# Research on grey correlation analysis model of enterprise human resources competitiveness

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**Abstract**

Human resources is one of the key indexes in measuring the competitiveness of en enterprise. However, evaluation of enterprise human resource competitiveness, evaluation index system and evaluation model remain a problem in academic and practice. Nowadays, key factors in evaluation of enterprise human resources competitiveness and evaluation index are incomplete and imperfect, and processing methods of corresponding evaluation index is not scientific. Thus, studies on analysis model of enterprise human resource are of great importance. In this paper, an improved grey correlation analysis model of human resource competitiveness was put forward. This model provides relative restrictive factors in analysis of enterprise resource competitiveness, and analysed enterprise competitiveness from the aspects of human resource quality competiveness, market development competiveness, management quality competiveness, etc. and evaluation analysis based on improved grey correlation analysis method was conducted. Its evaluation result can be a basis of selection of human resource developing strategies for direction and of frame of decision-making. Finally, the model and algorithm was proved feasible by implementation of actual case.

*Keywords:* human resources, competitiveness, grey correlation analysis, evaluating indicator, model

## 1 Introduction

Enterprise human resources refer to the human resources or labor force owned or controlled by the enterprise that can bring economic interest in the process of production and management. Along with the development of information technology and computer science and technology, the importance of enterprise human resource is increasing. And the emphasis of enterprise human resources not only on human resources or labour force, but has expanded to the strength and quality an enterprise owned that can make the enterprise obtain economic profit and develop sustainably, which embodies various aspects including the management ability of human resources, human resource competitiveness and extensible developing potential based on science and technology [1-3]. Thus, analysis of human resource evaluation needs to be based on the aspects of human resources, including sociality, reproducibility, profitability, marketability, dynamics, hierarchy and subjective initiative, for comprehensive analysis, and obtain key evaluation factors of its evaluation analysis of human resource competitiveness. And comprehensive evaluation index system of enterprise human resource competitiveness can be created, which will provide strong support for implementation of computer aided intelligent analysis method of evaluation of enterprise human resource competitiveness and implementation of the system [4-5]. By far, some relative studies had analysed and probe into enterprise human resources, and had provided good directions and strategies of implementation [6-10]. However, most of the existing studies on analysis of human resource competitiveness limited to provide relative guiding strategies based on quantitative analysis, cannot implement comprehensive evaluation analysis combining qualitative and quantitative aspects, and cannot provide qualitative analysis models, which can guide the analysis of enterprise human resources. Thus, this paper, based on existing researches and studies, via analysis of relative restrictive factors that influence enterprises human resources, established a comprehensive evaluation index system of enterprise human resources corresponding to restrictive factors, and established corresponding comprehensive evaluation calculation model of enterprise human resources based on grey correlation analysis.

## 2 Influence factors in enterprise human resource and comprehensive index system

### 2.1 ANALYSIS OF INFLUENCE FACTORS IN ENTERPRISE HUMAN RESOURCE

**Restraint of social factors:** human resource in a certain population engages in social labour. It cannot leave the society, and is limited by various conditions including social politics, economy and culture. Thus, human resource presents strong sociality. Sociality is the essential attribute of human resource, and is also the basic difference between human resource and material resource.

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It needs to be noted that along with the development of society and science and technology, human resources does not refer to human, but the individual capacity carried by human. That is to say, the carrier of human resource is human, and the core of human resources is labour force.

**Restraint of reproducibility factors:** reproducibility of human resources includes reproducibility of enterprise labour force and reproducibility of human resources. The reproducibility is realized via the process of continuous replacement, renewal and rehabilitation of the entire labour force population of enterprise and each individual in human resources. Along with the replacement of life circle of product designation and the development of social science and technology, the production technology of enterprise labour force will be supplemented and renewed constantly for adjusting to the requirements of designation, renewal and maintaining of new products. Thus, for improving of enterprise labour productivity and realizing reproducibility of enterprise human resources, influences and restraints of various reproducibility factors need to be.

**Restraints of profitability factors:** by combining with other kinds of resources, enterprise human resources can bring presumptive increment of value. But it needs to be noted that human resource is different from other forms of tangible resources. The enterprise human resource is not only restraint by internal factors of individual labour, but also influenced by organization management within the enterprise, economic environment out of the enterprise and other constraints, which makes its profitability full of uncertainty.

**Restraint of market factors:** enterprise human resource is an activity that serves business market. When in market activities implement, value evaluation of human resource obtain the evaluation result via the forming process of asset value and mechanism of action under the condition of simulative market. Thus, development potential and prospect of market is the key segment in enterprise human resource project. The enterprise human resource needs to correlate closely with the development trend and potential development competitiveness to combine effectively human resources, material resources and intangible assets in the process of market prediction and market exploitation and cannot deviate off market development. Thus, it can bring economic benefit to the enterprise.

**Restraints of dynamic factors:** dynamic refers to that value of human resource is evaluated from dynamic perspective. First of all, because human resource and its carrier cannot be separated, human resources cannot be quantized with money in static state like material resource. It can only be evaluated in dynamic state, namely the performance appraisal in its using process. The performance is not only decided by its own value, but also by environment, organizational system, supply and demand, etc. These variables of the value of human resources change constantly, which makes the evaluation of the value of human resources full of uncertainty.

**Restraint of hierarchy:** human resource is a new capital form, which is put forward directing at assumption of capital homogeneity in traditional theory. As a breakthrough of capital homogeneity, within human resources there is obvious heterogeneity，i.e. hierarchy. That is to say, human resource is influenced by the factors of hierarchy including learning capacity, working ability, creativity, ability to organize and manage and resources allocation abilities of the carrier of labour force.

**Restraints of subjective initiative:** the subjective initiative of human resource is a key segment industry in obtaining innovative development. That is to say, the carrier of human resources can conduct creative activities with certain purposes, and can change the world via its own labour. All the economic activities show up firstly as activities of human resources. Activities of human resources occupy the most important status in economic activities. Human resource is a very active economic resource and productive factors, which launches, organizes and coordinates other resources, and is the only factor, which can play the role of creativity in economic activities. The subjective initiative and creativity of human resource plays a decisive role in the development of social production.

## 2.2 ESTABLISHMENT OF COMPREHENSIVE EVALUATION INDEX SYSTEM OF ENTERPRISE HUMAN RESOURCE COMPETITIVENESS

To establish the corresponding comprehensive evaluation index system of enterprise human resource competitiveness, the human resource competitiveness of the whole enterprise should be evaluated from comprehensive perspectives both inside and outside of enterprise. And the influence of restraints mentioned above need to be taken into consideration, and analysis from the level of three constraints, namely human quality competitiveness, market competitiveness and management quality competitiveness, needs to be done. What's more, the evaluation indexes should be scientific, complete, comparable and operable. The evaluation index system is presented in Figure 1.

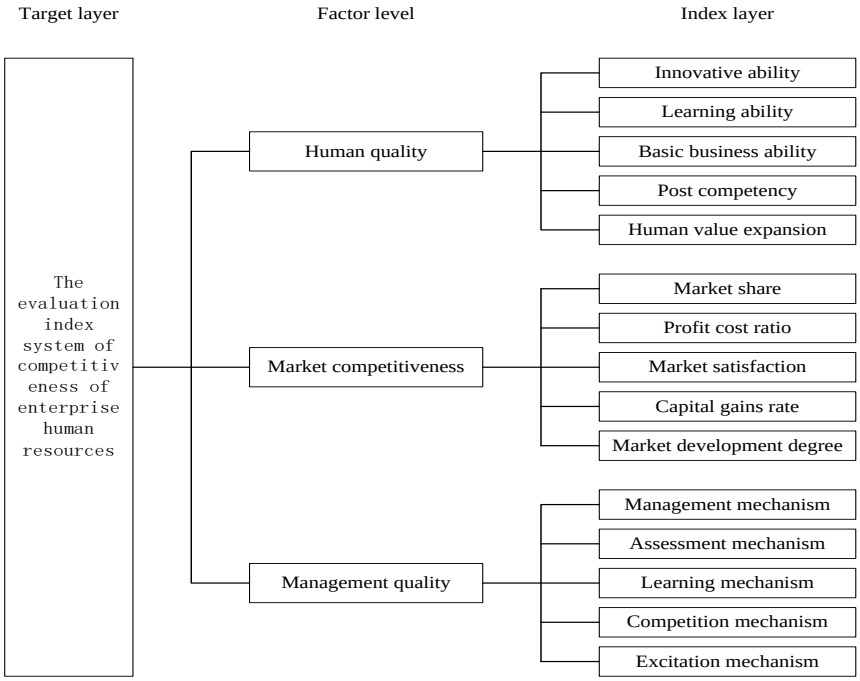


FIGURE1 The comprehensive evaluation index system of enterprise human resource competitiveness

The human quality competitiveness refers to technology and ability of enterprise employees. The ability and technology enables them to be qualified to their positions. The index of human quality competitiveness manifests as evaluation of human resource competitiveness from inside of enterprises. This category of index can comprehensively evaluate the capability of employees. Market competitiveness refers to the ability of an enterprise to occupy and expand the market. The index of market competitiveness is one of the important indexes that reflect the human resource management ability of an enterprise. And this category of indexed is outcome indexed that influence human resource competitiveness. They can work as objective index factors in adjustment of framework of human resource competitiveness which reflects the prospect of human resource management and make the human resource development strategic. Management quality competitiveness refers to rules related to personal management including system and rules of employment. Rational management, planning and employment cannot only improve human resource competitiveness but also promote the innovation and development of enterprises.

## 3 Grey correlation analysis model of enterprise human resources competitiveness

### 3.1 STANDARDIZATION OF EVALUATION INDEXES

Under the condition of that the comprehensive evaluation index system of enterprise human resource competitiveness has been built, evaluation indexes in different categories need to be standardized. According to the analysis of evaluation indexes mentioned above, evaluation indexes influenced by different factors have been transformed as positive indexes. Thus, in this paper, this paper applied ratio scale from 1 to 9 to mark fuzzy grade to evaluation indexes in different categories. Thus, fuzzy evaluation values corresponding to different types of evaluation indexes can be obtained. The concrete evaluation standard is presented in Table 1.

TABLE 1 The evaluation criteria of the standardization of evaluation indexes

| Ratio scale | Importance degree | Explanation |
|---|---|---|
| 1 | Not important | Of the least importance |
| 3 | Fairly important | Of fairly importance for evaluation analysis |
| 5 | Important | Of mediate importance for evaluation analysis |
| 7 | Vary important | Of considerate importance for evaluation analysis |
| 9 | Absolutely important | Of the highest importance |
| 2,4,6,8 | Median between two neighbouring levels | Applied when an average needs to be stroke |

### 3.2 GREY CORRELATON ANALYSIS OF EVALUATION INDEX

Grey correlation analysis is a correlation measuring method that sorts system characteristics and relative factors according to the corresponding calculated grey correlation. It is an analysis method that combines qualitative method and quantitative method, which can successfully solve the problem in evaluation indexes quantization and analysis. It can also make the evaluation result more scientific, objective and accurate by avoiding influence taken by human factors [11-14]. According to the theory of grey correlation, the closer the geometrical shapes of curves of two sequences, the larger the

correlation between them. Thus, after obtaining the fuzzy values of different indexes $\gamma_{ij}=\left[\gamma_{ij}^{lef},\gamma_{ij}^{rig}\right]$, $\gamma_{ij}^{lef}\le\gamma_{ij}^{rig}$, positive ideal grey correlation sequence of evaluation indexes can be built as:

$$\gamma_{i0}^{R}=\left[\gamma_{i0}^{R-lef},\gamma_{i0}^{R-rig}\right]= \max\left[\left(\gamma_{ij}^{lef}\mid 1\le \mathrm{j}\le \mathrm{m}\right),\max\left(\gamma_{ij}^{rig}\mid 1\le \mathrm{j}\le \mathrm{m}\right)\right]. \tag{1}$$

Similarly, negative ideal grey correlation sequence of evaluation indexes can be built as:

$$\gamma_{i0}^{N}=\left[\gamma_{i0}^{N-lef},\gamma_{i0}^{N-rig}\right]= \left[\min\left(\gamma_{ij}^{lef}\mid 1\le \mathrm{j}\le \mathrm{m}\right),\min\left(\gamma_{ij}^{rig}\mid 1\le \mathrm{j}\le \mathrm{m}\right)\right]. \tag{2}$$

In the Equations (1), (2) *i* is the parameter and *j* is the number of projects under implementation.

Thus, the Euclidean distance between the value of evaluation index $\gamma_{ij}=\left[\gamma_{ij}^{lef},\gamma_{ij}^{rig}\right]$ and the positive ideal grey correlation sequence is:

$$d_i^R=\sqrt{\frac{\left|\gamma_{i0}^{R-lef}-\gamma_{ij}^{lef}\right|+\left|\gamma_{ij}^{rig}-\gamma_{j0}^{R-rig}\right|^2}{2}}. \tag{3}$$

Thus, the Euclidean distance between the value of evaluation index $\gamma_{ij}=\left[\gamma_{ij}^{lef},\gamma_{ij}^{rig}\right]$ and the negative ideal grey correlation sequence is:

$$d_i^N=\sqrt{\frac{\left|\gamma_{i0}^{N-lef}-\gamma_{ij}^{lef}\right|+\left|\gamma_{ij}^{rig}-\gamma_{j0}^{N-rig}\right|^2}{2}}. \tag{4}$$

Thus, the grey correlation index $\delta_{ij}^R$ of the human resource implementation plan $P_j$ and positive ideal grey correlation sequence of the index $\gamma_{ij}$ is:

$$\delta_{ij}^R=\frac{\min\limits_i\min\limits_j d_i^R+\beta\max\limits_i\max\limits_j d_i^R}{d_i^R+\beta\max\limits_i\max\limits_j d_i^R}. \tag{5}$$

In the Equation, $\beta$ is resolution ratio，usually taken as $\beta=0.5$.

The grey correlation index $\delta_{ij}^N$ of the human resource implementation plan $P_j$ and negative ideal grey correlation sequence of the index $\gamma_{ij}$ is:

$$\delta_{ij}^N=\frac{\min\limits_i\min\limits_j d_i^N+\beta\max\limits_i\max\limits_j d_i^N}{d_i^N+\beta\max\limits_i\max\limits_j d_i^N}. \tag{6}$$

The weighted grey correlation $k_j^R$ of human resource implementation plan $P_j$ and the positive ideal grey correlation sequence:

$$k_j^R=\sum_{i=1}^{n}\left(w_i\ \delta_{ij}^R\right). \tag{7}$$

The weighted grey correlation $k_j^N$ of human resource implementation plan $P_j$ and the positive ideal grey correlation sequence:

$$k_j^N=\sum_{i=1}^{n}\left(w_i\ \delta_{ij}^N\right). \tag{8}$$

### 3.3 GREY CORRELATION ANALYSIS MODEL OF HUMAN RESOURCE COMPETITIVENESS AND ALGORITHM IMPLEMENTATION

Human resource implementation plan $P_j$ is attached to the optimal implementation plan. The membership of positive ideal grey correlation sequence is $\varphi_j\left(0\le\varphi_j\le 1\right)$, namely the grey correlation. And the membership of it attached to negative ideal grey correlation sequence is $1-\varphi_j$. In order to determine the comprehensive grey correlation $\varphi_j$, establish the objective function according to the strength and weakness of the implementation plan:

$$F\left(\varphi_j\right)=\min\left\{\left(\varphi_j\,k_j^R\right)^2+\left(\left(1-\varphi_j\right)k_j^N\right)^2\right\}. \tag{9}$$

Obtain the correlation of grey correlation $\varphi_j$ of the human resource implementation plan $P_j$ according to extremum principle:

$$\varphi_j=1/\left(1+\left(k_j^N/k_j^R\right)^2\right),\ j=1,2,L,m. \tag{10}$$

According to the above-mentioned grey correlation decision analysis, the grey correlation $\varphi_j$ of each implementation plan can be obtained. An obtain the principle of proximity of human resource competitiveness grey correlation analysis of multi-attributes based on the grey correlation $\varphi_j$ .If

$$\varphi_k=\max\left\{\varphi_1,\varphi_2,L,\varphi_m\right\}. \tag{11}$$

Then human resource implementation plan $P_k$ is the closest to the ideal grey matter-element, namely the human resource implementation plan $P_k$ is the optimal implementation plan.

## 4 Case analysis

In this paper, the human resource competitiveness evaluation of a certain enterprise was analysed based on the abovementioned algorithm and model. Via consulting relative specialists, divide its human resource

competitiveness into four grades, namely "good", "fairly good", "ordinary" and "bad". Table 2 presents fuzzy values of concrete evaluation indexes of the enterprise.

TABLE 2 The fuzzy value of enterprise human resource competitiveness

| Influence factor | weight | Evaluation index | weight | Evaluation grade | | | |
|---|---|---|---|---|---|---|---|
| | | | | *Fairly good* | *Good* | *Ordinary* | *Bad* |
| Human resource competitiveness | 0.30 | Innovative ability | 0.20 | 8.0-9.0 | 7.0-8.0 | 6.0-7.0 | 3.0-5.0 |
| | | Learning ability | 0.20 | 7.0-8.0 | 8.0-9.0 | 6.0-7.0 | 3.0-5.0 |
| | | Professional ability | 0.25 | 6.0-7.0 | 7.0-8.0 | 3.0-5.0 | 8.0-9.0 |
| | | Basic business ability | 0.20 | 6.0-7.0 | 8.0-9.0 | 7.0-8.0 | 3.0-5.0 |
| | | Human value expansion | 0.15 | 8.0-9.0 | 6.0-7.0 | 7.0-8.0 | 3.0-5.0 |
| Market competitiveness | 0.30 | Market share | 0.25 | 3.0-5.0 | 6.0-7.0 | 8.0-9.0 | 7.0-8.0 |
| | | Profit cost ratio | 0.15 | 8.0-9.0 | 7.0-8.0 | 3.0-5.0 | 6.0-7.0 |
| | | Market satisfaction | 0.20 | 6.0-7.0 | 8.0-9.0 | 6.0-7.0 | 3.0-5.0 |
| | | Profit gains rate | 0.15 | 7.0-8.0 | 6.0-7.0 | 8.0-9.0 | 3.0-5.0 |
| | | Market development degree | 0.25 | 7.0-8.0 | 3.0-5.0 | 8.0-9.0 | 6.0-7.0 |
| Management quality competitiveness | 0.40 | Management mechanism | 0.25 | 8.0-9.0 | 3.0-5.0 | 7.0-8.0 | 6.0-7.0 |
| | | Assessment mechanism | 0.20 | 3.0-5.0 | 8.0-9.0 | 7.0-8.0 | 6.0-7.0 |
| | | Learning mechanism | 0.20 | 7.0-8.0 | 6.0-7.0 | 3.0-5.0 | 8.0-9.0 |
| | | Competition mechanism | 0.15 | 6.0-7.0 | 7.0-8.0 | 8.0-9.0 | 3.0-5.0 |
| | | Excitation mechanism | 0.20 | 3.0-5.0 | 8.0-9.0 | 6.0-7.0 | 7.0-8.0 |

Table 3 presents grey correlation analysis statistics of enterprise human resource competitiveness obtained based on abovementioned algorithm and model.

TABLE 3 Grey correlation analysis values of enterprise human resource competitiveness

| | Rank | | | |
|---|---|---|---|---|
| | *Fairly good* | *Good* | *Ordinary* | *Bad* |
| Positive grey correlation | 0.785 | 0.817 | 0.633 | 0.432 |
| Negative grey correlation | 0.713 | 0.625 | 0.804 | 0.898 |
| Comprehensive grey correlation | 0.548 | 0.631 | 0.383 | 0.188 |

According to the analysis procedure and result, the human resource competitiveness of the enterprise is in good condition.

## 4 Conclusion

Evaluation of enterprise human resource competitiveness was a complex problem of system decision analysis with multiple levels, attributes and objects influenced by multiple factors. This paper put forward an improved evaluation index system of enterprise human resource competitiveness via analysis of relative restrictive factors in the process of implementation plan of enterprise human resource. Then standardize different categories of evaluation indexes under the evaluation index system and put forward an improved grey correlation analysis model of enterprise human resource competitiveness based on the theory of grey system. This model obtains the grades of enterprise human resource competitiveness or the optimal implementation plan in multiple implementation plans. The physical significance of the model is clear and definite, the calculation in the model is easy, and will provide strong support for implementation of computer aided intelligent analysis method of evaluation of enterprise human resource competitiveness and implementation of the system. In the paper, the model and algorithm proved feasible via case analysis.

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