3 & 1 \end{bmatrix} \begin{bmatrix} 0..707 \\ 0.6184 \\ 0.2768 \end{bmatrix} = \begin{bmatrix} 2.288 \\ 0.6184 \\ 0.2768 \end{bmatrix}$$

$$\lambda_{\max} = \frac{1}{3}\left(\frac{2.288}{0.707} + \frac{0.6184}{0.201} + \frac{0.2768}{0.092}\right) = 3.107$$

Corresponding eigenvector is $(0.707, 0.201, 0.092)^T$, calculate the maximum eigenvalue is $\lambda_{\max} = 3.107$.

C. Consistency Examination

$CR = \frac{CI}{RI}$,when $CR < 0.10$,the judgment matrix to be considered pass the consistency examination, otherwise make consistent correction. Saaty give the value of average random consistent index (RI),is shown in Table3.

TABLE3 RI

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

$$CI = \frac{\lambda_{\max} - n}{n-1} = 0.0535, CR = \frac{CI}{RI} = 0.092 < 0.1$$

pass the consistency examination.

D. Structure the Judgment Matris and Consistency Examination

By the same way, we can get the other judgment matrix are shown in Table4.

TABLE4 JUDGMENT MATRIX

M1	N1	N2	W
N1	1	4	0.8
N2	0.25	1	0.2

M2	N3	N4	N5	W
N3	1	2	2	0.5
N4	0.5	1	1	0.25
N5	0.5	1	1	0.25

According to 'sum method',

$$\begin{bmatrix} 1 & 4 \\ 1/4 & 1 \end{bmatrix} \to \begin{bmatrix} 0.8 & 0.8 \\ 0.2 & 0.2 \end{bmatrix} \to \begin{bmatrix} 1.6 \\ 0.4 \end{bmatrix} \to \begin{bmatrix} 0.8 \\ 0.2 \end{bmatrix} = w$$

$$Hw = \begin{bmatrix} 1 & 4 \\ 1/4 & 1 \end{bmatrix} \begin{bmatrix} 0.8 \\ 0.2 \end{bmatrix} = \begin{bmatrix} 1.6 \\ 0.4 \end{bmatrix}$$

$$\lambda = \frac{1}{2}\left(\frac{1.6}{0.8} + \frac{0.4}{0.2}\right) = 2$$

Corresponding eigenvector is $(0.8, 0.2)^T$, $\lambda_{\max} = 2$,

$CI = \frac{\lambda_{\max} - n}{n-1} = 0$,pass the consistency examination.

$$\begin{bmatrix} 1 & 2 & 2 \\ 1/2 & 1 & 1 \\ 1/2 & 1 & 1 \end{bmatrix} \longrightarrow \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.25 & 0.25 & 0.25 \\ 0.25 & 0.25 & 0.25 \end{bmatrix} \longrightarrow \begin{bmatrix} 1.5 \\ 0.75 \\ 0.75 \end{bmatrix} \longrightarrow \begin{bmatrix} 0.5 \\ 0.25 \\ 0.25 \end{bmatrix} = w$$

$$Hw = \begin{bmatrix} 1 & 2 & 2 \\ 1/2 & 1 & 1 \\ 1/2 & 1 & 1 \end{bmatrix} \begin{bmatrix} 0.5 \\ 0.25 \\ 0.25 \end{bmatrix} = \begin{bmatrix} 1.5 \\ 0.75 \\ 0.75 \end{bmatrix}$$

$$\lambda = \frac{1}{3}\left(\frac{1.5}{0.5} + \frac{0.75}{0.25} + \frac{0.75}{0.25}\right) = 3$$

Corresponding eigenvector is $(0.5, 0.25, 0.25)^T$,

$CI = \frac{\lambda_{\max} - n}{n-1} = 0$, $CI = \frac{CI}{RI} = 0$,

pass the consistency examination.

$$\begin{bmatrix} 1 & 3 \\ 1/3 & 1 \end{bmatrix} \longrightarrow \begin{bmatrix} 0.75 & 0.75 \\ 0.25 & 0.25 \end{bmatrix} \longrightarrow \begin{bmatrix} 1.5 \\ 0.5 \end{bmatrix} \longrightarrow \begin{bmatrix} 0.75 \\ 0.25 \end{bmatrix}$$

$$Hw = \begin{bmatrix} 1 & 3 \\ 1/3 & 1 \end{bmatrix} \begin{bmatrix} 0.75 \\ 0.25 \end{bmatrix} = \begin{bmatrix} 1.5 \\ 0.5 \end{bmatrix},$$

$$\lambda = \frac{1}{2}\left(\frac{1.5}{0.75} + \frac{0.5}{0.25}\right) = 2$$

Corresponding eigenvector is $(0.75, 0.25)^T$, $\lambda_{\max} = 2$,

$C_t = \frac{\lambda_{\max} - n}{n-1} = 0$,pass the consistency examination.

E. Level Overall Ordering

Weight of each element in level N to M, calculated by $\sum_{j=1}^{m} ajbij$, we get the weight of level overall ordering, the computeprocess are as follows: $0.707\times0.8+0.201\times0+0.092\times0=0.5656$, $0.707\times0.2+0.201\times0+0.092\times0=0.1414$, other computation are all the same, the result are shown in table 5.

M3	N6	N7	W
N6	1	3	0.75
N7	1/3	1	0.25

TABLE5 LEVELOVERALLORDERING

N	M1	M2	M3	Level Overall Ordering W
	0.707	0.201	0.092	
N1	0.8			0.5656
N2	0.2			0.1414

N3	0.5		0.1005
N4	0.25		0.05025
N5	0.15		0.05025
N6		0.75	0.069
N7		0.25	0.023

From upper table, we can see Compulsory course W_1 is 57%, Elective course W_2 is 14%, Moral score W_3 is 10%, Literary and sports score W_4 is 5%, Competition score W_5 score W_5 is 5%, Prize score W_6 is 7%, Cadre score W_7 is 2%. According to level overall ordering, we construct Scholarship Evaluation Table, as shown in Table6.

TABLE6 SCHOLARSHIP EVALUATION

___Department____---____Year Scholarship Evaluation Table

Name				
Number				
Study score	Compulsory course W1=0.57376	Test scoreQ1		
		Index scoreW1Q1		
	Elective course W2=0.14344	Test scoreQ2		
		Index score W2Q2		
Regular score	Moral score W3=0.09735	Test score Q3		
		Index score W3Q3		
	Literary and sports W4=0.048675	Test scoreQ4		
		Index scoreW4Q4		
	Competition score W5=0.048675	Test scoreQ5		
		Index scoreW5Q5		
Addition score	Prize score W6=0.066075	Test scoreQ6		
		Index scoreW6Q6		
	Cadre score W7=0.022025	Test scoreQ7		
		Index scoreW6Q7		

$$\text{Total score} = \sum_{i=1}^{7} WiQi$$

III. CONCLUSION

Use of AHP to build the assessment standards of scholarship is fair and impartial. AHP is an effective method in resolving such problems. I hope this evaluation criteria can mobilize the students' enthusiasm in study, and tap their potential, develop their strengths. Although this method has a lot of subjectivity in construct the judgment matrix, and also there are some uncertainties, different college can change the index or use same method to suit their reality condition.

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