Research on Vocational College Innovation and Enterprise Assessment Index

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Abstract. Thru the investigation on the Innovation and Enterprise education in Tianjin vocational colleges, the vocational college Innovation and enterprise assessment index emerged via the method of AHP and Comprehensive fuzzy assessment.

1. Foreword

On May 16, 2013, the General Office of the State Council released the document about the Notice on the employment of college graduates in 2013, code # 2013-35. Since then the series of 8 consecutive documents issued by the State Council, coded 2014-22, 2015-8, 2015-9, 2015-23, 2015-36, 2015-47 and 2015-53 aimed at the Innovation and Enterprise education in university and college. Obviously, China top government showed their serious concerns on the Innovation and Enterprise education in university and college, which was never emphasized in such high level in the past. As the forward position of the Innovation and Enterprise education, university and college have the duty to evoke the student’s sense of Innovation and Enterprise, improve their ability and quality of Innovation and Enterprise. These will be the first target in a certain long time. As to a reasonable evaluation system of the Innovation and Enterprise education, surely it will push the Innovation and Enterprise education in university and college.

In accordance with the top government documents, this article is addressed to select and build the assessment index system on the Innovation and Enterprise education in vocational college. It’s highly expected to evaluate the Innovation and Enterprise education in an objective and efficient way, meanwhile to promote the thematic education.

2. Core Concept Definition

It’s always a main factor related to the evaluation of education, to what extent an education subject is acceptable to both of Government and Non-Government Organizations. That is to say, the evaluation system of education practice must be set up. In this article, the Innovation and Enterprise education in vocational college means all the related achievement and social benefit caused by educational subjects, which is usually initiated by vocational college and supported by government investment. The assessment index is classified and selected from the outcome to build an assessment system of the Innovation and Enterprise education.

3. The Assessment Index Selected

In this paper, the assessment index of the Innovation and Enterprise education in vocational college is classified and selected by AHP. The Analytic Hierarchy Process AHP was invented by professor T.L. Satty from the University of Pittsburgh USA in 70’s of last century. As a decision analysis method, it’s applied by the Pentagon in the research of project “electric power allocation by industrial sectors contribution to the country”, based on network system theory and comprehensive evaluation method towards multi objective. This method emphasizes digitalization of a complicated decision by using little concrete information, while the elements affected the internal relationship.
It’s an easy way and a decision model for those complicated problems such as multi objective, multi principal and structurelessness. The most of educational practice effect assessment index belongs to qualitative, but not quantitative aspects. Therefore the AHP method is applicable.

Thru the research and sum up of the documents of Innovation and Enterprise released by the General Office of the State Council, Tianjin Municipal Government and Tianjin Municipal Education Commission, this article includes the Innovation and Enterprise education in vocational college supported by the government into 3 aspects of input and 5 aspects of output.

The questionnaire is designed on the basis of Analytic Hierarchy Process (AHP), which compares the importance of influencing factors at the same level. The level of measurements can be divided into 5 grades including Absolute Importance, Great Importance, Importance, Weak Importance, and Equal Importance, which are respectively corresponding to the magnitude of 9, 7, 5, 3, 1. According to your opinion, tick off the relevant box.

If you consider the level it mentioned can not accurately express your view on a comparative problem, for example, you think your consideration in one of the compare is between Great Importance and Importance, you can express your idea by drawing a circle between Great Importance and Importance.

Demonstration: Which aspect is more important, a car's safety or price? (The questionnaire for this demonstration will be generated below. Please do not modify any content related to the problem in the sample section. Please delete this part of the text in brackets).

If you think the safety of a car is more important than price, then please tick the box on the left (Great Importance).

Sample: The Relative Importance of Influence Factors in Cars' Assessment

<table>
<thead>
<tr>
<th>A</th>
<th>Assessment Scale</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>9 7 5 3 1 3 5 7 9</td>
<td>Price</td>
</tr>
</tbody>
</table>

Notes: The level of measurements can be divided into 5 grades including Absolute Importance, Great Importance, Importance, Weak Importance, and Equal Importance, which are respectively corresponding to the magnitude of 9, 7, 5, 3, 1.

Lack of space forbids further discussion at this questionnaire content. We only show the index meaning and the importance of each index. The questionnaires are released in 500 copies, 418 collected, among which 217 in Tianjin, 201 in other provinces. The efficient rate is 83.6%. According to the innovative and entrepreneurial spirit of the State Council, the Ministry of Education and Tianjin Municipal Education Commission, the index structure and importance ratio of Innovation and Enterprise education in vocational college are as following.

<table>
<thead>
<tr>
<th>Index</th>
<th>Contents and meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation and Enterprise education facilities</td>
<td>Office area 500M2 and up, Space and facilities support 100 staffs and up.</td>
</tr>
<tr>
<td>Encouragement measures</td>
<td>Released such measures by college regard to competition and minimum reward CNY500K per annum.</td>
</tr>
<tr>
<td>Management team Teacher: Student</td>
<td>Ratio 1: 10</td>
</tr>
<tr>
<td>Teachers team for basic course</td>
<td>Ratio 1:24, among the teachers team senior title proportion 30% and up.</td>
</tr>
<tr>
<td>Teachers team for professional course</td>
<td>Ratio 1:12, among the teachers team senior title proportion 30% and up.</td>
</tr>
<tr>
<td>Teacher's training</td>
<td>Consecutive investment no less than 100K annually.</td>
</tr>
<tr>
<td>Online course resource</td>
<td>Min. 36 hours course, and 10 times per student homework online.</td>
</tr>
</tbody>
</table>
| Course system | The whole course system suitable for layered
<table>
<thead>
<tr>
<th>Efficiency of the course</th>
<th>Per annum 10 and up excellent works from student.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of technology companies compared to student numbers</td>
<td>Ratio 3% qualified, 5% fair, 10% and up good.</td>
</tr>
<tr>
<td>Total assets</td>
<td>CNY 500K qualified, 500K~1M fair, 1M and up good.</td>
</tr>
<tr>
<td>Number of developed company in the industry</td>
<td>Compared to the total enterprises number, Ratio 60% qualified, 60%~70% fair, 70% and up good.</td>
</tr>
<tr>
<td>Patent quantity</td>
<td>Patent number: Student number</td>
</tr>
<tr>
<td>Patent conversion rate</td>
<td>Ratio 10% qualified, 10%~20% fair, 20% and up good.</td>
</tr>
<tr>
<td>Patent revenue</td>
<td>CNY annually 200K qualified, 200K~500K fair, 500K and up good.</td>
</tr>
</tbody>
</table>

4. Fuzzy Comprehensive Evaluation Method

Step one: Establish evaluation index set

According to The Assessment Index System of Innovation and Enterprise education in vocational college (Figure 1), we conclude that:

Factor gather $U = \{ \text{environment of Innovation and Enterprise education } u_1, \text{ teacher’s qualification } u_2, \text{ course } u_3, \text{ enterprises } u_4, \text{ scientific outcome } u_5 \}$

Which means: $u_1 = \{ \text{Innovation and Enterprise education facilities } u_{11}, \text{ Encouragement measures } u_{12}, \text{ management team } u_{13} \}$

$u_2 = \{ \text{Teachers’ quality for basic course } u_{21}, \text{ Teachers’ quality for professional course } u_{22}, \text{ Teacher’s training plan } u_{23} \}$

$u_3 = \{ \text{Online course resource } u_{31}, \text{ Course system } u_{32}, \text{ Efficiency of the course } u_{33} \}$

$u_4 = \{ \text{Number of technology companies } u_{41}, \text{ Total assets } u_{42}, \text{ Number of developed company in the industry } u_{43} \}$

$u_5 = \{ \text{Patent quantity } u_{51}, \text{ Patent conversion rate } u_{52}, \text{ Patent revenue } u_{53} \}$

Step two: Determine the importance of evaluation index

By issuing questionnaires (the importance of evaluation index questionnaire), we get the experts and scholars’ judgement on the importance of each index, and then obtain results from AHP:

The first class index weight: $A = (0.114, 0.136, 0.094, 0.282, 0.374)$

The second class index weight:

- $A_1 = (0.302, 0.415, 0.283)$
- $A_2 = (0.259, 0.481, 0.260)$
- $A_3 = (0.293, 0.373, 0.335)$
- $A_4 = (0.355, 0.309, 0.336)$
- $A_5 = (0.332, 0.409, 0.259)$

Step three: Single-factor fuzzy comprehensive evaluation method

The following form concluded from the results of the questionnaire.
Establish a matrix of fuzzy relation:

\[
\begin{bmatrix}
0.2 & 0.3 & 0.4 & 0.1 & 0 \\
0.3 & 0.2 & 0.3 & 0.1 & 0 \\
0.4 & 0.3 & 0.2 & 0.1 & 0 \\
\end{bmatrix}
\begin{bmatrix}
0.2 & 0.3 & 0.2 & 0.2 & 0.1 \\
0.1 & 0.2 & 0.3 & 0.2 & 0.2 \\
0.4 & 0.4 & 0.1 & 0.1 & 0 \\
\end{bmatrix}
= \begin{bmatrix}
0.2 & 0.2 & 0.4 & 0.2 & 0 \\
0.1 & 0.2 & 0.3 & 0.2 & 0 \\
0.4 & 0.2 & 0.2 & 0.2 & 0 \\
\end{bmatrix}
\begin{bmatrix}
0.3 & 0.4 & 0.2 & 0.1 & 0 \\
0.3 & 0.3 & 0.2 & 0.1 & 0 \\
0.1 & 0.2 & 0.5 & 0.1 & 0 \\
\end{bmatrix}
\]

Synthesis calculation gets the result that:
\[
B_1 = A_1 \circ R_1 = (0.298, 0.259, 0.302, 0.100, 0.041)
\]
\[
B_2 = A_2 \circ R_2 = (0.204, 0.278, 0.222, 0.174, 0.122)
\]
\[
B_3 = A_3 \circ R_3 = (0.267, 0.329, 0.233, 0.100, 0.071)
\]
\[
B_4 = A_4 \circ R_4 = (0.236, 0.200, 0.302, 0.200, 0.062)
\]
\[
B_5 = A_5 \circ R_5 = (0.248, 0.307, 0.278, 0.100, 0.067)
\]

Step four: Second level fuzzy comprehensive evaluation

Consider vectors \(B_1, B_2, B_3, B_4, B_5\) which were obtained as a matrix of fuzzy relation in the
second level fuzzy comprehensive evaluation method, then:

\[
R = \begin{bmatrix}
0.298 & 0.259 & 0.302 & 0.100 & 0.041 \\
0.204 & 0.278 & 0.222 & 0.174 & 0.122 \\
0.267 & 0.329 & 0.233 & 0.100 & 0.071 \\
0.236 & 0.200 & 0.302 & 0.200 & 0.062 \\
0.248 & 0.307 & 0.278 & 0.100 & 0.067 
\end{bmatrix}
\]

Because \( A = (0.114, 0.136, 0.094, 0.282, 0.374) \)

Then: \( B = A \circ R = (0.246, 0.269, 0.276, 0.138, 0.071) \)

Step five: Result interpretation of fuzzy comprehensive evaluation

Take the vector from Rating weight \( C = (5, 4, 3, 2, 1) \). The result of The Assessment Index System of Innovation and Enterprise education in vocational college can be expressed by letter \( D \):

\[
D = \frac{5 \times 0.246 + 4 \times 0.269 + 3 \times 0.276 + 2 \times 0.138 + 1 \times 0.071}{0.246 + 0.269 + 0.276 + 0.138 + 0.071} = 3.481
\]

This dissertation sets up an assessment Index System of Innovation and Enterprise education in vocational college. It affirms the index importance by AHP analysis, and establishes the model of fuzzy comprehensive evaluation to evaluate suppliers.

Summary

Those uncertain and subjective factors among the Assessment of Innovation and Enterprise education in vocational college are fuzzy. Thus the usage of fuzzy comprehensive evaluation conducive to show the theory's advantages, which can make evaluation results better than other ways. However, no one can promise fuzzy comprehensive evaluation is flawless in any situation. People can try to avoid unnecessary errors in practical application by paying attention to the following questions.

First of all, all datum in fuzzy comprehensive evaluation are collected by issuing questionnaires to experts and clients, which means we can only get datum objective and truly reflect the actual situation when the respondents are sufficient and representative. On the contrary, it will have a great impact on the evaluation results if the respondents are not representative or the data obtained are not true.

Second of all, the importance of factors is not showing themselves accompanied by the evaluation process in the fuzzy comprehensive evaluation.

Artificial determination of importance may appear with greater flexibility which can show the importance of factors themselves to their assesse to some extent. After all, artificial judgments always bring strong subjectivity, which may not be exactly the same as the objective reality.

References

