

The Application Study of Enterprise Online Reputation Evaluation Index Based on Comprehensive Evaluation of Fuzzy Matter-element

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Abstract—Under the background of the development of network economy, enterprise online reputation evaluation and management have become important topics for enterprises. Through research and analysis of enterprise online reputation evaluation models and evaluation indicators, a fuzzy matter-element evaluation model is constructed. The subjective weighting method and objective weighting method are respectively used to calculate the comprehensive weight of enterprise online reputation evaluation indicators and the main elements affecting enterprise online reputation level are obtained through analysis. It provides a scientific reference for enterprises to conduct online reputation evaluation and strengthen online reputation management.

Keywords—comprehensive evaluation; fuzzy matter-element; online reputation

I. INTRODUCTION

With the development of Internet technology and the promotion of mobile Internet technologies, user experience and sharing of opinions has become the key to online communication. The traditional business model is undergoing transformation, and user evaluation and online reputation have gradually become an important strategic decision-making element [1]. According to Nielsen's research on the degree of trust in advertising consumption, online evaluations account for 68% of the elements that influence customers consume. Online reputation consists of different opinions of people who have actual experience in social media and on the Internet. User evaluations are based on experience. Some evaluations are relatively objective, while others are not. User evaluations change with many elements. Personal preferences of individuals and evaluations motives will affect the objectivity of evaluation [2]. The impact of online reputation on the relationship between the enterprise and the user is much greater than the brand, so enterprises must make correct evaluation of the situation and pay great attention to the management of online reputation. Launching enterprise online reputation evaluation has become a new topic for enterprises to strengthen online reputation management.

II. ONLINE REPUTATION EVALUATION MODELS AND INDICATORS

Enterprise online reputation evaluation is based on enterprise reputation evaluation with the addition of a wide

range of social evaluation. It reflects enterprise online reputation dynamically and objectively in real time through collection of diverse, heterogeneous and multi-party information online. Enterprise online reputation is the possibility that enterprises comply with contracts and fulfill their commitments. It adopts a general 3C evaluation model that considers three basic components of enterprise reputation: Character, reputation and Capacity [3]. The establishment of enterprise online evaluation model shall mainly take into account the willingness, capacity and behavior of enterprises to fulfill their promises in reputation as well as extensive social evaluation, etc. Depending on whether it is decisive for online reputation of the company or reflects the level of online reputation, all evaluation elements are divided into two types: decisive elements and reflective elements. Performance willingness and performance capacity are the decisive elements of enterprise online reputation; performance behavioral expression and social evaluation information are reflective elements of enterprise online reputation [4]. On-line reputation evaluation model is constructed as shown in figure 1.

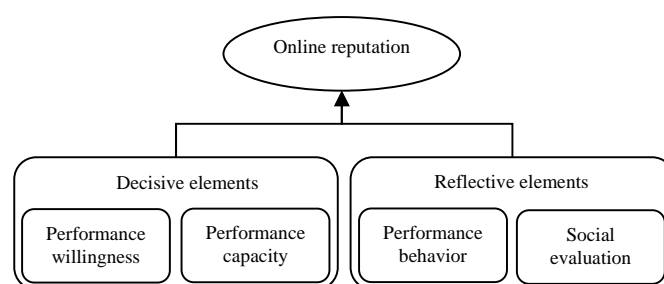


FIGURE I. ENTERPRISE ONLINE REPUTATION EVALUATION MODEL

According to enterprise online reputation evaluation model and overall consideration of enterprise reputation information items, two types of enterprise online reputation indicators can be initially established: decisive indicators include enterprise basic information (unified social reputation code related information, industry categories, related information, etc.), qualification license information, management information (human resources management, production management, operating management, etc.), transaction information, financial

information, etc.; reflective indicators include enterprise honor information, social responsibilities, market evaluation (public opinion information), administrative supervision and management, judicial information, etc.

TABLE I. ENTERPRISE ONLINE REPUTATION EVALUATION INDICATORS

Objective	Category	Criterion	Indicator
Enterprise online reputation evaluation	Decisive indicators	Performance willingness	Basic information Qualification license information
		Performance capacity	Management information Transaction information Financial information
	Reflective indicators	Performance behavior	Honor information Social responsibility information Administrative supervision and management information
		Social evaluation	Public opinion information

III. FUZZY MATTER-ELEMENT EVALUATION MODEL CONSTRUCTION

Fuzzy matter-element evaluation method is an organic combination of fuzzy set theory and matter-element analysis theory [5]. Fuzzy sets are used to express the set of fuzzy concepts and described by membership function $\mu_A(X) \in [0,1]$. The matter-element analysis method was proposed and established by Professor Cai Wen and focuses on resolving incompatible complex problems. It is an important theoretical basis for extenics and widely used in micro-decision making of various industries [6]. The values of enterprise online evaluation indicators are fuzzy, so fuzzy matter-element model can be constructed to evaluate enterprise online reputation.

A. Fuzzy Matter-element Model

For a given matter name M, feature C and value V, the three elements jointly constitute an ordered ternary $R=(M, C, V)$ as the basic element of evaluation (referred to as matter-element). C refers to the corresponding evaluation object indicator and V refers to its indicator value. If V is fuzzy, it will become a fuzzy matter-element. If the matter M has n features of C_1, C_2, \dots, C_n and corresponding values of V_1, V_2, \dots, V_n for description, then M is called n-dimensional fuzzy matter element. For n-dimensional compound matter-element R_{mn} of m matters, the corresponding matrix is expressed as follows:

$$R_{mn} = \begin{bmatrix} M_1 & M_2 & \cdots & M_m \\ C_1 & x_{11} & x_{21} & \cdots & x_{m1} \\ C_2 & x_{12} & x_{22} & \cdots & x_{m2} \\ \vdots & \vdots & \vdots & & \vdots \\ C_n & x_{1n} & x_{2n} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

B. Preference Membership Fuzzy Matter-element Model

The evaluation process of matter involves many evaluation indicators. If there are no uniform metrics among the indicators, the evaluation process will be difficult to perform. Corresponding fuzzy value membership degree of corresponding fuzzy value of each individual evaluation indicator is called the preference membership. The principle established thereout is called the principle of preference membership [7]. In order to transform the fuzzy matter-element matrix into a preference membership matrix, the preference principle is introduced. Generally there are two types of indicators:

$$\max X_j = \max(X_{1j}, X_{2j}, \dots, X_{mj}) \quad (2)$$

$$\min X_j = \min(X_{1j}, X_{2j}, \dots, X_{mj}) \quad (3)$$

The-smaller-the-better type:

$$\mu_{ij} = \frac{X_{ij}}{\min X_j} \quad (4)$$

The-bigger-the-better type:

$$\mu_{ij} = \frac{X_{ij}}{\max X_j} \quad (5)$$

Where μ_{ij} refers to the dimensionless result of the corresponding value of No. i matter and No. j feature; $\max X_j$ refers to the maximum corresponding value of the No. j feature of the matter evaluated; $\min X_j$ refers to the minimum corresponding value of the No. j feature of the matter evaluated. Formula (6) is obtained after processing of values in formula (1) through formula (4) and formula (5), that is, preference membership fuzzy matter-element \tilde{R}_{mn} .

$$\tilde{R}_{mn} = \begin{bmatrix} M_1 & M_2 & \cdots & M_m \\ C_1 & \mu_{11} & \mu_{21} & \cdots & \mu_{m1} \\ C_2 & \mu_{12} & \mu_{22} & \cdots & \mu_{m2} \\ \vdots & \vdots & \vdots & & \vdots \\ C_n & \mu_{1n} & \mu_{2n} & \cdots & \mu_{mn} \end{bmatrix} \quad (6)$$

C. Establish Difference Square Compound Fuzzy Matter-element Matrix

Generally speaking, the standard fuzzy matter-element R_{0n} is determined by the maximum or minimum value among the preference membership fuzzy matter-element \tilde{R}_{mn} ; perform difference calculation of standard fuzzy matter-element R_{0n} and preference membership fuzzy matter-element \tilde{R}_{mn} to get the Δ_{ij} that is the square of difference between standard fuzzy matter-element and preference membership fuzzy matter-element. Different Δ_{ij} form difference square compound fuzzy matter-element.

$$R_{\Delta} = \begin{bmatrix} & M_1 & M_2 & \cdots & M_m \\ C_1 & \Delta_{11} & \Delta_{21} & \cdots & \Delta_{m1} \\ C_2 & \Delta_{12} & \Delta_{22} & \cdots & \Delta_{m2} \\ \vdots & \vdots & \vdots & & \vdots \\ C_n & \Delta_{1n} & \Delta_{2n} & \cdots & \Delta_{mn} \end{bmatrix} \quad (7)$$

D. Determine the Weight

In the comprehensive evaluation, the weight of evaluation indicator directly affects the accuracy of evaluation results. Common subjective weighting methods include Delphi Method and AHP method; objective weighting methods include principal component analysis method, maximum deviation method, entropy method, etc [8]. AHP method and entropy weight method are respectively adopted below and applied in fuzzy matter-element model for evaluation. AHP method is first adopted below to calculate the subjective weight; entropy weight method is adopted to determine the objective weight. Finally, AHP method and entropy weight method are organically combined to get comprehensive weight.

1) AHP method

Analytic hierarchy process is called AHP for short. First proposed by Satty, an operational research expert in the United States, it is a decision analysis method that quantifies qualitative problems based on hierarchy [9]. The method is establish the evaluation system of hierarchical structure; secondly, 9-scale method is used to construct the comparison matrix of indicator layers; then, the judgment matrix passes the consistency test to obtain the subjective weight of indicators α_j .

2) Entropy method

Entropy method is a method used to determine the weight of indicators that is made up of evaluation indicators. In enterprise reputation evaluation, the weight is determined by

calculation of entropy, which is a method to objectively determine each evaluation indicator, and the evaluation result is more truthful [10]. For a certain indicator, the greater the

difference in indicator value X_{ji} , the greater the role that the indicator plays in comprehensive evaluation is and the greater the corresponding weight value is. For m evaluation matters, evaluation indicator matrix of n evaluation indicators $X = (X_{ji})_{m \times n}$; normalization processing is performed to form a normalized judgment matrix.

The entropy of No. j evaluation indicator is calculated as follows:

$$H_j = -\frac{1}{\ln m} \left(\sum_{i=1}^m f_{ji} \ln f_{ji} \right) \quad (i=1,2,\dots,m; j=1,2,\dots,n) \quad (8)$$

$$f_{ji} = \frac{1 + \mu_{ji}}{\sum_{i=1}^m (1 + \mu_{ji})}$$

Wherein,

Calculate the index of entropy weight W:

$$W = (\omega_j)_{1 \times n} \quad (9)$$

$$\omega_j = \frac{1 - H_j}{n - \sum_{j=1}^n H_j} \quad \text{and} \quad \sum_{j=1}^n \omega_j = 1$$

Wherein,

3) Comprehensive weight

The following formula is used to determine comprehensive weight:

$$\beta_j = \frac{\alpha_j \omega_j}{\sum_{j=1}^n (\alpha_j \omega_j)} \quad (10)$$

E. Evaluation Results

The evaluation results of each enterprise are calculated according to the value of each indicator and the comprehensive weight calculated above. After comparative analysis, enterprises with higher evaluation results are obtained. The main practices of enterprises on management of online reputation can be known by analyzing the indicator values of enterprises with higher evaluation results.

IV. APPLICATION ANALYSES

Four dimensions of enterprise online reputation evaluation are taken into account comprehensively; 8 comprehensive evaluation indicators are selected as basic evaluation indicators, including quality license information C_1 , management information C_2 , transaction information C_3 , financial information C_4 , administrative supervision and management C_5 , social responsibility information C_6 , honor information C_7 and public opinion information C_8 .

TABLE II. PROCESSING VALUES OF COMPREHENSIVE EVALUATION INDICATORS

X_{ij}	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6
C_1	20.0	21.1	21.7	20.4	21.2	22.0
C_2	49.5	57.2	58.0	56.2	61.3	62.4
C_3	16.6	20.3	19.2	17.0	22.1	20.8
C_4	50.15	58.2	57.16	50.64	61.32	58.95
C_5	26.35	26.5	26.14	25.68	28.22	29.92
C_6	68.8	72.8	70.0	63.5	77.0	74.5
C_7	76.48	53.95	38.91	141.07	85.59	55.2
C_8	2.28	2.23	1.89	2.29	2.44	2.19

The membership fuzzy matter-element matrix is constructed according to formula (4) and (5):

$$\tilde{R}_{mn} = \begin{bmatrix} M_1 & M_2 & M_3 & M_4 & M_5 & M_6 \\ C_1 & 0.922727 & 0.959091 & 0.986364 & 0.927273 & 0.963636 & 1 \\ C_2 & 0.793269 & 0.916667 & 0.929487 & 0.900641 & 0.982372 & 1 \\ C_3 & 0.751131 & 0.918552 & 0.868778 & 0.769231 & 1 & 0.941176 \\ C_4 & 0.817841 & 0.949119 & 0.932159 & 0.825832 & 1 & 0.96135 \\ C_5 & 0.880682 & 0.885695 & 0.873663 & 0.858289 & 0.943182 & 1 \\ C_6 & 0.893506 & 0.945455 & 0.909091 & 0.824675 & 1 & 0.967532 \\ C_7 & 0.542142 & 0.382434 & 0.275821 & 1 & 0.60672 & 0.391295 \\ C_8 & 0.934426 & 0.913934 & 0.77459 & 0.938525 & 1 & 0.897541 \end{bmatrix}$$

The difference square compound fuzzy matter element matrix is established according to that the standard fuzzy matter-element is determined by the maximum value of preference membership fuzzy membership matter-element:

$$R_{\Delta} = \begin{bmatrix} M_1 & M_2 & M_3 & M_4 & M_5 & M_6 \\ C_1 & 0.005971 & 0.001674 & 0.000186 & 0.005289 & 0.001322 & 0 \\ C_2 & 0.042738 & 0.006944 & 0.004972 & 0.009872 & 0.000311 & 0 \\ C_3 & 0.061936 & 0.006634 & 0.017219 & 0.053254 & 0 & 0.00346 \\ C_4 & 0.033182 & 0.002589 & 0.004602 & 0.030335 & 0 & 0.001494 \\ C_5 & 0.014237 & 0.013066 & 0.015961 & 0.020082 & 0.003228 & 0 \\ C_6 & 0.011341 & 0.002975 & 0.008264 & 0.030739 & 0 & 0.001054 \\ C_7 & 0.209634 & 0.381387 & 0.524436 & 0 & 0.154669 & 0.370522 \\ C_8 & 0.0043 & 0.007407 & 0.05081 & 0.003779 & 0 & 0.010498 \end{bmatrix}$$

A. Determine the Weight by AHP Method

The information values and weights calculated according to the AHP calculation procedures are as shown in table 3. It can be seen from the table that C_7 honor information among the comprehensive evaluation indicators has the greatest influence

on the enterprise online reputation evaluation and has the largest weight of up to 0.3969; it is followed by public opinion information with a weight of 0.1982. The other information has a relative small impact on enterprise online reputation and the weight is also low.

TABLE III. INFORMATION VALUE AND WEIGHT OF EACH COMPREHENSIVE EVALUATION INDICATOR

Indicator	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Information Value	0.1465	0.1306	0.2798	0.1854	0.1626	0.1429	1.0274	0.5130
Weight	0.0566	0.0505	0.1081	0.0716	0.0628	0.0552	0.3969	0.1982

B. Determine Weight through Entropy Weight Method

Normalization processing is performed to calculate the entropy H_j and weight W of each indicator as shown in table 4. It can be seen from the table that C_4 transaction information among the comprehensive evaluation indicators has the greatest influence on the enterprise online reputation evaluation and has the largest weight of up to 0.1270; it is followed by administrative supervision and management information with a weight of 0.1269. The other information has a relative small impact on enterprise online reputation and the weight is also low.

TABLE IV. ENTROPY AND WEIGHT OF EACH COMPREHENSIVE EVALUATION INDICATOR

Indicator	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Entropy	0.8469	0.8513	0.8471	0.8463	0.8465	0.8510	0.8486	0.8523
Weight	0.1265	0.1229	0.1264	0.1270	0.1269	0.1232	0.1251	0.1220

C. Calculate Comprehensive Weight

Comprehensive weight is calculated according to formula (10) as shown in table 5. It can be seen from the table that honor information, public opinion information and transaction information have a greater impact on enterprise online reputation evaluation after the comprehensive calculation, followed by financial information, administrative supervision and management information, qualification license information, social responsibility information and management information. This result is also in line with the general judgment that enterprise performance behavior and social evaluation information as reflective information have a greater impact on the level of enterprise online reputation.

TABLE V. COMPREHENSIVE WEIGHT OF EACH COMPREHENSIVE INDICATOR

Indicator	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈
AHP Method	0.0566	0.0505	0.1081	0.0716	0.0628	0.0552	0.3969	0.1982
Entropy Method	0.1265	0.1229	0.1264	0.1270	0.1269	0.1232	0.1251	0.1220
Comprehensive method	0.0574	0.0498	0.1096	0.0729	0.0639	0.0545	0.3981	0.1939

D. Calculation Results

It can be concluded that the level of enterprise online reputation is as shown in table 6 by measuring calculating the online reputation evaluation results of each company. Among then, company Q₄ has highest level of online reputation, followed by Q₅, Q₁, Q₆, Q₂ and Q₃; it can be seen from analysis of enterprises with a high level of online reputation that enterprises have high scores in terms of honor information, public opinion information, social responsibility information, transaction information and other reflective indicators. The external performance information is also the main element that affects enterprise online reputation. Therefore, enterprises must strengthen online reputation management and shall pay more attention to the reflective indicators of company in addition to strengthening internal management.

TABLE VI. ONLINE REPUTATION EVALUATION OF EACH ENTERPRISE

Enterprise	Q ₁	Q ₂	Q ₃	Q ₄	Q ₅	Q ₆
Weighted Value	49.4043	41.9874	35.0432	75.2232	55.9634	43.1385

V. CONCLUSION

The level of enterprise online reputation has a more and more far-reaching impact on the survival and development of enterprises in the current network economic environment and even surpasses the impact of brand to a certain extent. Therefore, mastering the main elements that affect enterprise online reputation and thus achieving scientific online reputation management appear to be particularly important. This paper constructs a fuzzy matter-element model by studying and analyzing enterprise online reputation model and evaluation indicator through research and analysis of enterprise online reputation evaluation model and evaluation indicator. The subjective weighting method and objective weighting method are respectively used to calculate to get that the main elements affecting enterprise online reputation level are enterprise honor information, public opinion information, transaction information and other reflective indicators. It provides a scientific reference for enterprises to improve online reputation management level.

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