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Dual-objective design of data mining-based employee performance evaluation rule extraction and optimization algorithms

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Abstract Employee performance assessment, as a core part of enterprise human resource management, has a direct impact on the operational efficiency and competitiveness of enterprises in terms of its accuracy and scientificity. This study proposes a comprehensive assessment model based on fuzzy logic and network analysis method (ANP) to address the complexity and ambiguity of enterprise employee performance assessment. The study first utilizes the ANP method to construct an assessment system with 12 indicators including 3 dimensions of work attitude, work ability and work performance, and determines the weights of each indicator through an expert questionnaire. Among them, work performance has the highest weight of 0.3964, work ability is the second highest of 0.3321, and work attitude is relatively low of 0.2721; among the specific indexes, sense of responsibility (0.1781), planning and efficiency (0.2171), and work progress (0.2943) occupy the first place among the dimensions respectively. The study used Mamdani-type fuzzy inference system, designed three fuzzy linguistic variables, established 27 fuzzy rule bases, and evaluated the employees of 10 service companies through Matlab/Simulink simulation platform. The results show that the comprehensive evaluation value of the planning and efficiency index is the highest at 59.65, learning and enterprising and commanding and managing are ranked second and third respectively, and the work progress is the lowest at 29.99. The study shows that the method effectively reduces the subjectivity of the evaluation process, improves the scientificity and operability of the evaluation, and provides decision-making support for the enterprises to formulate the employee motivation strategy.

Index Terms Employee performance assessment, fuzzy logic, network analysis method, affiliation function, fuzzy inference system, weighting analysis

I. Introduction

In today's deepening globalization, enterprises are facing more and more intense competition, and the uncertainty and rapid changes in the market require enterprises to adopt more precise and efficient strategies in talent management and resource allocation [1]. The scientific construction and efficient implementation of employee performance evaluation system has become a key path for enterprises to enhance competitiveness and realize sustainable development [2]-[4]. The performance evaluation system is not only a comprehensive evaluation of employee work results, but also a core mechanism to promote the realization of organizational goals, optimize the allocation of human resources, and motivate the development of employees [5]. With the rapid development of information technology, the means, methods and tools of enterprise performance assessment are also constantly innovating and changing, so that performance management no longer relies solely on traditional subjective judgments, but can provide more accurate and fair assessment results through data-driven, intelligent analysis and real-time feedback [6]-[8].

However, traditional methods of employee performance assessment often have problems such as strong subjectivity, single assessment dimension, low efficiency, etc., which are difficult to meet the human resource management needs of modern enterprises [9]. Lack of employee performance data, with fuzzy awareness and judgment of valuable information [10]. The emergence of fuzzy set theory makes up for the ability to assess the ambiguity of employee performance data [11]-[12]. Therefore, the study of fuzzy set theory in employee performance evaluation came into existence. Derebew, B et al. utilized fuzzy logic theory and an interval value based fuzzy weighted distance algorithm (IVFWDA) for hospital employee performance evaluation to improve the efficiency and effectiveness of employee performance evaluation [13]. Harl, M et al. proposed a new lattice-ordered image fuzzy supersoft set based on fuzzy logic theory, aiming to improve the validity of employee performance evaluation by deciding uncertainty and parameter ordering problems, as well as to provide a flexible framework for

human resource management decisions [14]. Zapa-Pérez et al. applied the theory of fuzzy logic in a manufacturing company and constructed fuzzy indicators for employee performance evaluation, and the study found that the method was able to reduce subjectivity and uncertainty in performance evaluation [15]. Mirahmadi, S et al. developed an analytical network method (ANP) model based on fuzzy logic theory for evaluating employee performance according to different corporate strategies, which involves expert participation, questionnaires focusing on the key indicators of differentiation strategies, and specific tests of the model using employee samples [16]. Yang, Y. F et al. used fuzzy theory and a multi-logic fuzzy inference system to construct an environmental, social, and governance (ESG) environmental management performance assessment model, aiming to provide a fair and objective assessment result for companies [17]. Afrasiabi, A et al. proposed a novel performance hybrid assessment framework for public sector organizations, which achieved good results by combining the balanced scorecard with fuzzy decision making methods to identify key employee performance factors and compare them with other assessment methods [18]. Abbasi, M et al. used the fuzzy Delphi method and fuzzy hierarchical analysis to identify and assign the dimensions and indicators of employee performance, and finally constructed an indicator system containing four dimensions: task performance, situational performance, negative work behavior, and adaptive performance [19]. To summarize the above studies, performance assessment based on fuzzy logic theory can construct objective and comprehensive employee performance assessment indexes by mining the massive work data of employees in order to efficiently and accurately assess employee performance performance and provide powerful support for human resource management decision-making [20].

With the increasingly fierce competition in the market, human resources have become a key factor for enterprises to gain competitive advantages. Employee performance evaluation, as an important tool of human resource management, is not only related to the career development of individual employees, but also directly affects the overall operational efficiency of the enterprise and the realization of strategic goals. However, traditional performance evaluation methods often use simple quantitative indicators or subjective scoring, which is difficult to fully reflect the real performance of employees. Especially in the modern service industry, the work content of employees involves professional knowledge, communication and collaboration, service attitude and other aspects, which affect and constrain each other, presenting obvious complexity and ambiguity characteristics. At the same time, the weight distribution between assessment indicators has been a difficult problem for managers, and the simple linear weighting method cannot accurately reflect the dependency relationship between indicators. The development of fuzzy logic theory provides a new perspective to solve this problem, which can effectively deal with the uncertainty and ambiguity in the assessment process by introducing the affiliation function and linguistic variables. As an extension of the hierarchical analysis method, the analytical network method (ANP) is able to consider the interdependence and feedback relationship between elements, which is more relevant to the actual assessment needs.

In this study, through literature analysis and expert interviews, the assessment indicator system is constructed from the three dimensions of work attitude, work ability and work performance, and the ANP method is used to analyze the interrelationships among the indicators and determine the weights of each indicator. Secondly, based on the theory of fuzzy logic, the affiliation function of input and output variables is designed, and the Mamdani type fuzzy inference system is constructed to transform the qualitative indicators into quantifiable assessment results. Finally, the fuzzy logic toolbox and Simulink simulation module in Matlab software are utilized to establish the simulation model of performance assessment, and 10 service enterprises in Shanghai area are used as empirical objects to verify the effectiveness and practicality of the model. By decomposing the complex performance assessment problem into a multi-level fuzzy reasoning process, this study expects to provide a more objective and accurate performance assessment method for enterprises.

II. Employee performance appraisal model based on fuzzy logic modeling

II. A. Theory of fuzzy logic

II. A. 1) Fuzzy sets

Fuzzy logic [21] introduces an affiliation function to describe the degree to which an element belongs to a set. It breaks the fixed framework of classical set theory that an element either belongs to a set completely or not at all, and provides a more flexible and detailed description.

The theory of fuzzy logic is developed based on the basic concept of fuzzy sets and the degree of affiliation function. For a set $X=\{x_1,x_2,\ldots,x_n\}$, any element x in the domain of the argument either belongs completely to the set X or does not belong to the set X at all, and the characteristic function of the set X is:

$$f_X(x)=\begin{cases}1 & x\in X\\ 0 & x\notin X\end{cases} \tag{1}$$

For a fuzzy set, an element in the domain can "partially belong" to the set X. The degree to which an element belongs to a set X is called the degree of affiliation, and a fuzzy set can be defined in terms of an affiliation function. If the elements of a set A are denoted by x, then the range of values of $u_A(x)$ is a closed interval. If $u_A(x)$ is closer to 1, it means that the element x belongs to the set A to a higher degree, and if $u_A(x)$ is closer to 0, it means that the element x belongs to the set A to a lower degree. It can be seen that a fuzzy set can be completely described by the degree of affiliation function. There are many ways to represent a fuzzy set, and the following three representations are most commonly used. Suppose there exists the set $U=\{x_1,x_2,\ldots,x_n\}$.

(1) Zadeh representation:

$$A=\frac{u_A(x_1)}{x_1}+\frac{u_A(x_2)}{x_2}+\cdots+\frac{u_A(x_n)}{x_n} \tag{2}$$

where $u_A(x_i)/x_i$ does not denote a "score" but the correspondence between an element x_i in the domain and its affiliation $u_A(x_i)$. The "+" does not mean "summation" either, but the whole of the fuzzy set on the domain U.

(2) Sequential Even Representation:

$$A=\{(x_1,u_A(x_1)),(x_2,u_A(x_2)),\ldots,(x_n,u_A(x_n))\mid x\in U\} \tag{3}$$

(3) Vector representation:

$$A=[u_A(x_1),u_A(x_2),\ldots,u_A(x_n)] \tag{4}$$

II. A. 2) Fuzzy linguistic variables

A fuzzy linguistic variable is a word or sentence in a natural language that takes values not as usual numbers, but as fuzzy sets expressed in a fuzzy language. A fuzzy linguistic variable usually consists of five parts: the name of the fuzzy linguistic variable x, the set of values of the fuzzy linguistic variable $T(x)$, the domain of the fuzzy linguistic variable U, the syntactic rule G, and the semantic rule M. Figure 1 shows a schematic diagram of a quintuple on error fuzzy linguistic variables.

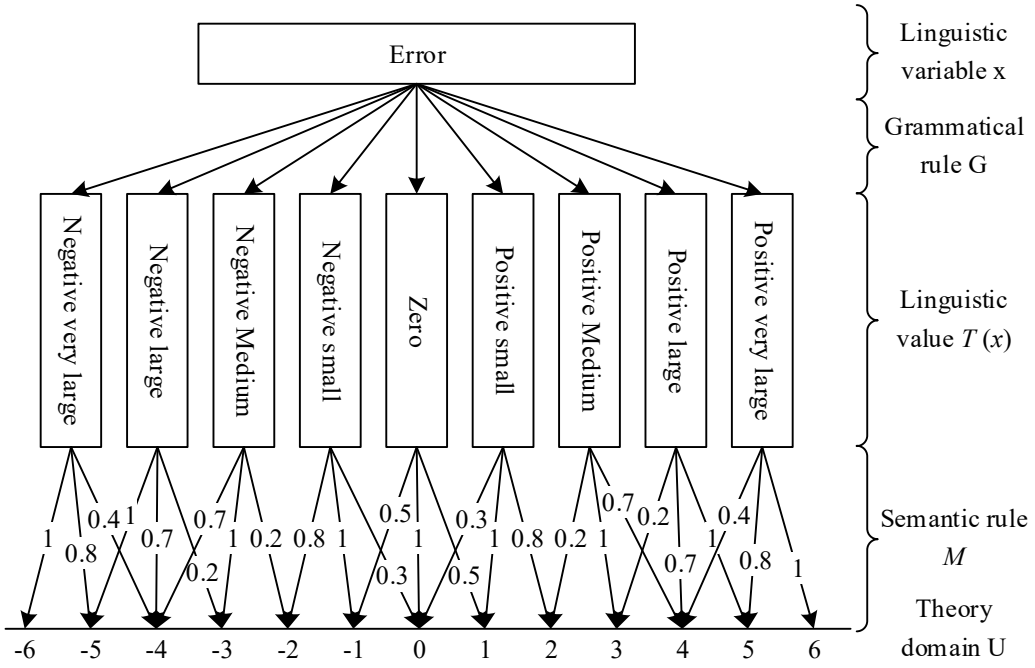

Figure 1: The five-element schematic of the error fuzzy language variable

II. A. 3) Basic structure of fuzzy systems

A fuzzy system is a system constructed based on fuzzy logic, which usually consists of four parts: fuzzification, fuzzy rule base, fuzzy inference machine, and defuzzification.

(1) Fuzzification

The role of defuzzification is to convert the input exact quantity into the defuzzified quantity, it is to convert the value of the input parameters into the corresponding fuzzy set by means of the affiliation function, each input

parameter can be computed by the affiliation function to obtain a value of affiliation, the fuzzy system will be the value of affiliation as the result of defuzzification. Assuming that there exists a real number domain U and a fuzzy set A, u_A is the affiliation function of the fuzzy set A. There are three main types of affiliation functions, mainly triangular affiliation function [22] and trapezoidal affiliation function [23].

① Triangular affiliation function, whose expression is:

$$u_A(x,a,b,c)=\begin{cases}(x-a)/(b-a) & a\le x\le b\\ (c-x)/(c-b) & b\le x\le c\\ 0 & x\le a\ Or\ x\ge c\end{cases} \tag{5}$$

The parameters a and c correspond to the left and right vertices of the lower part of the triangle, and the parameter b corresponds to the vertices of the upper part of the triangle.

② A trapezoidal affiliation function with the expression:

$$u_A(x,a,b,c,d)=\begin{cases}(x-a)/(b-a) & a\le x\le b\\ 1 & b\le x\le c\\ (d-x)/(d-c) & c\le x\le d\\ 0 & x\le a\ Or\ x\ge d\end{cases} \tag{6}$$

The parameters a and d correspond to the left and right inflection points of the lower part of the trapezoid, and the parameters b and c correspond to the left and right inflection points of the upper part of the trapezoid. In the determination of the affiliation function, the more commonly used methods are intuitive method, binary comparison ranking method, fuzzy statistical test method and other methods.

(2) Fuzzy rule base

Fuzzy control rule base [24] is composed of a series of “IF-THEN” type fuzzy conditional sentences. At present, fuzzy control rules are mainly divided into two categories, one is Mamdani type fuzzy control rules, and the other is Sugeno type fuzzy control rules. In this paper, we mainly introduce Mamdani type fuzzy control rules in the form of IF X is A and Yis B Then Zis C, where X, Y, Z are the fuzzy variables, A, B, C are the corresponding fuzzy concepts, and indicates the intersection between the fuzzy subsets, and the right neighboring to IF is the antecedent, and then the right neighboring to C is the consequent. neighbor is the back piece. If the fuzzy system has m input variables, and the number of fuzzy subsets for each input is $n_1,n_2,\ldots,n_m$, the maximum number of fuzzy rules generated is $N_{\max}=n_1\times n_2\times n_m$.

(3) Fuzzy Reasoning Machine

The fuzzy inference machine imitates the human thinking process of reasoning and decision making on fuzzy concepts, in essence, it is a comprehensive assessment of a series of input situations by applying fuzzy control rules, so as to arrive at a qualitative output expressed in fuzzy linguistic values, i.e., the values of the variables used in defuzzification.

(4) Defuzzification

The output after fuzzy logic reasoning is a fuzzy quantity, while the fuzzy logic system requires that the final output to the actuator is a precise quantity, so it is necessary to defuzzify the result of fuzzy reasoning. Commonly used defuzzification methods include maximum affiliation method, center of gravity method, median method, and in this paper, the center of gravity method is selected for defuzzification. Its calculation equation is as follows:

$$x_0=\frac{\int_a^b xu_A(x)dx}{\int_a^b u_A(x)dx} \tag{7}$$

where the lower limit of integration a and the upper limit of integration b represent the lower and upper values of the interval of the fuzzy set A, respectively. In the case where the domain of the argument is discrete, Eq. (7) transforms to:

$$x_0^*=\frac{\sum_{i=1}^n x_iu_A(x_i)}{\sum_{i=1}^n u_A(x_i)} \tag{8}$$

II. B. The construction of the company's employee performance evaluation model

The ANP method is used to establish the company's employee performance evaluation model in 3 steps. First, determine the evaluation index system and construct the ANP network structure accordingly; second, design the expert questionnaire according to the network structure of the ANP model, interview the human resource experts, use the expert questionnaire to collect the data, obtain the weights of the indicators after the data processing and combine the results after the ANP model, reduce the subjectivity of the results of the expert questionnaire by using the GRA method, and analyze the alternatives' performance; finally, verify the reasonableness of the indicator design and the robustness of the model by the sensitivity analysis to verify the reasonableness of the indicator design and the robustness of the model.

II. B. 1) Constructing an assessment indicator system and ANP network structure

Performance evaluation indicators can be divided into three dimensions: "morality", "diligence" and "achievement". "Morality" refers to the spirit of collaboration and professional ethics; "diligence" refers to a sense of responsibility and the situation of social work. "Achievement" refers to the quantity and quality of work. Performance evaluation should emphasize the knowledge, ability and attitude of employees, so the evaluation of employee performance involves professional knowledge, communication and collaboration, management ability, sense of responsibility, motivation, quality of work, and quantity of work. The indicators are categorized into four types according to the content of performance evaluation: professional ethics, work ability, diligence, and work performance. Based on literature exploration method, this paper organizes and analyzes the company's employee performance evaluation dimensions and indicators, constructs the company's employee performance evaluation index system from three dimensions, such as work attitude, work ability and work performance, and selects 12 employee performance indicators. Employee performance evaluation indicators are different but affect each other. Based on the relationship between the indicators, taking into account the interdependence of the elements within the hierarchy and the feedback of the elements of the next level to the elements of the previous level, using the ANP method, the structure of the employee performance assessment network constructed is shown in Figure 2. Among them, the circular arrows indicate that the elements within the element group are influenced by other elements within their own element group.

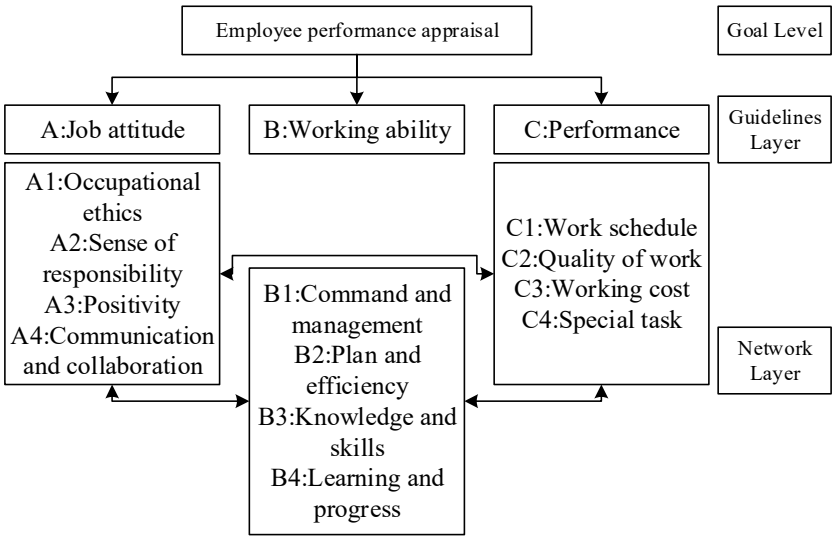

Figure 2: Employee performance appraisal network structure

II. B. 2) Determination of indicator weights

There is an interdependence between performance assessment dimensions and assessment indicators, and the ANP method is used to determine the weights of the indicators, which can avoid the limitations of simple weighted summation.

(1) Data collection

Questionnaire design: A questionnaire is designed based on the network structure of employee performance assessment to investigate and understand the weights of the indicators for the performance assessment of the company's employees. The questionnaire takes the criterion level factors as the evaluation criteria, compares the importance of two factors, and points out the operational definition of each evaluation index in detail in the

questionnaire for the reference of the target. Questionnaire distribution and collection. The questionnaire was distributed from July 1 to November 30, 2024, and 15 human resource experts were selected for the distribution of the questionnaire. Face-to-face questionnaire survey was conducted by using expert interview method. ANP questionnaires were distributed in total 15 questionnaires were recovered, with a recovery ratio of 100%. The overall standard deviation was calculated after the expert group scored the questionnaires. When the overall standard deviation is less than 1, it can be considered that the expert group's opinion is more unified. The questionnaire was organized to obtain the judgment matrix of relative importance between the 3 assessment dimensions and 12 assessment indicators.

(2) Applying network analysis to determine the weights

Network analysis method (ANP) by comparing the importance of elements in a group to another element, to get the judgment matrix of the influence of the element in the group to another element, and finally to get the influence of any element to the target by establishing the weighted supermatrix and the limit supermatrix. ANP utilizes the supermatrix to comprehensively analyze the factors affecting each other to get their mixed weights, which can clearly reflect the dependence between the dimensions or criteria.

Step 1: Establish judgment matrix and consistency test

Let the elements of criterion layer in ANP structure be $P_i(i=1,2,3)$ and the elements of network layer be $C_j(j=1,2,\cdots,n)$, and compare the importance of the elements in cluster C_i to C_j two by two, i.e., to build a judgment matrix. The sorting vector w_{ij} is obtained by the feature root method:

$$w_{ij}=\begin{bmatrix} w_{i1}^{(1)} & w_{i1}^{(2)} & \cdots & w_{i1}^{(nj)} \\ w_{i2}^{(1)} & w_{i2}^{(2)} & \cdots & w_{i2}^{(nj)} \\ \vdots & \vdots & & \vdots \\ w_{ini}^{(1)} & w_{ini}^{(2)} & \cdots & w_{ini}^{(nj)} \end{bmatrix} \tag{9}$$

Step 2: Build the unweighted supermatrix

In matrix w_{ij}, the column vectors are ordered by the level of influence of each element C_{im} in P_i on the elements of the cluster P_j, and $w_{ij}=0$ if the individual elements of P_i have no influence on the elements in P_j. The final unweighted supermatrix W_{ij} is formed from the sub-block matrix w_{ij}:

$$W_{ij}=\begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1n} \\ w_{21} & w_{22} & \cdots & w_{2n} \\ \vdots & \vdots & & \vdots \\ w_{n1} & w_{n2} & \cdots & w_{nn} \end{bmatrix} \tag{10}$$

Step 3: Build the weighted supermatrix

Since W_{ij} is not a column normalized vector, it is necessary to compare the two-by-two importance of P_i with $P_j\left(j=1,2,3\right)$ to obtain the weight matrix a_{ij}, $\left(i=1,2,\cdots,n;j=1,2,\cdots,n;n<4\right)$, and finally multiplied with the unweighted supermatrix W_{ij} to obtain the weighted supermatrix i.e:

$$\overline{W}_{ij}=a_{ij}W_{ij},\left(i=1,2\cdots,n;\ j=1,2,\cdots,n;\ n<4\right) \tag{11}$$

Step 4: Establishing the Limit Supermatrix

In order to accurately reflect the relationship between the employee performance evaluation indicators, therefore, the weighted supermatrix $\overline{W}$ is stabilized, i.e., the limit supermatrix is established:

$$W^{\infty}=\lim_{k\to\infty}\overline{W}^{k} \tag{12}$$

After the 4 steps of ANP calculation, the weights of employee performance assessment indicators are obtained, the local weights are the weights of each three-level indicator to the upper-level indicator, and the global weights are the weights of each three-level indicator to the total goal, i.e., employee performance. The results of the weights of the employee performance assessment indicators are shown in Table 1. In the dimension weights, the weights of work ability and work performance are 0.3321 and 0.3964 respectively, while the weight of work attitude is relatively small, 0.2721. Based on the nature of the company, as the important purpose of business is the pursuit of work performance, the employee is the most important resource of the company, and the work progress, work quality, and cost of the employee determines its performance.

The weights of the assessment indicators under the dimension of work attitude are, in descending order: sense of responsibility>motivation>communication and collaboration>professional ethics, and sense of responsibility has the highest importance in this dimension (0.1781). The actual completion of the work will affect the customer's recognition of the company in terms of the relevant service requirements explained by the customer. The weights of the assessment indicators under the dimension of work competence are, in descending order, Planning and Efficiency, Knowledge and Skills, Learning and Enterprising, and Command and Management, with global indicators ranging from 0.0109 to 0.2171.

The company is aiming at profitability and developing employees' and team's ability to improve the overall performance of the company, thus promoting the company's development. Therefore, under this dimension, Planning and Efficiency has the highest importance with 66.05%. The weights of the assessment indicators under the work performance dimension are, in descending order: work progress, work quality, special tasks, and work cost. The important purpose of the company's operation is to pursue good work performance, and the two indicators of work progress and work quality are the fundamental guarantee for realizing good performance.

Table 1: Employee performance assessment index weight

Secondary indicator	Weighting	Tertiary index	Local weight	Global weight
A: Job attitude	0.2721	A1: Occupational ethics	0.0655	0.0173
		A2: Sense of responsibility	0.6553	0.1781
		A3: Positivity	0.1447	0.0392
		A4: Communication and collaboration	0.1345	0.0366
B: Working ability	0.3321	B1: Command and management	0.0319	0.0109
		B2: Plan and efficiency	0.6605	0.2171
		B3: Knowledge and skills	0.1551	0.051
		B4: Learning and progress	0.1525	0.0514
C: Performance	0.3964	C1: Work schedule	0.7368	0.2943
		C2: Quality of work	0.1452	0.0573
		C3: Working cost	0.0457	0.0179
		C4: Special task	0.0723	0.0289

II. C.Performance evaluation methods based on fuzzy logic

Fuzzy rules establish the connection of language values between input and output in the form of "if - then". The membership functions of input indicators and output indicators obtained through expert discussions are used to generate the fuzzy rule base, and in the process of establishing the rule base, the relative weights between indicators need to be considered, that is, to establish a weighted logical reasoning system. Regarding the "financial aspect" as an output, there are four input variables: "customer aspect", "internal process aspect", and "learning and development", each with three input indicators, and "social benefits" with two input indicators. Therefore, five sub-models need to be established (the output of the sub-models is the input of the overall model). By considering the state combinations of the input parameters and their weights, the state levels and corresponding fuzzy intervals of "financial aspect", "customer aspect", "internal process aspect", "learning and development aspect", and "social benefit aspect" can be obtained.

The status levels on the customer side and their corresponding fuzzy intervals are shown in Table 2. The corresponding fuzzy rules are as follows:

Rule 1: If "Customer satisfaction" is evaluated as "good", "customer retention rate" as "good", and "customer acquisition rate" as "good", then the enterprise's "performance level in terms of customers" is "good".

Rule 2: If the "customer satisfaction" is evaluated as "good", the "customer retention rate" as "good", and the "customer acquisition rate" as "medium", then the enterprise's "performance level in terms of customers" is "good".

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Rule 13: If the "customer satisfaction" is evaluated as "medium", the "customer retention rate" as "medium", and the "customer acquisition rate" as "good", then the enterprise's "performance level in terms of customers" is rated as "medium".

Rule 14: If the "customer satisfaction" is evaluated as "medium", the "customer retention rate" is evaluated as "medium", and the "customer acquisition rate" is evaluated as "medium", then the enterprise's "performance level in terms of customers" is evaluated as "medium".

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Rule 26: If "Customer satisfaction" is evaluated as "poor", "customer retention rate" as "poor", and "customer acquisition rate" as "medium", then the enterprise's "performance level in terms of customers" is "poor".

Rule 27: If "customer satisfaction" is evaluated as "poor", "customer retention rate" as "poor", and "customer acquisition rate" as "poor", then the enterprise's "performance level in terms of customers" is "poor".

Similarly, the status levels of "financial aspect", "internal process aspect", "learning and development aspect", and "social benefit aspect", along with their corresponding fuzzy intervals and rules, can be obtained. This article will not provide them here.

The overall model is based on five input variables: financial aspect, customer aspect, internal process aspect, learning and development aspect, and social benefit aspect.

The fuzzy logic toolbox in the Matlab program is adopted to construct the fuzzy reasoning system. These fuzzy IF-THEN rules can transform fuzzy inputs into fuzzy outputs.

Table 2: The state level of the customer and its corresponding fuzzy interval

Parameter	Customer satisfaction 0.2492	The customer retention rate is 0.5881	The customer's availability rate is 0.1627	Customer performance level	Fuzzy interval
State level	Good	Good	Good	Good	0.7-0.8-0.9-1
			Medium	Good	0.7-0.8-0.9-1
			Bad	Good	0.7-0.8-0.9-1
		Medium	Good	Good	0.7-0.8-0.9-1
			Medium	Medium	0.3-0.5-0.7-0.9
			Bad	Medium	0.3-0.5-0.7-0.9
		Bad	Good	Medium	0.3-0.5-0.7-0.9
			Medium	Bad	0-0-0.3-0.5
			Bad	Bad	0-0-0.3-0.5
	Medium	Good	Good	Good	0.6-0.7-0.8-1
			Medium	Good	0.6-0.7-0.8-1
			Bad	Good	0.6-0.7-0.8-1
		Medium	Good	Medium	0.2-0.4-0.6-0.8
			Medium	Medium	0.2-0.4-0.6-0.8
			Bad	Medium	0.2-0.4-0.6-0.8
		Bad	Good	Bad	0.1-0.2-0.3-0.4
			Medium	Bad	0.1-0.2-0.3-0.4
			Bad	Bad	0.1-0.2-0.3-0.4
	Bad	Good	Good	Good	0.5-0.7-0.9-1
			Medium	Medium	0.3-0.4-0.5-0.6
			Bad	Medium	0.3-0.4-0.5-0.6
		Medium	Good	Medium	0.3-0.4-0.5-0.6
			Medium	Medium	0.3-0.4-0.5-0.6
			Bad	Bad	0-0-0.1-0.2
		Bad	Good	Bad	0-0-0.1-0.2
			Medium	Bad	0-0-0.1-0.2
			Bad	Bad	0-0-0.1-0.2

III. Analysis of the results of employee performance evaluation based on fuzzy logic

III. A. Employee performance appraisal

In this paper, 10 Shanghai service companies are selected to complete the empirical analysis. The members of the assessment team of each company include the manager of the human resources department, performance management experts, department supervisors, the manager of the personnel department, and other assessment teams totaling 50 people, and the employees of the company's personnel department and finance department are surveyed, combined with the fuzzy logic method, to obtain the required assessment data.

Against the fuzzy set and affiliation function of the established employee performance assessment model, the employee work attitude, work ability and work performance of the actual case under study is obtained corresponding to the degree of affiliation, and its variables correspond to the linguistic value and affiliation, and the employee

performance affiliation is shown in Table 3. The affiliations corresponding to the input variables are processed in the fuzzy inference machine to get the risk values corresponding to the output variables.

Table 3: Employee performance membership

Variable	Corresponding language value	Corresponding membership
A: Job attitude	A1: Occupational ethics	0≤A<0.1
	A2: Sense of responsibility	0.01≤A<0.2
	A3: Positivity	0.01≤A<0.1
	A4: Communication and collaboration	0≤A<0.5
B: Working ability	B1: Command and management	[1100,3500]
	B2: Plan and efficiency	[1300,12571]
	B3: Knowledge and skills	[1230,11527]
	B4: Learning and progress	[1026,9891]
C: Performance	C1: Work schedule	[0,1]
	C2: Quality of work	[0,1]
	C3: Working cost	[0,1]
	C4: Special task	[0,1]

Similarly, the risk assessment model of employee performance under fuzzy logic can be used to calculate the employee's work attitude, work ability and work performance, determine its corresponding affiliation function and fuzzy rules, and finally use the fuzzy logic analysis model to find out the outputs of the employee's work attitude, work ability and work performance as shown in Fig. 3 to Fig. 5. As shown in the figure, the employee's work attitude performance value is 0.4973, and then calculate the performance value of the employee's work ability and work performance, respectively, to get the work ability value of 0.05, and the work performance value of 50. For the employee's performance in this case, the performance of the three types of performance should be taken to determine its performance of the performance of the maximum value, that is, the case of the employee's performance value of 0.4973, the case of the employee's higher performance, corresponding to the medium grade The employee's performance is high and corresponds to medium level, which can be incentivized by taking countermeasures such as commission.

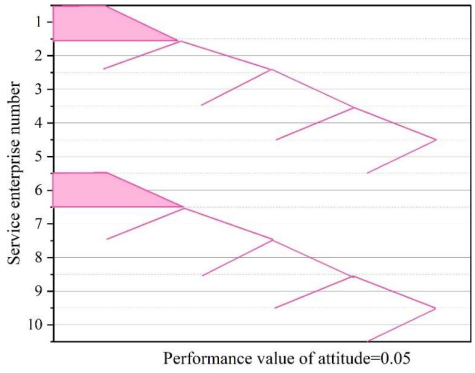

Figure 3: Output of employee attitude

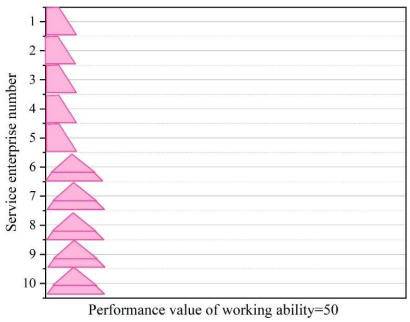

Figure 4: The output of the employee's working ability

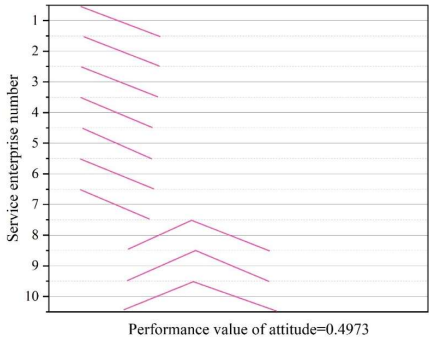

Figure 5: Output results of employee performance

III. B. Simulation results and evaluation

The realization of fuzzy inference system needs to use Matlab software, and this paper uses Matlab as a platform to build the employee performance evaluation selection model.

The first step to build the fuzzy inference system is to construct the structure file of the fuzzy inference system, including the first three layers and the fourth layer of two types of fuzzy inference system. First, use the "Fuzzy" command to bring up the fuzzy logic designer. Set the fuzzy reasoning type to Mamdani type, the dimension of the input variable to two-dimensional, the clarification method to the focus method, and set the fuzzy logic operation according to the "take small - take large" method. After that, the affiliation function of the first three layers of the fuzzy inference system is set using the affiliation function editor. After the affiliation functions of input and output are set, the fuzzy inference rules are imported into the fuzzy inference system using the fuzzy rule editor. This completes the design of the first three layers of the fuzzy inference system structure file, and then use the same method steps to design the fourth layer of the fuzzy inference system structure file, these two parts of the structure file is the basis of the simulation model.

The fuzzy inference system structure file can not be directly used for fuzzy inference, which needs to be realized with the help of Simulink simulation module in Matlab. The Simulink simulation module is used to embed the structure files of the first three layers and the fourth layer of the fuzzy inference system into the fuzzy inference system respectively.

Simulink simulation module is used to embed the first three layers and the fourth layer of the fuzzy inference system structure file into the fuzzy logic controller, select the appropriate signal source and receiver module, and then build the simulation model of employee performance evaluation selection according to the model framework.

Table 4: Comprehensive evaluation and sorting of employee performance

Employee performance indicators	Integrated evaluation	Sort
A1: Occupational ethics	40.92	9
A2: Sense of responsibility	47.36	4
A3: Positivity	39.44	10
A4: Communication and collaboration	32.51	11
B1: Command and management	53.91	3
B2: Plan and efficiency	59.65	1
B3: Knowledge and skills	43.56	6
B4: Learning and progress	54.94	2
C1: Work schedule	29.99	12
C2: Quality of work	42.5	7
C3: Working cost	46.51	5
C4: Special task	41.1	8

The weighted evaluation value of the indicators of each employee's performance is input into the simulation model, and the comprehensive evaluation value of each employee's performance and the sorting results are shown in Table 4. From the evaluation results, the comprehensive evaluation value of planning and efficiency is the highest, and its comprehensive evaluation value is 59.65. The performance of learning and enterprising and command and management is similar, and they are ranked in the 2nd and 3rd positions respectively. Work progress, on the other hand, was relatively poor and ranked the lowest, with its composite score of 29.99. The rest of the performance

indicators were ranked from 4 to 11, with their composite evaluation values ranging from 32.51 to 47.36. Therefore, under the comprehensive evaluation selection criteria of employee performance in this paper, the plan is best represented by the efficiency index, which is more appropriate as an important indicator of employee performance measurement, and this conclusion can be used as a decision-making reference for the selection of employee performance measurement in enterprises.

Through the evaluation results above, the relatively important employee performance evaluation indexes can be screened out, indicating that the fuzzy system constructed in this paper is effective. It is just that the comprehensive assessment value of each employee performance in the evaluation result is low, which needs to be analyzed. Using the surface observation window in the fuzzy logic designer to view the relationship between the input value and the output value in each fuzzy inference system, the first three layers of fuzzy inference system output volume surface shown in Figure 6; the fourth layer of fuzzy inference system output volume surface shown in Figure 7. It can be seen that the spatial surface of the model is relatively smooth and the output values are continuous, indicating that the design of the fuzzy rules is in accordance with the standard. However, from the point of view of the maximum value of the output of the two fuzzy inference systems, the maximum output value of the first three layers is lower than 25, and the maximum output value of the fourth layer is lower than 62, which is smaller than the maximum value of the physical domain of the output variables, which is caused by the design of the fuzzy inference rules by adopting the principle of “taking the smallest average value”.

It can be seen that the fuzzy inference rule designed in this paper is relatively conservative and prudent, but it will lower the comprehensive evaluation value of employee performance, coupled with the cumulative effect of the four layers of fuzzy inference, resulting in a lower final evaluation value. In addition, the design of the affiliation function and the weights of the evaluation indexes also have an impact on the final results. The fuzzy domain of the affiliation function is equal to the physical domain, which will make the output value avoid the lowest and the highest values; the weight calculation will also reduce the evaluation value of some indicators in the data preprocessing process.

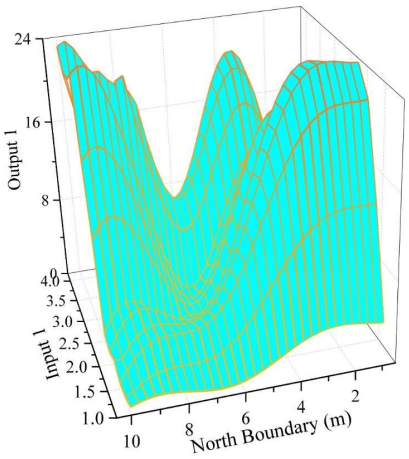

Figure 6: The first three layers of fuzzy reasoning system output surface

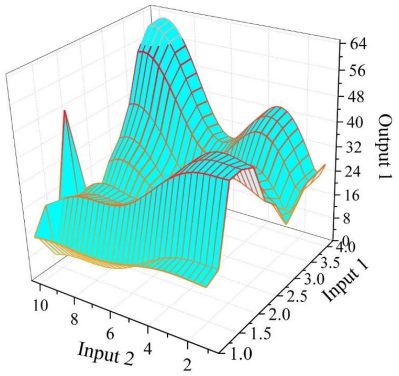

Figure 7: The fourth layer of fuzzy reasoning system output surface

The above analysis shows that the main reason for the low final evaluation result is the conservative fuzzy rule design principle of “taking the mean value to be small”. However, the low value of the final evaluation does not affect

the ranking of employee performance, and the appropriate indicators can still be selected for the evaluation of employee performance. The model can also be adjusted according to the decision maker's risk preference to obtain the evaluation results that meet the needs of corporate employee performance evaluation.

IV. Conclusion

This study successfully constructed an employee performance assessment model based on fuzzy logic and ANP, and verified the effectiveness and practicality of the method through theoretical analysis and empirical research. The main conclusions obtained are as follows:

In the weight distribution of assessment dimensions, work performance accounts for the highest proportion (39.64%), followed by work ability (33.21%), and work attitude is relatively low (27.21%), which is in line with the performance-oriented management characteristics of service enterprises.

Among the 12 specific indicators, the global weight of work progress reaches 0.2943, which becomes the most critical factor affecting employee performance; planning and efficiency (0.2171) and sense of responsibility (0.1781) rank second and third respectively.

Analyzed by Simulink simulation, the assessment results of the 10 companies show that Planning and Efficiency has the highest overall evaluation value (59.65 points), Learning and Aggressiveness is second (54.94 points), while Work Progress is the lowest (29.99 points).

The output surface of the fuzzy inference system is smooth and continuous, which indicates that the rules are well-designed, but the overall evaluation value is conservative due to the principle of “taking the mean to be small”.

The results show that the model can effectively deal with the ambiguity and uncertainty in performance evaluation, and provides a scientific basis for enterprises to formulate differentiated employee motivation strategies. It is suggested that enterprises can adjust the fuzzy rule base and the affiliation function appropriately according to their own characteristics and management needs in order to obtain evaluation results that are more in line with the actual situation of the enterprises.

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