An effective human resource management mode via analytic hierarchy process

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Abstract

With the rapid development of social economics, there are a large number of enterprises in China. However, the profitability of some enterprises is still not satisfied. The reasons lie in that human resource allocation and management ability of these enterprises should be improved. Therefore, in this paper, we focus on the problem of human resource management mode selection based on analytic hierarchy process. Functions of human resource management consist of basic work, routine work, and strategic work. Afterwards, a three level index system of the human resource management problem is provided which can cover the above three functions. Then, we propose a novel human resource management mode selection approach based on analytic hierarchy process, which is a multi-criteria decision-making calculating method via relative assessment and prioritization of alternatives. Finally, experiments are conducted using the data collected from listed companies. Experimental results show that the performance of the proposed method is quite close to the ground truth, and “Management rules”, “Salary and welfare”, and “Enterprise culture” are the most important factors in the proposed problem. Furthermore, we can find that 1) human resource management mode selection of a specific enterprise must be consistent with its business strategy, 2) enterprise culture and staff incentive mechanism are also have profound impact on modern enterprise development.

Keywords: Human resource management, Analytic hierarchy process, Index system, Comparison matrix of criteria

1 Introduction

With the rapid development of knowledge economy, human resources management has been a key part for companies to obtain competitive advantage. Furthermore, human resources management departments have been the strategic partner of the enterprises. But, in the field of human resource management, many human resources management divisions are in a very difficult position [1]. Therefore, the effective human resource management mode is of great importance, it not only satisfies organizational performance management’s requirements, but also improves the human resource management department performance [2].

In this paper, we define human resources as the overt talents and underlying characteristics which people holds. On the other hand, we define three important aspects in human resource management: 1) the individual, 2) the organizational and 3) the societal/global. In the academic field, human resource management mainly considers the requirements of managers to hire and the management method [3][4].

Competing globally will make China’s companies to continuously promote their management quality, efficiency, and productivity. Hence, this mode will let all human resource managers to concentrate on how to design an effective human resource management mode [5]. Based on the above analysis, we will discuss which factors can influence the human resource management mode using Analytic hierarchy process, which refers to a widely utilized approach for multi-criteria decision support via the hierarchical decomposition of objectives, evaluation of preferences based on pairwise comparisons, and a subsequent aggregation into global evaluations. Afterwards, with the proposed method in this paper, quality of human resource management can be enhanced greatly.

The main innovations of this paper lie in that we introduce the analytic hierarchy process in human resource management mode design. The rest of the paper is organized as follows. In section 2, a survey of analytic hierarchy process is described. Section 3 illustrates the proposed problem. In section 4, the analytic hierarchy process based human resource management method is given. Section 5 provides experiments to verify the effectiveness of our algorithm. Finally, the conclusions are drawn in section 6.

2 Literature review

Chen et al. proposed an approach using the data from the testing of food-waste feed with comprehensive evaluation of its product safety by integrating fuzzy mathematics and the analytic hierarchy process model. Particularly, the authors exploited the EM algorithm and AHP process to compute the weights of the individual evaluation indices [6].

Durbin et al. combined the AHP technology with stochastic multi-criteria acceptability analysis, which denotes an inverse-preference approach to allow the pairwise comparisons. Furthermore, simulation experi-

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ments demonstrate that the proposed model can discern the best alternative deteriorates as uncertainty increases [7].

Zhang et al. studied on the fuzzy analytic hierarchy process synthetic evaluation models, which integrate different kinds of data from multiple sensors to convert these data to health evaluating scores. Particularly, we select a piecewise distribution for membership functions, and then we define several fuzzy operators to construct fuzzy-AHP evaluation program [8].

Dong et al. presented a consensus reaching model for a group by using the Analytic Hierarchy Process model. The proposed model can help humans to enhance their group consensus quality via updating judgments. Particularly, in this model, we design a moderator to help decision maker making judgments. Moreover, this model can also support decision makers to make determination using the moderator [9].

As a powerful computing tool, analytic hierarchy process can be widely used in many application fields. Parsons et al. utilized analytic hierarchy process model to help Local Government Authorities in England and Wales have statutory responsibility for the maintenance of Public Rights of Way, for example, pathways and byways open to non-motorised traffic [10]. Paul et al. exploited analytic hierarchy process to tackle the problem of waste treatment technology assessment in Mexico [11]. Ramanujan et al. used Stochastic Analytic Hierarchy Process to design for environment within an industry setting with quantitative measures of environmental performance [13]. Furthermore, analytic hierarchy process also can be applied in Axial vibration source identification [14]. New Product Development Strategy [15], hydrogen storage systems for automobiles in Korea [16], agriculture [17], Technology Standards Battles [18], evaluating effect degree of damaged mountains [19], and Hospital Information Systems [20].

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3 Problem statements

In this section, we will introduce the problem of human resource management mode design, which is the key step of this paper. As is shown in Fig 1, functions of human resource management are mainly made up of three parts: 1) Basic work, 2) Routine work, and 3) Strategic work. In this paper, we aim to design an effective human resource management mode to effectively management the three parts of functions.

![Diagram of Human Resource Management](image-url)

**FIGURE1.** Functions of human resource management.
To tackle the proposed problem, we should know what are influencing factors about human resource management in advance. Therefore, in the following section, we should illustrate the index system of human resource management (shown in Table.1).

<table>
<thead>
<tr>
<th>First level index</th>
<th>Second level index</th>
<th>Third level index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic work</td>
<td>Position management</td>
<td>I1: Perfect post management measures</td>
</tr>
<tr>
<td></td>
<td>Management rules</td>
<td>I2: Objective and fair post evaluation</td>
</tr>
<tr>
<td></td>
<td>Information systems</td>
<td>I3: Accuracy of post establishment</td>
</tr>
<tr>
<td></td>
<td>Recruitment</td>
<td>I4: Update frequency of post establishment</td>
</tr>
<tr>
<td></td>
<td>Performance managed</td>
<td>I5: Reasonable work flow</td>
</tr>
<tr>
<td></td>
<td>Training and developement</td>
<td>I6: Normative rules</td>
</tr>
<tr>
<td></td>
<td>Salary and welfare</td>
<td>I7: Perfect employee handbook</td>
</tr>
<tr>
<td></td>
<td>Employee Relationship</td>
<td>I8: Standardization of labor contract management</td>
</tr>
<tr>
<td>Routine work</td>
<td>Strategic Human Resource Planning</td>
<td>I9: Easy to use</td>
</tr>
<tr>
<td></td>
<td>Key post management</td>
<td>I10: Maintenance and updating in time</td>
</tr>
<tr>
<td></td>
<td>Enterprise culture</td>
<td>I11: Average cost of staff recruitment</td>
</tr>
<tr>
<td></td>
<td>Organizational reform</td>
<td>I12: Rationality of human resource structure</td>
</tr>
<tr>
<td></td>
<td>Financial index</td>
<td>I13: Timeliness of performance appraisal management</td>
</tr>
</tbody>
</table>

### 4 Human resource management mode selections by the analytic hierarchy process

The Analytic Hierarchy Process is initially developed by Thomas Saaty, which refers to a multi-criteria decision-making computing framework with relative assessment and prioritization of alternatives. Furthermore, AHP is designed via the application of pair-wise comparisons. Analytic hierarchy process may achieve a priority of the importance of each alternative. In this way, an overall object is positioned at the top level, and the criteria in the middle level denotes to the overall object. The elements at a given level are denoted as $X_1, X_2, \ldots, X_n$. Exploiting the relative evaluations computed by a decision maker, a pairwise comparison matrix is given as follows:

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

(1)

In the above equation, the condition $a_{ij} \cdot a_{ji}$ is equal to one, and the derivation of priorities at some levels is executed by the pairwise matrix in the above equation as well. Then, the pairwise comparisons matrix is defined as follows.

$$
A = \begin{pmatrix}
w_{11} & w_{12} & \cdots & w_{1n} \\
w_{21} & w_{22} & \cdots & w_{2n} \\
  \vdots & \vdots & \ddots & \vdots \\
w_{n1} & w_{n2} & \cdots & w_{nn}
\end{pmatrix}
$$

(2)

Where the vector $w = (w_1, \ldots, w_n)$ is satisfied. Next, exploiting the matrix $A$, a priority vector is calculated by the following equation.

$$
Aw = mw
$$

(3)

$$
Aw = \lambda_{max} w
$$

(4)

Where $\lambda_{max}$ denotes to the largest eigenvalue of matrix $A$ and $w$ refers to the weight vector. Afterwards, by using parameter $\lambda_{max}$, the consistency index is calculated as follows.

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

(5)
Based on the above analysis, EV method is utilized to tackle the eigenvector problem, and the executing process of the analytic hierarchy process model is illustrated in Figure 2.

If the hierarchy is constructed, a numerical scale is given to each pair of $n$ alternatives ($A_i, A_j$) by experts. Afterwards, the symbol $\alpha_{ij}$ represents the individual judgment of the $k^{th}$ expert which is related to alternative $A_i$ compared with $A_j$, and then all expert judgments are organized to construct the following matrix:

$$M = \begin{bmatrix} a_{i1} & a_{i2} & \cdots & a_{in} \\ a_{j1} & a_{j2} & \cdots & a_{jn} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (6)$$

Where the following conditions $a_{ij} > 0$ and $a_{ij} \cdot a_{ji} = 1$ should be satisfied.

Using the above analytic hierarchy process model, we can solve the human resource management mode selection problem by computing the index weights in Table 1. Then, important factors in this problem have higher value of weight. To promote the effectiveness human resource management, managers should pay more attentions to the factors with higher values of index weights.

5 Experiments

In this section, a series of experiments are designed using the dataset which is collected from ten different listed companies. For each company, the data we collected can cover the above 33 indexes, which are shown in Table 1. Furthermore, utilizing the analytic hierarchy process model, weight of each index in the proposed index system can be obtained (shown in Figure 3).
Figure 3 demonstrates the weight of each index computing by AHP, and the experimental results show that indexes with highest weights are 129, 119, 120, 17, 18, 16 and 15 respectively. That is, “Management rules”, “Salary and welfare”, and “Enterprise culture” are the most important in the human resource management problem. Next, to testify the effectiveness of our proposed method, performance evaluation based on ten different listed companies is given in Fig. 4 as follows.

In Figure 4, our proposed AHP based method is compared with expert evaluation using management effectiveness. Particularly, we invite six experts to evaluate the management effectiveness for the ten listed companies, and experiment evaluation results are regarded as the ground truth. Combining all the results of the given ten listed companies, the average error rate between our method and ground truth is 4.87%.

In a word, based on the above experimental results, several suggestions for human resource management can be obtained. Firstly, enterprise human resource management mode selection must conform to its business strategy. Secondly, enterprise culture and staff incentive mechanism are another two important factors for modern enterprise management.

6 Conclusions

In this paper, we propose an effective human resource management mode selection method via analytic hierarchy process. To tackle this problem, a three level index system of the human resource management problem is designed in advance. Afterwards, we select human resource management mode through a multi-criteria decision-making calculating process using relative assessment and prioritization of alternatives. Experimental results provide some useful suggestions for human resource managers.

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