A Performance Evaluation Study of Human Resources in Low-Carbon Logistics Enterprises

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Abstract: With China’s rapid economic development, restructuring the economy will require a development model based on high-to-low carbon transition. The development of logistics enterprises has its own characteristics associated with the trend of low carbon. This article discusses the significance of structuring a human resource performance evaluation system for low-carbon logistics enterprises. We used an analytic hierarchy process (AHP) and triangle-definite weighted functions as the technology platform to determine the performance evaluation and measure corporate status quo. The results can serve as a reference for companies to make the best talent decisions and achieve long-term development strategies. In addition, this study helps to make up for a lack of relevant research in this area.

Keywords: low-carbon logistics enterprises human resources; performance evaluation; AHP; analytic hierarchy process; green management; gray evaluation

1. Introduction

High-speed global economic development is based on the rapid consumption of energy, which has resulted in varying degrees of energy issues among different countries. Traditional models of economic development cannot cope with the severe international situation. In 2003, British prime minister Tony Blair proposed the concept of a low-carbon economy, which, through the use of new technology and new energy, aims to achieve low power consumption and low pollution, thus promoting green, sustainable economic development throughout the world [1]. As a new model of economic development, the low-carbon economy has become a focus of attention in various countries [2] and is considered an inevitable trend in future development.

2.1. Particular Human Resources in Carbon Logistics Companies

The EREC (2008) defines low carbon as using low-carbon energy sources to replace fossil fuels with the aim of ensuring economic growth and improving people’s well-being [1]. With the continuous development of society, the content of the low-carbon concept has been continuously enriched. In short, the low-carbon economy falls under the concept of sustainable development. Through the use of industrial restructuring, technological innovation, new energy development, and other means, it aims to change the structure of energy and minimize oil and other high-carbon energy consumption, thus reducing carbon dioxide and other greenhouse gas emissions. In this way, a win–win outcome can be achieved in terms of economic and social development, as well as ecological protection [2,3].

Talent is not only the main labor organization of an enterprise but also a scarce resource. Logistics enterprises are among the primary energy consumption organizations. Under the development trend of low-carbon economies, the scarcity of human resources in such organizations is particularly prominent. Compared to general enterprises, human resources in low-carbon logistics enterprises have their own characteristics:

1. Low-carbon technologies. The logistics operation system includes transportation, warehousing, distribution, handling, and packaging [3,4]. Transportation uses networks to determine the best routes, warehousing uses research optimization theory to determine optimal inventory levels, and so forth. The various subsystems of logistics systems require low-carbon technologies for support; therefore, their human resources should have certain low-carbon technologies.

2. Low-carbon concept. Low-carbon logistics is a new trend in the development of the logistics industry. It requires integrating the low-carbon concept in the process of logistics system improvement, with consideration of environmental and energy issues, to help enterprises attain economic benefits while also protecting the environment [5]. Therefore, the concept of low carbon is necessary for the work-skills component of human resources in low-carbon logistics enterprises.

3. Strategic vision. The future development trend of low-carbon logistics will involve the whole supply chain, not just a single logistics enterprise. Supply chains themselves save costs. Low carbon is involved in the procurement of raw materials, product manufacturing, transport, and packaging. A series of links will be integrated into low carbon, and the whole supply chain will have a two-pronged effect. The sustainable development of supply chain trends and the human resource requirements of enterprises must have a strategic vision for global efforts. Such a vision will be put toward greater output while forming the competitive core of enterprises.

4. Innovation consciousness. Since the logistics industry is knowledge-and-talent intensive, competition between enterprises is growing. Knowledge renewal and technology innovation are necessary for achieving sustainable development. Thus, human resources in low-carbon logistics enterprises have a strong sense of innovation.

2.2. The Significance of Human Resources Performance Evaluation in Low-Carbon Logistics Enterprises

Performance evaluation plays an important role in development. Reasonable performance evaluation is an effective means to ensure the core competitiveness of enterprises and promote employee innovation [6]. By building a performance evaluation index system, we can determine the index that will contribute to enterprises and strengthen them, and thus reject the lower-effect index. Performance evaluation is highly significant for employees, managers, and the whole enterprise in the following ways:

1. For the general staff. Through performance evaluation, employees can see the results of their hard work and know their strengths and weaknesses, as well as their development potential, while better understanding the enterprise’s objectives.
(2) For the supervisor. Based on the results of performance evaluations, managers can allocate and transfer human resources and determine remuneration. Employee evaluation is conducted to provide targeted training or promotion for outstanding officers.

(3) For the organization. Performance evaluation is an important means for achieving an organization’s strategic objectives. It guides employee behavior and organizational goals. Performance evaluation is a central part of performance management. Evaluations not only show the results of the first phase of a performance plan but also provide a reference for improving the next program. By establishing a human resource performance appraisal system for low-carbon logistics enterprises, an enterprise’s previous work standard can be measured. This can help enterprises understand their development status and improve their plans for determining the best human resource management and development decisions. It plays a guiding role in the future development of an enterprise.


3.1. Establishing an Evaluation Matrix Based on AHP

The analytic hierarchy process (AHP), developed by Thomas Saaty in the mid-1970s, is a systematic, hierarchical combination of qualitative and quantitative analysis that has great practical value for dealing with complex decision problems [7,8]. For a performance evaluation index for human resources in low-carbon logistics enterprises, the index is, importantly, not the same. Therefore, we used an AHP index hierarchy and gave weights.

3.1.1. Index Options and Index Hierarchical Model Construction

Before using the triangle transform function to conduct gray evaluation, it is important to build an index system and analyze the operational processes of low-carbon logistics enterprises and human resource characteristics. Selecting a scientific and reasonable performance evaluation index is the basis for accurate evaluation.

Constructing an index system is based on the following principle levels. First, human resource performance evaluation in a low-carbon logistics enterprise can be divided into three levels. This is referred to as the first index, which includes working ability, working performance, and working attitude, where each level can be divided into various subindices, referred to as the second index. The secondary assessment index of working ability is subdivided into low-carbon professional knowledge (including the low-carbon concept), low-carbon professional skill (including low-carbon skills), and low-carbon innovation potential (including innovation in low-carbon skills and innovative use of low-carbon technologies). The secondary assessment index of working performance is subdivided into the quantity of tasks completed, quality of tasks completed, and efficiency of task completion. The secondary assessment index of working attitude is subdivided into discipline, cooperation, and enthusiasm. These are shown in Table 1.

<table>
<thead>
<tr>
<th>Working Ability A_1</th>
<th>Weighting factor U_1</th>
<th>Working Performance A_2</th>
<th>Weighting factor U_2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-carbon professional knowledge A_{11}</td>
<td>Weighting factor U_{11}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-carbon professional skill A_{12}</td>
<td>Weighting factor U_{12}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-carbon innovation potential A_{13}</td>
<td>Weighting factor U_{13}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Quantity of task completion A_{21} | Weighting factor U_{21} |
| Quality of task completion (whether the low-carbon index is achieved) A_{22} | Weighting factor U_{22} |
| Efficiency of task completion (whether the use of low-carbon skills improved efficiency) A_{23} | Weighting factor U_{23} |
Table 1. Performance evaluation index hierarchical model.

<table>
<thead>
<tr>
<th>Working</th>
<th>Weighting factor U_3</th>
<th>Discipline A_3</th>
<th>Weighting factor U_31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude A_1</td>
<td></td>
<td>Cooperation (whether seen as part of low-carbon thinking) A_32</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A_i represents the first index, U_i represents the weights of the corresponding first index, A_ij represents the second index under the corresponding first index, and U_ij represents the weights of the corresponding second index (i = 1, 2, 3; j = 1, 2, 3; \( \sum_{i=1}^{3} U_i = 1 \), \( \sum_{i=1}^{3} \sum_{j=1}^{3} U_{ij} = 1 \)).

3.1.2. Construction of the Judgment Matrix

After constructing the hierarchical model, the factor affiliation between the upper and lower levels was also determined. The factors on the same level of the structural model can be compared (pairwise) with the factors of the upper layer. According to the relative importance of comparison, we established a series of judgment matrices. Based on the data, questionnaires, and expert analysis, we judged the matrix assignment pairwise factors. A comparison of the standards adopted for the nine-point scale is shown in Table 2.

Table 2. Evaluation of classification table.

<table>
<thead>
<tr>
<th>Factor A: Factor B Ratio</th>
<th>Compare Quantized Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factors A and B are equally important</td>
<td>1</td>
</tr>
<tr>
<td>A slightly more important factor than B</td>
<td>3</td>
</tr>
<tr>
<td>A more important factor than B</td>
<td>5</td>
</tr>
<tr>
<td>A very important factor compared to B</td>
<td>7</td>
</tr>
<tr>
<td>A factor is definitely more important than B</td>
<td>9</td>
</tr>
<tr>
<td>AB adjacent judgment intermediate value</td>
<td>2, 4, 6, 8</td>
</tr>
</tbody>
</table>

Backward count of the upper figure is the reciprocal comparison of the two factors

Based on the comparison results of the level factors, it can be configured into a comparison matrix as follows:

\[
A = \begin{pmatrix}
    a_{11} & a_{12} & \cdots & a_{1j} & \cdots & a_{1n} \\
    a_{21} & a_{22} & \cdots & a_{2j} & \cdots & a_{2n} \\
    \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
    a_{i1} & a_{i2} & \cdots & a_{ij} & \cdots & a_{in} \\
    \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
    a_{n1} & a_{n2} & \cdots & a_{nj} & \cdots & a_{nn}
\end{pmatrix}
\]

When \( a_{ij} > 1 \), index i is more important for the target than index j; its numerical size represents an important extent.

3.1.3. Single-Level Sorting and Determination of Index Weight

Single-level sorting is used to calculate the relative important scheduling problem of each factor on this level with respect to the upper single criterion. We need to calculate the maximum eigenvalue and the corresponding eigenvector of each judgment matrix to obtain single-level sorting and the important data sequence from the index layer to the target layer, thereby obtaining the optimal decision. Then, a consistency check is performed. Specifically, we first calculate the maximum eigenvalue \( \eta_{max} \) of judgment matrix A, and then use the formula \( A \omega = \eta_{max} \omega \) to obtain eigenvector \( \omega \) corresponding to \( \eta_{max} \). After standardization, the sorted weight of the relative importance of certain factors is on the same level of the element corresponding to the previous level [7–9]. For the solution of the maximum eigenvalues and eigenvectors of the judgment matrix, the obtained eigenvector \( \omega \) is the sorted weight of the relative importance of certain factors, which is the same level as the element that corresponds to the previous level. We can use geometric mean normalization to normalize \( \omega: \omega_i = \sqrt[\eta_{max}]{\omega_1 \omega_2 \cdots \omega_n} \) and
can obtain the approximate eigenvector \( \omega'_i = \frac{\omega_i}{\sqrt{\omega_1 \omega_2 \cdots \omega_n}} \); \( \omega'_i \) is the sorted weight of relative importance after normalization, and \( n \) represents the number of eigenvalues in the judgment matrix.

3.1.4. Consistency Check

We calculated the consistency index and consistency ratio as follows:

\[
C.I = \frac{n - 1}{\lambda_{\text{max}} - n}, \quad C.R = \frac{C.I}{R.I}
\]

where \( n \) is the order of the judgment matrix, and \( R.I \) is the average random consistency index; for the matrix \( n = 1–9 \), the reference values are shown in Table 3 [8].

Table 3. Average random consistency index.

<table>
<thead>
<tr>
<th>( n )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R.I )</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
</tr>
</tbody>
</table>

When \( C.R \) is small, the consistency of the judgment matrix is better. Generally, when \( C.R < 0.1 \), the judgment matrix meets satisfactory consistency standards, and the result of single-level sorting is acceptable. Otherwise, the judgment matrix needs to be corrected to achieve satisfactory consistency.

3.1.5. Determine the Evaluation Grade

To convert the qualitative index into a quantitative index, we assigned values to each index. The assignment of each grade was determined by a five-point principle; the evaluation rating criteria are shown in Table 4.

Table 4. Classification index.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Excellent</th>
<th>Good</th>
<th>Moderate</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

The index level between two adjacent levels corresponds to score point values of 8, 6, 4, and 2.

3.1.6. Evaluation Matrix Established by Assessment Factors

Selecting the number \( p \) as the reviewer, we can then use the Delphi method to obtain the grade, evaluated by the number \( l \) expert, according to evaluation index \( A_{ij} \). Then, we can construct the \( d_{ij} \) evaluation matrix \( D_i \) of the performance evaluation for the first-level evaluation index \( A_i \), such that

\[
D_i = \begin{pmatrix}
A_{i1} \\
A_{i2} \\
\vdots \\
A_{in}
\end{pmatrix}
= \begin{pmatrix}
d_{i11} & d_{i11} & \cdots & d_{i1p} \\
d_{i21} & d_{i21} & \cdots & d_{i2p} \\
\vdots & \vdots & \ddots & \vdots \\
d_{inp} & d_{in2} & \cdots & d_{inp}
\end{pmatrix},
\]

where \( n \) is the index number of second-level evaluation index \( A_{ij} \).

3.1.7. Notes

In the application of AHP factor selection and hierarchy construction, if the selected elements are not reasonable, the meaning is confused, or elements of the relationship are not correct, it will reduce the quality of the results and even lead to decision failure. To ensure the rationality of the hierarchical structure, we need to grasp the following principles:

(1) simplify the problem to grasp the main factors, not leakage; and
3.2. A Gray Comprehensive Evaluation Method Based on Central Point Triangle Whiten Weight Function

The triangle whiten function refers to the Cartesian coordinates of three lines. It can quantitatively assess the degree of an object belonging to a gray class (the relationship changes along with the evaluation index of samples or size) called the weight function \([9–12]\). The gray estimation method of triangular whitening weight function (following Liu Sifeng’s 1993 proposal) is applicable to the evaluation of small samples with poor information uncertainty \([13–17]\).

This study uses an improved triangle whitening weight function. This is more reasonable than endpoint assessment \([17–21]\). First, the cluster of the center assessment of the triangle whiten function is more reasonable than endpoint assessment. The cluster of the endpoint assessment of the triangle whiten function has more than two gray cross-phenomena, whereas the cluster of the center assessment of the triangle whiten function does not have this phenomenon. Second, the endpoint assessment of the triangle whiten function may indicate that the sum of the value of a certain index of gray classes, such as dividing the value range of index \(A_{ij}\) into \(s\) small sections \([\lambda_1, \lambda_2], \cdots, [\lambda_{k-1}, \lambda_k], \cdots, [\lambda_{s-1}, \lambda_s], [\lambda_s, \lambda_{s+1}]\); the value of \(\lambda_k(k = 1, 2, \cdots, s, s + 1)\) is determined in accordance with the requirements of practical problems or qualitative research results \([10]\). At the same time, point \((\lambda_{k-1}, 0)\) is connected to the center point \((\lambda_{k-1}, 0)\) of the \(k - 1\) section and \((\lambda_k, 1)\) is connected to the center point \((\lambda_{k+1}, 0)\) of the \(k + 1\) section to obtain the index \(A_{ij}\), the triangle whiten function \(f_k(\bullet), k = 1, 2, \cdots, s, \) with respect to gray cluster \(k\). The extent of the \(A_{ij}\) index number field to the left of \(\lambda_0\) and the right of \(\lambda_{s+1}\), to obtain the triangle whiten function \(f_1(\bullet)\) and \(f_s(\bullet)\) of \(A_{ij}\) related to gray cluster \(1\) and \(s\), is shown in Figure 1 \([25,26]\).

![Figure 1. Center assessment of the triangle whiten function schematic diagram.](image)

For one observed value \(x\) of index \(A_{ij}\), we can use the formula

\[
f_k(x) = \begin{cases} 
0, & x \notin [\lambda_{k-1}, \lambda_{k+1}] \\
\frac{x - \lambda_{k-1}}{\lambda_k - \lambda_{k-1}}, & x \in (\lambda_{k-1}, \lambda_k) \\
\frac{\lambda_k - x}{\lambda_{k+1} - \lambda_k}, & x \in (\lambda_k, \lambda_{k+1}) 
\end{cases}
\]

to calculate the membership degree \(f_k(x)\) belonging to gray cluster \(k\) (where \(k = 1, 2, \cdots, s\)) \([27,28]\).
3.2.2. Calculating the Gray Factor Evaluation Vector and Evaluation Matrix

In gray evaluation theory, each evaluator’s score is a gray number. The scores given by \( p \) evaluators of evaluation index \( A_{ij} \) are \( d_{ij1}, d_{ij2}, \ldots, d_{ijp} \). Therefore, the whitening weight of index \( A_j \) belonging to the number \( k \) evaluation of the gray cluster considered by evaluators is \( f_k(d_{ij1}), f_k(d_{ij2}), \ldots, f_k(d_{ijp}) \). The total whitening function of \( A_j \) belonging to the number \( k \) evaluation of the gray cluster considered by the total evaluators is \( y_{ijk} = \sum_{l=1}^{p} f_k(d_{ijl}) \), and the total whitening weight of \( A_j \) belonging to each evaluation of the gray cluster is \( y_i = \sum_{k=1}^{s} \sum_{j=1}^{p} f_k(d_{ijl}) \). The ratio between the two is \( r_{ijk} = \frac{\sum_{l=1}^{p} f_k(d_{ijl})}{\sum_{k=1}^{s} \sum_{j=1}^{p} f_k(d_{ijl})} \). Its size reflects the strong degree to which all evaluators consider the index \( A_j \) belonging to the number \( k \) gray cluster. This value is the gray evaluation coefficient of index \( A_j \) belonging to the number \( k \) gray cluster marked as \( r_{ijk} \). Vector \( r_{ij} \) contains the gray evaluation coefficient of each gray cluster where index \( A_j \) belongs to its gray evaluation vector \( r_{ijk} = (r_{11}, r_{12}, \ldots, r_{1s}), i = 1, 2, \ldots, m; j = 1, 2, \ldots, n; s \) is divided by the number of the gray cluster. The gray evaluation weight vector of the gray evaluation cluster of \( A_i \) belonging to index \( A_j \) is summed to obtain the gray evaluation matrix of index \( A_i \):

\[
R_i = \begin{pmatrix}
  r_{11} \\
  r_{12} \\
  \vdots \\
  r_{1s}
\end{pmatrix}
\begin{pmatrix}
  r_{11} & r_{12} & \cdots & r_{1s} \\
  r_{21} & r_{22} & \cdots & r_{2s} \\
  \vdots & \vdots & \ddots & \vdots \\
  r_{m1} & r_{m2} & \cdots & r_{ms}
\end{pmatrix},
\]

\[
r_{ijk} = \frac{\sum_{l=1}^{p} f_k(d_{ijl})}{\sum_{k=1}^{s} \sum_{j=1}^{p} f_k(d_{ijl})}.
\]

3.2.3. Calculating the Comprehensive Evaluation Value and Sorting

We set \( C_i \) as the result of the comprehensive evaluation of index \( A_i \), and \( C_i = U_i \bullet R_i = (c_{i1}, c_{i2}, \ldots, c_{is}) \). From \( C_i \), we can obtain the gray evaluation weight \( R \) of each gray evaluation cluster related to the performance evaluation \( A \) that belongs to index \( A_i \) [27,28]. Then, the comprehensive evaluation of the results can be obtained; \( C \):

\[
R = \begin{pmatrix}
  c_{11} & c_{12} & \cdots & c_{1s} \\
  c_{21} & c_{22} & \cdots & c_{2s} \\
  \vdots & \vdots & \ddots & \vdots \\
  c_{m1} & c_{m2} & \cdots & c_{ms}
\end{pmatrix} \cdot C = U \bullet R = U \bullet \begin{pmatrix}
  U_1 \bullet R_1 \\
  U_2 \bullet R_2 \\
  \vdots \\
  U_m \bullet R_m
\end{pmatrix} = (c_{1}, c_{2}, \cdots, c_{s}).
\]

The maximum weight principle in evaluation target \( A \) can determine the rate associated with the grade of every evaluation gray cluster, \( c_i = \max(c_{i1}, c_{i2}, \ldots, c_{is}) \); so the rate is the \( l \) class. However, this method for determining the rate’s class of the gray cluster sometimes fails due to the large amount of information lost. In addition, \( C \) cannot be directly used to assess subjects’ sorting and optimal selection. Thus, the gray comprehensive assessment vector is constructed for further processing and made into a single value, and the value of comprehensive evaluation \( W \) of the appraisal target is calculated. Each gray cluster grade is assigned according to the gray level. Then, the value of the gray-type hierarchical vector is \( V = (v_1, v_2, \ldots, v_s) \), which is used to calculate the value of the comprehensive evaluation \( W = CV^T \) according to the value of \( W \), and any number of objects participating in the evaluation can be sorted. The main characteristic of the multilevel gray comprehensive evaluation method is describing dispersing information from multiple evaluators as a vector that belongs to a different evaluation gray cluster. Then, the vector is converted into a single value, except for the evaluation of the grade of the rate. The result can also be used to sort and optimally select the value of the gray comprehensive evaluation when there are multiple rates involved in the evaluation.
4. Examples of Application and Discussion

In recent years, logistics enterprises have been committed to low-carbon development and have achieved certain results. Enterprises want to understand their own human resource utilization status and whether there is room for more development. Combined with the actual situations of enterprises, we evaluate the use of AHP and the gray comprehensive evaluation method, based on triangular whitening weight function, to construct a performance appraisal system for human resources in low-carbon logistics enterprises according to an index system of human resource management efficiency.

(1) Determining the index weight and evaluation matrix

We use AHP to determine the first-level index weight vector \( U = (0.33, 0.46, 0.31) \) and the second-level index weight vector \( U_1 = (0.35, 0.35, 0.30); U_2 = (0.40, 0.28, 0.32); U_3 = (0.42, 0.32, 0.26) \). The Delphi method is used to select human resource management experts and logistics enterprise experts using the ninth grade to score the two performance evaluation index systems. The evaluation matrix is then obtained:

\[
D_T^1 = \begin{pmatrix}
3 & 3 & 4 \\
5 & 3 & 2 \\
3 & 4 & 3 \\
4 & 4 & 2 \\
3 & 3 & 4 \\
\end{pmatrix} ;
D_T^2 = \begin{pmatrix}
5 & 3 & 2 \\
4 & 2 & 2 \\
3 & 4 & 3 \\
4 & 4 & 2 \\
3 & 3 & 4 \\
\end{pmatrix} ;
D_T^3 = \begin{pmatrix}
4 & 3 & 3 \\
5 & 2 & 2 \\
3 & 3 & 4 \\
3 & 5 & 2 \\
3 & 2 & 5 \\
\end{pmatrix} .
\]

(2) Establishing the triangle whitening weight function

\[
f_1(x) = \begin{cases}
0, & x \notin [0, 6] \\
\frac{x-3}{2}, & x \in (0, 3] \\
\frac{x}{3}, & x \in (3, 6]
\end{cases} ;
f_2(x) = \begin{cases}
0, & x \notin [2, 8] \\
\frac{x-2}{3}, & x \in (2, 5] \\
\frac{x}{3}, & x \in (5, 8]
\end{cases} ;
f_3(x) = \begin{cases}
0, & x \notin [4, 10] \\
\frac{x-4}{3}, & x \in (4, 7] \\
\frac{x}{3}, & x \in (7, 10]
\end{cases} .
\]

(3) Comprehensive evaluation and sorting

Using the triangle whiten function formula, the total whitening weights of the index weights \( A_{11} \) belonging to the first gray cluster are obtained: \( y_{111} = f(3) + f(5) + f(3) + f(4) + f(3) = 4.00 \). The whitening weights of the second gray cluster are similarly obtained: \( y_{112} = 2.67 \). The whitening weights of the third gray cluster are \( y_{113} = 4.00 + 2.67 + 0.33 = 7.00 \). As the total whitening weights of \( A_{11} \) are \( y_{11} = 4.00 + 2.67 + 0.33 = 7.00 \), the evaluation coefficient of \( A_{11} \) belonging to the first gray cluster is \( r_{111} = \frac{y_{111}}{y_{11}} = \frac{4}{7} = 0.57 \). The same method is used to obtain \( r_{112} = 0.38; r_{113} = 0.05 \), and the gray evaluation vector obtained is \( r_{11} = (0.57, 0.38, 0.05) \). The same approach is used to obtain \( r_{12} = (0.58, 0.37, 0.05); r_{13} = (0.57, 0.38, 0.05) \). Then, the gray evaluation matrix is obtained:

\[
R_1 = \begin{pmatrix}
0.57 & 0.38 & 0.05 \\
0.58 & 0.37 & 0.05 \\
0.57 & 0.38 & 0.05 \\
\end{pmatrix} .
\]

(4) Comprehensive evaluation results
The comprehensive evaluation of $A_1$ is $C_1$, where

$$C_1 = U_1 \cdot R_1 = (0.35, 0.35, 0.30) \begin{pmatrix} 0.57 & 0.38 & 0.05 \\ 0.58 & 0.37 & 0.05 \\ 0.57 & 0.38 & 0.05 \end{pmatrix} = (0.57, 0.38, 0.05)$$

The same method is used to obtain $C_2 = (0.63, 0.35, 0.02); C_3 = (0.52, 0.32, 0.02)$. When $C$ is the overall comprehensive rating, the equation is equivalent to a single value for the $C$ vector.

$V$ is the gray-level vector, and $V = (3, 5, 7)$. Then, we get a single comprehensive evaluation value $W = CV^T = (0.65, 0.39, 0.03)(3, 5, 7)^T = 4.11$. It can be seen from the results of the comprehensive evaluation that the human resources performance of the logistics enterprise is low and needs improvement.

5. Conclusions

Human resources affect the operations of enterprises and are important for participation in market competition. It is very important, therefore, to evaluate the performance of human resources in low-carbon logistics enterprises. We used an index system and AHP to determine the weights of performance evaluation; this helps to avoid deviations caused by human factors. Then, we used the triangular whitening weight function gray evaluation method to evaluate human resources based on the evaluation index. This can help promote innovative reforms in the human resources management of low-carbon logistics enterprises, while further implementing green and sustainable development.

To some extent, this study helps to make up for a lack of relevant research in this area. In addition, constructing a human resource performance evaluation system is important for education in the field of human resource management. Providing a new method for constructing a performance evaluation system can help to make the teaching of human resources management more robust. In addition, the results can serve as a reference for companies to make the best talent decisions and achieve long-term development strategies.

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