Performance Appraisal of Enterprise Middle-Level Management Based on Fuzzy Comprehensive Evaluation

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Keywords: fuzzy comprehensive evaluation; performance appraisal

Abstract. Based on the study of enterprise middle-level management performance appraisal index, this paper sets up the fuzzy comprehensive evaluation model of middle-level management performance and carries out the empirical study, which offers theoretical and realistic basis for strengthening middle-level management performance appraisal. At present, the effective performance appraisal on enterprise middle-level managements is playing an increasing important role in human resource management and determines the basis of promotion and reward for enterprise middle-level managements. Therefore, building a scientific detection, inspection and evaluation system, which is used for enterprise managers, is a key for effectively managing enterprise middle-level managements.

The Principles For The Performance Appraisal Of Enterprise Middle-Level Managements

In order to achieve the expected management appraisal management skills, we should abide by the following basic principles in the performance appraisal:

A. The Principle of Openness
The standards, procedures and responsibilities of enterprise performance appraisal should be open to the staff.

B. The Principle of Objectivity
According to the standards of performance appraisal, performance appraisal should objectively carry out examinations\cite{1}.

C. The Principle of Feedback
The result of performance appraisal should be sent back to the evaluated person to play the education and development function of performance appraisal.

D. The Principle of Work-focus Evaluation
Performance appraisal index refers to the output from which to assess the work, and it is to solve what question is evaluated\cite{2}.

The Performance Appraisal Index System Design of Enterprise Middle-Level Management

The performance appraisal index system of enterprise middle-level management includes: (1) one's own quality, including physical quality and ideological quality; (2) work attitude, including responsibility awareness and enterprising spirit; (3) actual achievement of work, including achievement of goal and team construction; (4) work ability, including profession competence, leadership, innovation ability and the ability of handling the emergency. The index set is divided into two levels by us: the first-level and the second-level index set are: $U = \{ U_1, U_2, U_3, U_4 \}$, $U_1 = \{ V_{11}, V_{12} \}$, $U_2 = \{ V_{21}, V_{22} \}$, $U_3 = \{ V_{31}, V_{32} \}$, $U_4 = \{ V_{41}, V_{42}, V_{43}, V_{44} \}$.
The fuzzy comprehensive evaluation in performance appraisal of enterprise middle-level management

E. Construction of fuzzy comprehensive evaluation in the performance appraisal of enterprise middle-level management

(1) Determination of the facts in comprehensive evaluation
Total numbers of the first-level evaluation index and the second-level evaluation index are four and ten respectively. The score of every level is as follows: 

\[ v_i(i = 1, \ldots, 5) \]

\[ v_1 = 100 \text{(Excellent), } v_2 = 80 \text{ (Good), } v_3 = 70 \text{ (Moderate), } v_4 = 60 \text{ (Bad), } v_5 = 40 \text{ (Worse), so, } V = (v_1, v_2, v_3, v_4, v_5) \]

(2) Determination of index weight

1. Construction of important judgment matrix

We adopt the AHP method to determine the index weight of main factor and sub-factor levels[4].

The estimated value of the relative importance of index i to index j is denoted by \( a_{ij} \), thus, the comments of all the experts make up a group of fuzzy judgment matrixes as follows:

\[
\begin{bmatrix}
1 & 3 & 5 & 7 \\
3 & 1 & 4 & 3 \\
5 & 4 & 1 & 2 \\
3 & 2 & 1 & 1
\end{bmatrix}
\]

Construction of judgment matrix mainly relies on 1-9 scaling.

Take the every factor weight of work ability in Table II as the example, according to experts’ consultation scores, we can construct the important judgment matrix:

\[
\begin{bmatrix}
1 & 3 & 5 & 7 \\
3 & 1 & 4 & 3 \\
5 & 4 & 1 & 2 \\
3 & 2 & 1 & 1
\end{bmatrix}
\]

2.Calculate the weight value of every factor

\[
W_i = \frac{1}{\sum_{j=1}^{n} a_{0j}} \sum_{j=1}^{n} a_{ij} 
\]

and get as follows: 

\[ W_1 = 0.0631, \quad W_2 = 0.1101, \quad W_3 = 0.6171, \quad W_4 = 0.2097 \]

3.Consistency Check

According to the formula 

\[
\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} (AW)_i 
\]

we can obtain the most obvious feature of matrix 

\[ A : \lambda_{max} = 4.2298, \text{ then we put the numerical value into the formula } CI = \frac{\lambda_{max} - n}{n-1} = 0.0766, \text{ and } \]

RI indices the average coefficient of random one-time.

According to the formula, 

\[ CR = \frac{CI}{RI} = \frac{0.0766}{0.9} = 0.0851 < 0.1, \text{ judgment matrix has satisfactory consistency. In the light of above methods, we can calculate in Table 1:} \]

<table>
<thead>
<tr>
<th>( U_1 )</th>
<th>( U_2 )</th>
<th>( U_3 )</th>
<th>( U_4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0631</td>
<td>0.1101</td>
<td>0.6171</td>
<td>0.2097</td>
</tr>
<tr>
<td>( V_{11} )</td>
<td>( V_{12} )</td>
<td>( V_{21} )</td>
<td>( V_{22} )</td>
</tr>
<tr>
<td>0.0105</td>
<td>0.0525</td>
<td>0.0551</td>
<td>0.0551</td>
</tr>
<tr>
<td>0.4628</td>
<td>0.1543</td>
<td>0.112</td>
<td>0.0499</td>
</tr>
</tbody>
</table>

(3) Fuzzy comprehensive appraisal

Concrete evaluation adopts the fuzzy calculation method: if A and B are the fuzzy matrices of dimensions \( n \times m \) and \( m \times l \), thus the their product is that 

\[ C = A \cdot B \]

which is the matrix of dimension \( n \times l \), and its entries are:
\[ C_g = \bigvee_{k=1}^m (a_{ik} \land b_{ij}) (i = 1, 2, \cdots, m; j = 1, 2, \cdots, I) \]

The mark “\( \lor \)” means \( a \lor b = \max(a, b) \), and the mark “\( \land \)” means: \( a \land b = \min(a, b) \). Find the comprehensive evaluation matrix \( B_i \) for each \( U_i \) (\( i = 1, 2, 3, 4 \)), \( B_i = W_i \bullet R_i \) [3], the evaluation matrix (membership matrix) on \( U \) is: \( B = (B_1, B_2, B_3, B_4)^T \), and the weight vector is \( W_{1:5} \). The comprehensive evaluation matrix of \( U \) is \( A = W \cdot B \).

\[ \text{F. Analysis of examples} \]

According to the designed index system, we invite ten experts to make scores on performance appraisal factors of Mr./Mrs. Li by using the software Matlab.

**TABLE 2 THE FACTOR’S SCORES RESULT OF MR./MRS. LI’S PERFORMANCE APPRAISAL**

<table>
<thead>
<tr>
<th></th>
<th>( V_{11} )</th>
<th>( V_{12} )</th>
<th>( V_{21} )</th>
<th>( V_{22} )</th>
<th>( V_{31} )</th>
<th>( V_{32} )</th>
<th>( V_{41} )</th>
<th>( V_{42} )</th>
<th>( V_{43} )</th>
<th>( V_{44} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>0.06</td>
<td>0.08</td>
<td>0.03</td>
<td>0</td>
<td>0.02</td>
<td>0.13</td>
<td>0.07</td>
</tr>
<tr>
<td>M</td>
<td>0.16</td>
<td>0.1</td>
<td>0.15</td>
<td>0.21</td>
<td>0.26</td>
<td>0.21</td>
<td>0.3</td>
<td>0.23</td>
<td>0.14</td>
<td>0.16</td>
</tr>
<tr>
<td>G</td>
<td>0.42</td>
<td>0.36</td>
<td>0.41</td>
<td>0.36</td>
<td>0.38</td>
<td>0.4</td>
<td>0.42</td>
<td>0.41</td>
<td>0.31</td>
<td>0.36</td>
</tr>
<tr>
<td>E</td>
<td>0.42</td>
<td>0.54</td>
<td>0.34</td>
<td>0.37</td>
<td>0.28</td>
<td>0.36</td>
<td>0.28</td>
<td>0.34</td>
<td>0.42</td>
<td>0.41</td>
</tr>
</tbody>
</table>

When we use the model of fuzzy comprehensive evaluation of enterprise middle-level management, we can calculate the effect of work ability on the performance evaluation is as follows:

\[
B_4 = W_4 \bullet R_4 = (0.112, 0.0499, 0.0311, 0.0167) \bullet 
\begin{bmatrix}
0 & 0 & 0.3 & 0.42 & 0.28 \\
0 & 0.02 & 0.23 & 0.41 & 0.34 \\
0 & 0.13 & 0.14 & 0.31 & 0.42 \\
0 & 0.07 & 0.16 & 0.36 & 0.41
\end{bmatrix}
\]

\[= (0.0311, 0.112, 0.112, 0.112)\]

In a similar way, the comprehensive evaluation results can be obtained:

\[
B_1 = (0, 0, 0.0525, 0.0525, 0.0525), B_2 = (0, 0.0551, 0.0551, 0.0551, 0.0551), \]
\[
B_3 = (0, 0.08, 0.26, 0.38, 0.28)
\]

Therefore, the second–level comprehensive evaluation result of Mr./Mrs. Li is as follows:

\[
A = W \cdot B = (0.0631, 0.1101, 0.6171, 0.2097) \bullet 
\begin{bmatrix}
0 & 0 & 0.0525 & 0.0525 & 0.0525 \\
0 & 0.0551 & 0.0551 & 0.0551 & 0.0551 \\
0 & 0.08 & 0.26 & 0.38 & 0.28 \\
0 & 0.0311 & 0.112 & 0.112 & 0.112
\end{bmatrix}
\]

\[= (0.08, 0.26, 0.38, 0.28)\]

Therefore, Mr. /Mrs. Li got the scores of performance evaluation: 100*0.28+80*0.38+70*0.26+60*0.08+40*0=81.4, which can be ranked as good. From the primary evaluation result, we can see the actual work achievement of Mr. /Mrs. Li is evaluated as good.

**References**


