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Research Article

Evaluate the Operation Risk of Food Producing Enterprises in East China

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Abstract: Food producing enterprises are one important part of pillar industries in China. There are a lot of factors to cause risks which might bring trouble, loss or disaster, so that we ought to manage those risks so as to reduce and avoid those risks, therefore we need to evaluate the risks which could happen. In this study, in order to evaluate the risks of some food producing enterprises in East China which are belong to one large power group, we use literature text content analysis method to analyze a lot of risk exploration reports to build risk evaluation index system and every index' weight, then evaluate risk level for every risk factor with analytic hierarchy process and discuss the risk comprehensive evaluation of enterprises with fuzzy comprehensive evaluation method. According to the result of risk evaluation, the risk status of food producing enterprise in East China is in middle-lower level.

Keywords: Analytic hierarchy process, food producing enterprises, fuzzy evaluation method, risk evaluation

INTRODUCTION

Food producing generation is the important part of electric power energy resources. According to the latest national electric industry annual statistical data published by the China Power Association, until the end of 2011, whole dynamotor capacity of China was 1.056 billion KW, where the percentage of food producing reached 72.5%. Food producing always takes the most proportion of China's electric power industry, therefore, it is significant to research on the operation risk evaluation of food producing Enterprises.

Risk evaluation is an important content of risk management (Chen, 2009). Recently, the research on the risk evaluation of food producing industry has been paid more attention. Li and Qi (2010) and Zhang and Zhou (2008) use AHP to analyze and evaluate water power projects. Jiang (2004) used Monte Carlo simulation method to research investment risk evaluation on wind power projects. Peng and Qiang (2009) uses fuzzy AHP to evaluate the risk of wind power projects. Zhang (2006) analyses the most risks which food producing enterprises undergo and emphasizes on the comparatively important bid risks and maintenance risks. Gao (2009) analyses the existing risks in the operation activities of food producing enterprises and brings forward the advice on the avoidance of risk.

Existing research on the risk evaluation of thermal power, emphasizes more on the prophase investment evaluation, or the evaluation of the market benefit, less on the evaluation of operation risk of electric power enterprises, especially much less to food producing enterprises. In the research on risk evaluation, evaluation index and its weight is the most crucial section. In this study, we will change the previously mostly used expert inquiry questionnaire method and use the more objective and quantitative content analysis method (Chen, 2010) to make sure the evaluation indices and their weights.

In this study, in order to effectively control the operation risk of food producing enterprises, we will use some food producing factories in East China affiliated to a famous electric power group as the application case, using content analysis method to analyze 45 risk exploration reports from 2007-2011 years, to acquire the risk evaluation indices and the relative weights between them and to evaluate the operation risk factors and status of thermal enterprises by AHP method and Fuzzy comprehensive evaluation method (Du *et al*., 2008).

RISK EVALUATION INDEX SYSTEM

We adopt content analysis method and use ATLAS.ti text analysis tool to read, code and analyze the 56 food producing factories' risk exploring reports, finally we get the whole reports of code with which to confirm the index system.

Confirming the first-level index: We consider paragraph as the analysis granularity for the content and code identifier for the every paragraph of every report and name first-level Bi corresponding to the relative paragraph, then we get an concept set B which contains multiple first-level Bi. where, B = {Bi, 0 = <i = <n}, n is the number of paragraphs which have been identified. Then, we adopt formula $B_i \Big/ \sum_{i=0}^{n} B_i$ to compute the frequency of the appearance of first-level index in the

Table 1: Index system of risk evaluation and result of evaluation of risk factor

First-level index B	Weight	Second-level index C	Weight	Hierarchical total sort
Natural risk B1	0.21	Windstorm C11	0.1469	0.0308
		Rainstorm C12	0.2517	0.0529
		Earthquake C13	0.2308	0.0484
		lightning strike C14	0.2028	0.0426
		defiled flashover C15	0.1678	0.0352
Accident B2	0.3	Fire, blast C21	0.4239	0.1272
		drop of objects in the air C22	0.3804	0.1141
		collapse of factories C23	0.1957	0.0587
Management B3	0.12	safety management C31	0.3913	0.047
		Human resource management C32	0.3043	0.0365
		Equipment management C33	0.3043	0.0365
Equipment destroy or hurt B4	0.185	Factitious error operation C41	0.2824	0.0522
		The fault of equipment itself C42	0.1374	0.0254
		design, setup error C43	0.1374	0.0254
		Sudden accident cause C44	0.1298	0.024
		Original material C45	0.1679	0.0311
		Natural damage cause C46	0.145	0.0268
Responsibility risk B5	0.09	Public responsibility C51	0.3229	0.0291
		Food producing supply responsibility C52	0.3125	0.0281
		Vendor responsibility C53	0.3646	0.0328
Other risks B6	0.095	Vehicle's transportation risk C61	0.2763	0.0262
		Theft, damage from outside force C62	0.25	0.0238
		Computer system C63	0.1842	0.0175
		Disloyalty of employees C64	0.1447	0.0137
		Construction risk C65	0.1447	0.0137

all texts, eliminate the concept terms which rarely emerge in the food producing factories of East China area, finally we select natural disaster risk, sudden accidents, management risk, equipment failure and abrasion risk, responsibility risk and other risks.

Confirming the second-level index: We analyze the whole contents of report texts and code identification for the concept terms of risks, those risk concepts are the second-level indices (Ci) we seek. Then we adopt formula 1 to classify and filter the second-level indices:

$$\mathrm{Re}l(i, j) = D_{i,j} \big/ D_i \tag{1}$$

where, D_i represents the numbers of text in the n-text set which has the appearance of first-level index concept i, $D_{i,j}$ represents the numbers of text in the n-text set which simultaneously has the appearance of first-level index concept i and second-level index concept j. Rel represents the importance degree of second-level index concept j with respect to first-level index concept i.

Since formula 1 computes the relation of second-level index concept j to first-level index concept i, we use threshold value to make sure only the most related concepts to be retained. As well as the reference of experts' advices, we set 50% as the threshold value, select the concept j whose value $\mathrm{Re}l(i, j) \geq 0.5$ as the second-level index concept belonging to the first-level index concept i.

Finally, we can get the index system for the risk evaluation, which is listed in the index column of Table 1.

EVALUATION OF RISK FACTORS WITH AHP

While using AHP to solve problems, firstly we have to hierarchy those problems. Then decompose the problem into several different make-up factors on the basis of the problem's quality and the main aim to attain, aggregate those factors according to different levels in terms of the relative effect of factors and subjective relation and constitute a multi-level analysis structure model. Finally we attribute the system analysis to the confirmation of importance weight of the bottom level corresponding to the top level or the sort problem of the comparative good-bad order.

Confirming weight of the comparative importance of every index: We use the combination of content analysis method and AHP to confirm the weight value.

Construct the judgement matrix: After confirming the index of every level with content analysis method, we get the frequency ratio among the first-level index and the frequency ratio of second-level index to its affiliated first-level index, namely Di, j/Di, t, which represents the importance degree of second-level index j and t to first-level index i. After integrating this number, we construct a judge matrix composed of the aimed level-oriented judge values computed by the comparison of every pair of evaluation indices according to the 1-9 scaling method, namely construct 6 judge matrices $C = (Cij)_{nxn}$ for second-level indices and one judge matrix $B = (Bij)_{nxn}$ for first-level indices.

Compute comparative importance degree: Normalize every judge matrix, get the importance degree of every index corresponding to its up-level object.

Table 2: Level partition of operation risk

Risk degree	Weight	Importance degree	Detailed risk
Level I	0.1~1	Highest risk	C21, C22
level II	0.05~0.1	Rather high risk	C12, C23, C41
level III	0.01~0.05	Common risk	C11, C13, C14, C31, C32, C33, C42, C43, C44, C45, C46, C51, C52, C53, C61, C62, C63, C64, C65
level IV	0~0.01	Slight risk	

Coherence test and single-level sort: Because in the process of evaluation, evaluator judges the matrix coarsely, maybe makes the mistake of mutual conflict, even makes the logic mistakes, in order to avoid this kind of problems, we use AHP to test coherence by formula 2:

$$CI = (\lambda_{\max} - n)/(n-1)) \tag{2}$$

In the formula 2, the less the CI value is, the better the coherence of judge matrix get. λ_{max} is the biggest latent root of judge matrix, its value can be computed and obtained by formula 3:

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(CW)_i}{nW_i} \tag{3}$$

In the formula 5, C is the judge matrix for second-level indices, W is the feature vector for judge matrix, it is stated as: $W = [W_1, W_2, \ldots W_n]^T$, the value of Wi can be computed in turn from formula (4), (5), (6):

$$M_i = \prod_{j=1}^{n} c_{ij}, i = 1, 2, \ldots n \tag{4}$$

$$\overline{W}_i = \sqrt[n]{M_i} \tag{5}$$

$$W_i = \overline{W}_i \Big/ \sum_{j=1}^{n} \overline{W}_j \tag{6}$$

After we make sure the judge matrix has satisfactory coherence with the coherence test, the feature vector we compute and obtain is just the weight values of indices for each level, we also get the result for single-level sort, the result is stated as the weight value column in Table 1.

Sorting comprehensive-level for every risk factor: We take turns to compute from the top level to the bottom level along with the ladder-level structure, then we can get the comparative importance degree of the bottom level factor to the top level factor. We use formula 7 to compute and get the weight value of the comprehensive-level order, which is stated in the total sort column in Table 1:

$$\sum_{j=1}^{n} b_j c_{ij} (i = 1, 2, \ldots m) \tag{7}$$

According to Table 1, we can see that the risk of sudden accident is highest, it lies in the top 3 of risk ranking, the next is the natural risk of rainstorm, earthquake, lightning strike and etc, management risk, factitious error operation also should be paid more attention.

In order to be convenient for the management and operation of risk, we partition the risks according to the levels. It often uses 0.1, 0.05, 0.01 as the judge criterion. Here, we choose 4-level and the level partition result is stated as Table 2.

COMPREHENSIVE EVALUATION WITH FUZZY EVALUATION METHOD

The above part evaluated the importance degree of the lowest level of the index factors to the highest level of the target. In order to evaluate the overall risk status of food producing enterprises, we need to do further comprehensive evaluation. Based on the index weight of the above identified evaluation factors, the use of fuzzy comprehensive evaluation method to make a comprehensive evaluation[9].

Confirming membership degree: We use Fuzzy statistics and Delphi method to determine the standard membership degree set U and the reviews set V:

Risk assessment reviews set is: V = {V1, V2 and V3 and V4, V5}

Standard membership degree set is: U = {U1, U2, U3, U4, U5}

where, V1, V2 and V3 and V4, V5 indicate respectively the index of reviews for the "excellent", "good", "", "poor" and "poor", the corresponding degree of risk as "low", "more low "," medium "and" higher "and" high ". U1, U2, U3, U4, U5 corresponding to the standard membership 1.00, 0.75, 0.5, 0.25, 0.00.

Confirming the weights: According to Table 1 shows, we can confirm weights with AHP as follows:

A = (0.21, 0.3, 0.12, 0.185, 0.09, 0.095); A1 = (0.147, 0.252, 0.231, 0.203, 0.148); A2 = (0.424, 0.380, 0.196); A3 = (0.391, 0.304, 0.304); A4 = (0.282, 0.137, 0.130, 0.168, 0.145); A5 = (0.323, 0.313, 0.365); A6 = (0.276, 0.25, 0.184, 0.145, 0.145).

Confirming fuzzy judgment matrix: We invited the 20 power systems experts to mark the questionnaire on the evaluation index system of the second layer of each evaluation factor in accordance with the evaluation set V. Through the collation of the questionnaire, statistical and data processing and normalization we can easily get fuzzy comprehensive evaluation table of the various factors.

We can calculate the value of the fuzzy judgment matrix Ri for every upper factor, Ri is denoted by:

$$R_i = \begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i1n} \\ r_{i21} & r_{i22} & \cdots & r_{i2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{im1} & r_{im2} & \cdots & r_{imn} \end{bmatrix}$$

where, i = 1, ..., 6, m is for number of elements of the comprehensive evaluation index set Bi (that is the number of second-level indexes contained by the first-level index). n is the number of elements in the evaluation set v, that is n = 5.

According to Table 1, which can construct a fuzzy judgment matrix R1, R2, … R6.

Result of comprehensive evaluation: With the index weights and the fuzzy evaluation judgment matrix in above part, we can make a comprehensive evaluation for every level. According to the following formulas to calculate, you can get a comprehensive evaluation vector D:

$$D_i = A_i \circ R_i = (d_{i1}, d_{i2}, d_{i3}, d_{i4}, d_{i5},), (i = 1, 2, \cdots, 6) \quad (8)$$

$$R = [D_1 \quad D_2 \quad \cdots \quad D_6]^t \quad (9)$$

$$D = A \circ R = A \circ \begin{bmatrix} A_1 \circ R_1 \\ A_2 \circ R_2 \\ \cdots \\ A_6 \circ R_6 \end{bmatrix} = (d_1, d_2, d_3, d_4, d_5) \quad (10)$$

Input the weights of factors and the value of the fuzzy evaluation matrix and calculated with the above formula 8, 9, 10, we can calculate the last general evaluation vector D:

$$D = A \circ R = (0.198428, 0.298649, 0.315715, 0.138228, 0.04898)$$

According to the maximum membership degree principle, food producing enterprises in the East China run the risk in the middle-lower level.

CONCLUSION

According to the results of the evaluation, the comprehensive risk of food producing enterprises in East China is in good condition with middle-lower level risk. But we still need to take measures to keep away the accident happened. During the operation of food producing enterprises, we should take the necessary precautionary measures to reduce the probability of occurrence of the risk and reduce losses caused by its occurrence. Especially, we need to pay attention to the risk with higher risk degree, i.e., fire disaster, blast, factitious error operation, etc.

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