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.

B. Construct Pair Comparing Judgment Matrix

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

\[
A = \begin{bmatrix}
  a_{11} & a_{12} & \cdots & a_{1n} \\
  a_{21} & a_{22} & \cdots & a_{2n} \\
  \vdots & \vdots & \ddots & \vdots \\
  a_{n1} & a_{n2} & \cdots & a_{nn}
\end{bmatrix}
\]

Where \( a_{ij} = 1/ a_{ji} \) \((i \neq j) \) \((i, j = 1, 2, \ldots, n) \). In the above matrix the value of \( a_{ij} \) is 1, 2, ..., 9 based on 1-9 measures, define in table 1.

<table>
<thead>
<tr>
<th>Deciding scale</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ai’s effect is the same with aj’s</td>
</tr>
<tr>
<td>3</td>
<td>ai’s effect is a little bigger than aj’s</td>
</tr>
<tr>
<td>5</td>
<td>ai’s effect is bigger than aj’s</td>
</tr>
<tr>
<td>7</td>
<td>ai’s effect is bigger than aj’s clearly</td>
</tr>
<tr>
<td>9</td>
<td>ai’s effect is bigger than aj’s definitely</td>
</tr>
<tr>
<td>2,4,6,8</td>
<td>The ratio of ai’s effect to aj’s is between the opposition the above adjacent layers</td>
</tr>
<tr>
<td>1/2, ..., 1/9</td>
<td>The ratio of ai’s effect to aj’s is the opposite with the above ai</td>
</tr>
</tbody>
</table>

Determine \( a_{ij} \) according to the result of survey. Build judgment matrix is shown in Table 2.

<table>
<thead>
<tr>
<th>F</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>0.707</td>
</tr>
<tr>
<td>M2</td>
<td>1/5</td>
<td>1</td>
<td>3</td>
<td>0.201</td>
</tr>
<tr>
<td>M3</td>
<td>1/6</td>
<td>1/3</td>
<td>1</td>
<td>0.092</td>
</tr>
</tbody>
</table>

Table 1 IMPORTANCE MEASURES

Table 2 JUDGMENT MATRIX
are shown in Table 4.

C. Consistency Examination

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

D. Structure the Judgment Matris and Consistency Examination

By the same way, we can get the other judgment matrix are shown in Table 4.

According to ‘sum method’,

\[
\begin{bmatrix}
1 & 4 & 6 \\
1/5 & 1 & 3 \\
1/6 & 1/3 & 1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.7317 & 0.7895 & 0.6 \\
0.1463 & 0.1579 & 0.3 \\
0.1220 & 0.0526 & 0.1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
2.1212 \\
0.6042 \\
0.2746
\end{bmatrix}
\rightarrow
\begin{bmatrix}
2.288 \\
0.6184 \\
0.2768
\end{bmatrix}
\]

\[
H_w = \begin{bmatrix}
1/5 & 1 & 3 \\
1/6 & 1/3 & 1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.707 \\
0.201
\end{bmatrix}
\]

\[
\lambda = \frac{1}{n-1} \left( \lambda_{\text{max}} - n \right)
\]

\[
\begin{bmatrix}
1/5 & 1 & 3 \\
1/6 & 1/3 & 1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.707 \\
0.201
\end{bmatrix}
\rightarrow
\begin{bmatrix}
2.288 \\
0.6184 \\
0.2768
\end{bmatrix}
\]

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

E. Level Overall Ordering

Weight of each element in level N to M, calculated by

\[
\sum_{j=1}^{m} a_{ij}b_{ij},
\]

we get the weight of level overall ordering, the computation are as follows: 0.707×0.8+0.201×0+0.092×0 = 0.5656, 0.707×0.2+0.201×0+0.092×0 = 0.1414, other computation are all the same, the result are shown in table 5.

According to ‘sum method’,

\[
\begin{bmatrix}
1 & 4 \\
1/4 & 1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.8 & 0.8 \\
0.2 & 0.2
\end{bmatrix}
\rightarrow
\begin{bmatrix}
1.6 \\
0.4
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.8 \\
0.2
\end{bmatrix}
\]

\[
H_w = \begin{bmatrix}
1 & 4 \\
1/4 & 1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.8 \\
0.2
\end{bmatrix}
\]

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

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

\[
C_l = \frac{\lambda_{\text{max}} - n}{n-1}, CI = \frac{C_l}{RI} = 0, pass the consistency examination.
\]

\[
\begin{bmatrix}
1 & 2 \\
1/2 & 1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.5 & 0.5 \\
0.25 & 0.25
\end{bmatrix}
\rightarrow
\begin{bmatrix}
1.5 \\
0.75
\end{bmatrix}
\]

\[
H_w = \begin{bmatrix}
1/2 & 1/1 \\
1/2 & 1/1
\end{bmatrix}
\rightarrow
\begin{bmatrix}
0.75 \\
0.75
\end{bmatrix}
\]

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

Corresponding eigenvector is \((0.5, 0.25, 0.25)^T\), \(\lambda_{\text{max}} = 2\).

\[
C_l = \frac{\lambda_{\text{max}} - n}{n-1}, CI = \frac{C_l}{RI} = 0, pass the consistency examination.
\]

Weight of each element in level N to M, calculated by

\[
\sum_{j=1}^{m} a_{ij}b_{ij},
\]

we get the weight of level overall ordering, the computation are all the same, the result are shown in table 5.
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 \( W_5 \) 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.

### Table 6: Scholarship Evaluation Table

<table>
<thead>
<tr>
<th>Department</th>
<th>Year</th>
<th>Scholarship Evaluation Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Number</td>
<td>Study score</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elective course</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regular score</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Addition score</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total score = \( \sum_{i=1}^{7} W_i Q_i \)

### 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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### REFERENCES


