

# Analysis of the Advantages and Disadvantages of Four Comprehensive Evaluation Methods

Mingyang Liu, Wenge Qin Shuang Yang

Business School (School of Quality Management and Standardization), Foshan University, Jiangwan Street, Chancheng District, Foshan 528000, China

**Abstract:** This paper introduces the AHP, entropy value method, TOPSIS method and fuzzy comprehensive evaluation method in the comprehensive evaluation method, and analyzes the advantages and disadvantages of the four from the perspectives of subjectivity and objectivity, acceptance of decision makers, and difficulty of evaluation. The value method depends on the amount of initial data, the AHP research results are too subjective, the TOPSIS research conclusions do not fit the reality, and the results of the fuzzy comprehensive evaluation may have poor resolution. Finally, suggestions are put forward for the application scope of the four methods of single use and combined use. It is believed that the four evaluation methods can be combined in pairs or three, such as: entropy weight-TOPSIS, AHP-TOPSIS or entropy weight-AHP -Methods such as fuzzy comprehensive evaluation method avoid being affected by the limitations of a single evaluation method.

**Keywords:** AHP, TOPSIS method, Entropy value method, Fuzzy comprehensive evaluation method.

## 1. Introduction

Comprehensive evaluation refers to the process of conducting a general analysis of the evaluation object according to different evaluation purposes, using the information of the evaluated object, selecting systematic, standardized and scientific evaluation methods [1]. However, since different evaluation methods calculate, process or analyze the object to be evaluated differently, the final results obtained using different evaluation methods may be different, which is possible. As a result, the results of the evaluation did not meet the actual needs. Therefore, it is necessary to analyze the advantages and disadvantages of the four evaluation methods based on the analysis of AHP, TOPSIS method, entropy value method, and fuzzy comprehensive evaluation principle, and then consider the joint use according to their respective advantages and disadvantages. Avoid being affected by shortcomings in evaluation methods.

## 2. Introduction to the Method

### 2.1. Entropy method

#### 2.1.1. Rationale

The entropy value method is a representative objective empowerment method in comprehensive evaluation, which calculates the weight of indicators according to the amount of data information and the degree of mutual difference of the evaluated objects. The concept of entropy was proposed by the German physicist Clausius as a measure of the degree of disorder of the system, and the entropy weight refers to the weight of an evaluated index [2]. The entropy method calculates the weight of the index according to the size of the observations of the sample data and the degree of difference between them, if the difference between the sample observations of the index of an evaluated object is smaller, proving that the indicator provides less information, the greater the entropy of the indicator. At the same time, it means that the less information the indicator provides to decision-makers, the smaller the entropy weight; When the sample observations of the index are completely consistent, the

entropy value reaches the maximum, indicating that the index basically does not provide useful information to decision makers, and the entropy weight reaches the minimum value. Conversely, if the difference between the indicator observations is large, proving that the indicator observations provide useful information, the smaller the entropy value, the greater the entropy weight.

#### 2.1.2. Basic usage steps

(1) Establish a matrix to be evaluated for  $m$  objects to be evaluated and  $n$  evaluation indicators, substitute the original data, and obtain the matrix

$$R = (X)_{m \times n}$$

Among them,  $x_{ij}$  it is the original data of the  $i$ th evaluation object on the  $j$ th evaluation index.

(2) Data standardization, due to the different dimensional dimensions, positive and negative directions of different original data under different evaluation indicators, in order to make the data under different evaluation indicators can be compared with each other, so the initial data should be dimensionless. The methods of dimensionless processing of data include squared sum normalization, intervalization, forwardization, negative orientation, and *Min - max* normalization [3]. In the entropy method, normalization is generally chosen because it is necessary to make the processed raw data present a linear relationship with the original data. *Min - max* The processed data is  $y_{ij}$ .

(3) Normalization under each evaluation object  $y_{ij}$ . Let the normalized data be normalized  $\gamma_{ij}$  as follows

$$\gamma_{ij} = y_{ij} / \sum_{i=1}^m y_{ij}$$

(4) Calculate the entropy value of the evaluation index of item  $j$ ,  $H_j$  where,  $k = 1/\ln m$

$$H_j = -k \sum_{i=1}^m \gamma_{ij} \ln(\gamma_{ij})$$

(5) Calculate the difference coefficient and  $G_j$  entropy weight of the  $j$ th index  $W_j$

$$G_j = 1 - H_j W_j = G_j / \sum_{i=1}^n G_i$$

(6) Through the entropy weight, the evaluation results of m objects to be evaluated under n evaluation indicators are calculated  $s_i$ .

$$s_i = \sum_{j=1}^m W_j \cdot \gamma_{ij}$$

## 2.2. AHP

### 2.2.1. Rationale

The analytic hierarchy method (AHP) is a representative subjective empowerment method in comprehensive evaluation. AHP in the complex decision-making problems of multi-objective, multi-evaluation indicators and multi-program, through the subjective experience judgment of decision-makers, will The overall judgment of multiple evaluation indicators in the whole question becomes a "two-by-two comparison" of each evaluation index, and then determines the relative importance of each evaluation index at each level [4]. Finally, the subjective empirical judgment

of the decision maker is synthesized, and each evaluation index at each level is weighted.

### 2.2.2. Basic usage steps

(1) Clarify the problem and establish a hierarchical hierarchy according to the mutual subordination of many indicators. Divide the problem to be decided into three layers: the target layer, the criteria layer, and the indicator layer. There is only one element in the target layer, which is the final goal to be decided. The criterion layer and the indicator layer can have multiple elements.

(2) Construct a comparative judgment matrix B, use the subjective experience judgment of decision makers, and subjectively evaluate and score the elements in the criterion layer and the index layer according to the importance comparison between elements. In AHP, the importance scale between indicators is expressed using 1-9 and its reciprocal [5]. Assuming that the ratio of the importance of criterion A to criterion B in the criterion layer is 2, the ratio of criterion B to criterion A is 1/2 of importance. The specific scales between 1-9 are meaningfully defined in the following table.

**Table 1.** Indicator Meaning

Factor i is better than factor J	Quantified value
Equally important	1
Slightly more important	3
Strong is important	5
Strongly important	7
Extremely important	9
The middle value of two adjacent judgments	2, 4, 6, 8
reciprocal	$a_{ij}=1/a_{ji}$

The final constructed judgment matrix B form is as follows:

$$B = \begin{bmatrix} b_{11} & b_{12} & \dots & b_{1n} \\ b_{21} & b_{22} & \dots & b_{2n} \\ \vdots & \vdots & \dots & \vdots \\ b_{n1} & b_{n2} & \dots & b_{nn} \end{bmatrix} \quad b_{ij} > 0, \quad b_{ii} = 1, \quad b_{ij} = 1/b_{ji}$$

( $b_{ij}$  is the ratio of the importance of factor I to factor J).

(3) Hierarchical single ranking, through mathematical calculation of the weight of each index of a certain level compared to a certain index of the previous level. The calculation of hierarchical single sorting can be obtained by judging the eigenroots and eigenvectors of the matrix:

$$B \cdot W = \lambda_{max} W$$

where  $\lambda_{max}$  is the B largest feature root, is the W normalized feature vector, and the component  $\lambda_{max}$  is the  $W W_i$  weight value of the hierarchical single ranking of the corresponding element.

(4) Consistency test, in order to avoid logical errors such as "element A is more important than element B, element B is more important than element C, and element C is more important than element A", it is necessary to perform a consistency test on the judgment matrix B. The consistency test is done by defining and calculating the consistency metric  $C_i$ , random consistency metric,  $R_i$  and consistency ratio CR.

$$C_i = \frac{\lambda_{max} - n}{n-1} CR = \frac{C_i}{R_i}$$

Among them, the value of is determined according to the dimension of the judgment  $R_i$  matrix, and it is generally believed that if the value of CR is less than or equal to 0.1, the consistency test of the judgment matrix is passed, otherwise it is necessary to check whether the judgment matrix has a logical error. The values of the matrix of order 1-9  $R_i$  can be referred to the table below.

**Table 2.**  $R_i$  values

n	1	2	3	4	5	6	7	8	9
$R_i$	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

(5) Overall ranking of levels, sorting the elements of the criterion layer and indicator layer layer by layer from top to bottom, and finally obtaining the final weight of each indicator. After the end of the hierarchical total sorting, it is also necessary to perform a consistency test [6] on the hierarchical total sorting, and the test formula is as follows:

$$CR = \frac{\sum_{i=1}^n b_i \cdot C_i}{\sum_{i=1}^n b_i \cdot R_i}$$

where  $b_i$  is the weight of the benchmark layer.  $C_i$  It is a consistency test indicator and a  $R_i$  random consistency indicator.

## 2.3. TOPSIS law

### 2.3.1. Rationale

TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) method is a commonly used comprehensive evaluation method, which constructs the "positive ideal solution" and "negative ideal solution" of the scheme to be evaluated by making full use of the original data information. Then each evaluation object is sorted by calculating the Euclidean distance between the "positive ideal solution" and the "negative ideal solution" of each evaluation object. Among them, the optimal evaluation object is the closest to the "positive ideal solution" and the farthest from the "negative ideal solution". Conversely, the worst evaluation object is the closest to the "negative ideal solution" and the farthest from the "positive ideal solution". Among them, the "positive ideal solution" is the most ideal scheme for each evaluation object, because there is probably no "positive ideal solution" and "negative ideal solution" in reality, so TOPSIS is also called "the ordering method that is infinitely close to the ideal solution" [7].

### 2.3.2. Basic usage steps

(1) Construct a data matrix, assuming that there are  $m$  objects to be evaluated, in order to analyze each different evaluation object, which covers a total of  $n$  evaluation indicators, wherein The resulting raw data matrix is as follows:

$$X = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \quad r_{ij} \text{ is the original value of the } i\text{th}$$

evaluation object under the  $j$ th indicator.

(2) Because the original data dimensions are different, the positive and negative indicators in the original data need to eliminate the dimensions, and the methods of dimensionless processing of the data include squared sum normalization, intervalization, positiveization, negative orientation and normalization, etc., and the original data after processing is set to  $\min - \max$ .

(3) Determine the "positive ideal solution" and "negative ideal solution", the formula is as follows:

$$\begin{aligned} \text{Positive ideal solution: } H_j^+ &= \{[\max(x_{1j}, x_{2j}, \dots, x_{nj}) | j \in S^+], [\min(x_{1j}, x_{2j}, \dots, x_{nj}) | j \in S^-]\} \\ \text{Negative ideal solution: } H_j^- &= \{[\min(x_{1j}, x_{2j}, \dots, x_{nj}) | j \in S^+], [\max(x_{1j}, x_{2j}, \dots, x_{nj}) | j \in S^-]\} \end{aligned}$$

Among  $S^+$  them  $S^-$ , it is a benefit-type index and a cost-oriented index [8].

(4) Calculate the distance between each object to be evaluated and the distance between the positive ideal solution and the distance between the negative ideal solution  $sep_i^+ : sep_i^-$

$$sep_i^+ = \sqrt{\sum_{j=1}^n (x_{ij} - H_j^+)^2} \quad sep_i^- = \sqrt{\sum_{j=1}^n (x_{ij} - H_j^-)^2} \quad (j=1, 2, \dots, n)$$

(5) Calculate the comprehensive evaluation index of each object to be evaluated  $C_i$ , and the formula is as follows:

$$C_i = \frac{sep_i^-}{sep_i^- + sep_i^+}$$

(6) Sort  $C_i$  each object to be evaluated according to the size of the value, and the larger the comprehensive evaluation index of the object to be evaluated, the better the object to be evaluated.

## 2.4. Vague comprehensive evaluation

### 2.4.1. Rationale

Fuzzy comprehensive evaluation uses fuzzy mathematics and uses the principle of fuzzy relationship synthesis to quantify the fuzzy concept, so as to comprehensively evaluate the advantages and disadvantages of the objects to be evaluated. This method is mainly used to understand the ambiguity of the problem to be solved, and to convert qualitative evaluation into quantitative evaluation according to the membership theory of fuzzy mathematics [9].

### 2.4.2. Basic usage steps

(1) Determine the set of indicators of the object to be evaluated  $X = \{x_1, x_2, \dots, x_m\}$ , which is the  $M$  index of the object to be evaluated. where  $x$  is the element in the evaluation indicator.

(2) Establish a collection of comments on evaluation indicators  $V$ . Set  $V = \{v_1, v_2, \dots, v_n\}$  this to be the  $N$  rating of comments of the object to be evaluated. The review set is a necessary factor for fuzzy evaluation, and the review level will be used to vaguely evaluate the indicators of the evaluation object.

(3) Establish a fuzzy relationship matrix  $R$ .

$$R = \begin{bmatrix} r_{11} & r_{21} & \cdots & r_{1n} \\ r_{12} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

where  $m$  represents the number of evaluation indicators and  $n$  represents the number of evaluation levels.  $r_{ij}$  Indicates the degree to which an indicator of the object being evaluated is affiliated to  $x_i$  a fuzzy subset of the  $V$  comment set  $v_i$ . Here requires normalization of the degree of membership, i.e.  $\sum_j^n r_{ij} = 1$

The  $x_i$  evaluation of an object to be evaluated in terms of an indicator is described  $r_i = (r_{i1}, r_{i2}, \dots, r_{in})$ , in other words, the degree vector of the degree of affiliation of an index to the set of comments of an object to be evaluated  $x_i$  is  $V$  where  $n$  indicates  $n$   $r_i = (r_{i1}, r_{i2}, \dots, r_{in})$  kinds of comments or grades. All membership vectors form the fuzzy relation matrix  $R$ .

(4) Determine the weight of the index, in order to reflect the importance of each index to be evaluated, set the index weight for each index to be evaluated  $W = (w_1, w_2, \dots, w_m)$ . An element in this weight vector  $w_i$  is essentially the degree of membership of the metric  $x_i$  to the entire set of metrics  $X$ . Requested here  $w_i > 0$ ,  $\sum w_i = 1$ .

(5) Establish fuzzy comprehensive evaluation, select appropriate fuzzy operators, and generally select all-factor weighted average fuzzy synthetic operators [10]. Obtain the result vector  $W \cdot R = (b_1, b_2, \dots, b_n) = B$ . where vector  $B$  needs to be normalized.  $\sum b_n = 1$  Indicates  $b_i$  the degree of affiliation of the evaluated object as a whole  $v_i$ .

(6) The final results of fuzzy comprehensive evaluation are analyzed. The final result vector is the degree of affiliation of the evaluated object to  $V$  each level in the review set. This result is analyzed using the maximum membership principle and the weighted average principle.

### 3. The Analysis of Advantages and Disadvantages

#### 3.1. Entropy method

##### 3.1.1. Advantages

The entropy method only calculates the weight of the index from the amount of data information and the degree of mutual difference of the object to be evaluated, and does not mix the subjective judgment of the decision maker in the evaluation process, and can not be affected by human factors, so the objectivity of the evaluation results is strong. At the same time, the entropy method has no requirements for the number of evaluation indicators and the amount of data in the evaluation index, so the entropy method has a wide range of applications, and the obtained weights can be combined with other comprehensive evaluation methods. Finally, the calculation process of the entropy method is more convenient, and the weight of each evaluation index obtained is easy for decision-makers to understand.

##### 3.1.2. Disadvantages

First of all, the evaluation process of the entropy method is easily affected by the dimensionality of the original data, because the dimensions of different data are different, so the original data needs to be dimensionless before using the entropy method to evaluate. The dimensionless processing method will affect the value of the new data generated, which will affect the final evaluation result.

Secondly, the entropy method cannot reflect the decision-maker's understanding of the importance of each index, because the entropy method is calculated only by data, which is easily affected by the difference in data observations, and there will be a situation where the weight of an important index is small instead of the weight of the importance index is large. For example, if the difference in the observed values of the data under an important indicator is too small, the entropy value will be too large and the final entropy weight will be too small, which is contrary to the understanding of decision makers<sup>[11]</sup>.

Third, the role of the entropy method is limited to determining the weight of the index to be evaluated, so it may not help the decision-maker to make the final decision, and it will be of limited help to the decision-maker in practical application.

Finally, the use of the entropy method depends on the initial amount of data, but if the initial amount of data is small, the use of the entropy method may result in the calculated entropy weight being inaccurate and may contradict the facts.

#### 3.2. AHP

##### 3.2.1. Advantages

AHP establishes a hierarchical structure based on many objects to be evaluated, which will obtain a clear combination of weights for decision makers, which can avoid the cognitive bias of traditional subjective determination due to too many indicators to be evaluated. In addition, AHP transforms the vague importance comparison between various indicators into a clear quantitative comparison, so that the importance of different indicators at the same level has a clear quantitative identification, which is not affected by the original data<sup>[12]</sup>. Finally, the weights obtained by AHP are the subjective judgments of different decision-makers, and the evaluation results are more in line with the subjective intentions of decision-makers, while the final results are

objectively calculated, so that the final evaluation results of AHP take into account subjectivity and objectivity, and the conclusions drawn have strong adaptability and can be combined with different comprehensive evaluation methods.

##### 3.2.2. Disadvantages

The disadvantages of AHP are obvious, first of all, the objects to be evaluated should not be too much, otherwise the hierarchical structure established will be more complicated, the overly complex evaluation matrix will also make the amount of calculation too large, and the consistency test of the evaluation matrix will lead to the whole process of AHP being slightly complicated. Second, when comparing indicators in pairs, decision-makers' judgments will be influenced by their own subjective wishes and preferences, and may not reflect actual needs, and if there are slightly more indicators in one level, it will also make it difficult for decision-makers to subjectively judge and score, even if they use 1-9 Scaling tends to lead decision-makers to make contradictory judgments. Finally, the results obtained by AHP are not fixed, and with the same hierarchical structure, decision-makers may make different evaluation matrices in different situations to obtain different evaluation results [13].

#### 3.3. TOPSIS law

##### 3.3.1. Advantages

First of all, the TOPSIS method does not have too many restrictions on the number of objects to be evaluated and the number of indicators in the original data, and the applicability is strong, regardless of the objects to be evaluated and the number of indicators, the TOPSIS method can always find the "positive ideal solution" and "negative ideal solution" of the object to be evaluated And calculate the relative closeness. At the same time, the TOPSIS method is not affected by the subjective empirical judgment of decision-makers, and the closeness of the "positive and negative ideal solution" calculated in the evaluation process only relies on the original data, and the evaluation results are relatively objective. Secondly, the evaluation results directly obtained by the TOPSIS method can rank the advantages and disadvantages of the evaluation objects, which is convenient for decision-makers to make decisions. Finally, the TOPSIS method makes full use of the original data, so that the final evaluation results are both holistic and local [14].

##### 3.3.2. Disadvantages

Since the TOPSIS method calculates the closeness of the object to be evaluated and the "positive and negative ideal solution", the setting of the "positive ideal solution" is only to combine the best positive indicators, and the setting of the "negative ideal solution" is only to combine the worst negative indicators, and all positive indicators are combined. The "positive ideal solution" may conflict between indicators, and the evaluation results may not be close to reality, as well as the "negative ideal solution". In other words, considering the closeness of the object to be evaluated to the "positive ideal solution" and "negative ideal solution" may be contrary to reality when the evaluation indicators may conflict with each other. Therefore, when using the TOPSIS method, it is necessary to consider the actual situation of the object to be evaluated and the evaluation index to avoid the situation that the "ideal solution" is not in line with the reality, which will increase the workload during the evaluation.

Secondly, the ranking obtained by the TOPSIS method is only the ranking of relative fit, and the size of the relative fit is not similar to the intuitive "weight" obtained by AHP or

entropy methods, and the relative fit as a numerical value may not enable decision-makers to distinguish grades for each object to be evaluated [15].

Finally, the TOPSIS method has a high dependence on the weight of each index to be evaluated, and the weight between the indicators in the TOPSIS method will affect the final evaluation result, while the weight setting of the index may be subjective, and different index weight settings may affect the objectivity of the final evaluation.

### 3.4. Vague comprehensive evaluation

#### 3.4.1. Advantages

Firstly, the evaluation results of fuzzy comprehensive evaluation are relatively clear, and the fuzzy comprehensive evaluation obtains the fuzzy evaluation vector through the calculation of the weight vector and the fuzzy relationship matrix, and then analyzes it through the principle of maximum membership degree or weighted average principle, which can intuitively observe what grade or interval the final evaluation result is in, which is convenient for decision-makers to make decisions. It also facilitates comparison between different subjects to be evaluated.

Secondly, because the set of comments and indicators of fuzzy comprehensive evaluation are realistic, and the fuzzy relationship matrix is determined by the scores of many evaluators, the results of fuzzy comprehensive evaluation have strong "accuracy", "systematicness" and "credibility".

Finally, fuzzy comprehensive evaluation can quantify the original qualitative problems, deal with the ambiguous evaluation objects through accurate numerical means, and make a more scientific, reasonable and realistic quantitative evaluation of the data containing ambiguity in information, so that the fuzzy comprehensive evaluation has a wider scope of application [16].

#### 3.4.2. Disadvantages

It can be seen from the use process of fuzzy comprehensive evaluation that fuzzy comprehensive evaluation is a more subjective evaluation method, which is mainly manifested in the setting of weight vectors may be subjective settings of decision makers, and the data of the fuzzy relationship matrix is also based on the subjective judgment of the evaluator, and the choice of fuzzy operators may not be determined by objective facts, so the final evaluation result of fuzzy comprehensive evaluation has a high degree of subjectivity and may contradict the facts.

Second, similar to AHP, at different times, different judges are likely to give different evaluation results, so that the final judgment results cannot be highly fixed.

Finally, when the number of index sets is large, because the weight vector of the index needs to be normalized, the weight coefficient of the relative membership degree may be small, and the resolution of the results obtained by fuzzy comprehensive evaluation is poor, resulting in the failure of the evaluation. Finally, fuzzy comprehensive evaluation is similar to TOPSIS, and the indicators in the index set of fuzzy comprehensive evaluation also need to be empowered, so the different weights of indicators will also affect the evaluation results of fuzzy comprehensive evaluation.

## 4. Scope of Application and Suggestions for Use

### 4.1. Scope of application

The entropy method and AHP are both used to give weights

to the indicators to be evaluated, unlike the entropy method, which gives weights based on the initial data, while AHP relies on the evaser's empirical judgment. Therefore, when the object to be evaluated has rich initial data, it is recommended to use the entropy method, while the object to be evaluated does not have initial data or has less initial data, and AHP can be used. The same is true for TOPSIS method and fuzzy comprehensive evaluation, when the object to be evaluated has rich initial data, the TOPSIS method can be used to determine the relative proximity to the "positive ideal solution" and "negative ideal solution" to judge the order of the object to be evaluated, and if there is no rich initial data, the index set and comment set can be established, and the fuzzy comprehensive evaluation can be used by the scoring method.

The four comprehensive evaluation methods can be applied to evaluate the competitiveness of industries and products, but if a comprehensive evaluation method is used alone, it will be affected by the disadvantages of this method, so when it is necessary to evaluate an object to be evaluated, two or three of the four methods can be used.

### 4.2. Recommendations for use

#### 4.2.1. Entropy weight-TOPSIS, AHP-TOPSIS

When using the TOPSIS method for evaluation, if the weight of the evaluation index is not set, the TOPSIS method defaults to the equal weight of each index, which is often not in line with reality, so it is necessary to manually assign weight to the evaluation index, at this time, if the initial data is richer, you can choose the entropy method to determine the weight of the evaluation index to obtain the entropy weight, and then assign the entropy weight to the index to be evaluated, and then use the TOPSIS method to calculate the relative closeness. The entropy weight obtained by combining the entropy method with the TOPSIS method - the TOPSIS method can take into account the objective weight of the entropy method and the objective ranking of the TOPSIS method, and at the same time, Since both the entropy method and the TOPSIS method do not limit the number of evaluation objects and the number of indicators too high, the use of entropy weight-TOPSIS to evaluate the objects to be evaluated will not be caused by excessive data Impact evaluation process and results.

When the initial amount of data is small, the entropy value method to calculate the entropy weight will not be accurate enough, so the AHP method can be used to weight each index to be evaluated, and then the weight can be assigned to the index to be evaluated, and the final result can be obtained by using the TOPSIS method.

#### 4.2.2. AHP-fuzzy comprehensive evaluation, entropy weight-fuzzy comprehensive evaluation

When the initial data of the indicators of the fuzzy comprehensive evaluation is small, and the subjective will of the decision makers is strong, the AHP can choose to empower the indicators, and then use the AHP-fuzzy comprehensive evaluation method to obtain the final evaluation results. When the initial data of the index of fuzzy comprehensive evaluation is large and objective weight is required, the entropy weight-fuzzy comprehensive evaluation method can be used to weight the index.

These two methods can form a more systematic "empowerment-evaluation" system, with a wide range of applications and scientific methods.

### 4.2.3. Entropy weight-AHP-fuzzy comprehensive evaluation

The entropy method is more objective and avoids the subjective experience judgment of decision-makers, but it is difficult to reflect the importance that decision-makers attach to evaluation indicators. AHP empowerment can extract the subjective intentions of decision-makers, but it is easy to contradict objectivity. Therefore, the evaluation method of combining entropy and AHP can be used to determine the entropy weight-AHP combined with AHP by the entropy value method. When using entropy weight-AHP, there are three approaches.

(1) The entropy method is used for indicators with more objective weights, while AHP is used for indicators with more subjective weights.

(2) The entropy method was used to obtain the objective weight,  $W_i$  the AHP was used to obtain the subjective weight, and then the preference coefficient was used to obtain the subjective and objective comprehensive weighting to obtain the comprehensive weight  $W_j\alpha W$  [17]. The formula is as follows:

$$W = \alpha W_i + (1 - \alpha) W_j$$

(3) Construct a hierarchical model, use the entropy method to calculate the weights for the indicators that need objective evaluation, and then replace the 1-9 evaluation scale of the decision-makers in AHP according to certain conversion standards, and finally obtain the weights measured by AHP, which can effectively avoid the strong subjectivity of decision-makers in AHP.

For the evaluation system combining subjectivity and objectivity, entropy weight-AHP empowerment can be used, and then combined with fuzzy comprehensive evaluation to obtain the entropy weight-AHP-fuzzy comprehensive evaluation method [18]. This avoids the evaluation method from losing one over the other in the evaluation process.

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