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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 11 (4): 484-487, 2012
ISSN 1812-5638 / DOI: 10.3923/itj.2012.484.487

Fuzzy Comprehensive Evaluation on the Selection of Material Management Project Partner

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Abstract: This study introduces a kind of fuzzy comprehensive evaluation method and combined with AHP, puts forward a comprehensive evaluation model for the selection of material management project partner. On that basis, the study utilizes this model in a practical case and verifies the effectiveness of this mode in evaluation of material management project partner.

Key words: Material management, fuzzy comprehensive evaluation, partner

INTRODUCTION

Generally, a large material management project is often offered by a stronger supplier as the general contractor. Then the general contractor organizes itself and some other subcontractors, who are weak in overall strength but are specialized in their own fields, so as to complete the whole project cooperatively (Jie-He, 2003). Thus, for a general contractor, to select suitable project partners, subcontractors, becomes crucial. Before selection, it is necessary to make a scientific comprehensive evaluation to all the partners. But the influencing factors of material management project partners evaluation are multitudinous, involved in both quantitative indexes and qualitative indexes. Even quantitative indexes are due to a variety of subjective and objective reasons can't get the concrete numerical value of index. And there are many indicators of evident fuzziness, no clear criteria. This leads to the project partner evaluation index of fuzziness, uncertainty and difficult to measure. In view of the above reasons, this study tries to use a method of fuzzy comprehensive evaluation which based on the fuzzy mathematical theory for evaluation on the material management project partner selection.

EVALUATION PROCESS

The evaluation process includes: Establishing fuzzy evaluation sets, sure comments level domain, determine evaluation membership matrix, determines the index weight, comprehensive evaluation, result analysis, etc (Crainic *et al*., 2009).

Establish fuzzy evaluation set: According to the existing evaluation index system, construct a fuzzy evaluation set, $U=\{u_1,u_2,u_3,\ldots,u_i\}$, u_i means the ist primary index. And in $u_i=\{u_{i1},u_{i2},\ldots,u_{ij}\}$, u_{ij} means the jst secondary index in the ist primary index.

Make sure comments level domain: Before fuzzy comprehensive evaluation, comments level should be determined. In setting the comments level, the grad of levels usually take the odd number which less than 9 larger than 4. Too many comments levels would make it difficult to determine the discriminatory power of semantic level of economic benefit belongs. On the other hand, too little comments level grads can not meet the quality requirements of fuzzy comprehensive evaluation. And odd number grades will have a middle class, facilitate judgment on partner level.

Make sure evaluation membership matrix: After setting comments grade, the membership rate for enterprise to each index can be judged. Membership rate means the degree of one index belongs to a comment level (Zhong-Bao, 2008). We can use the number of people who choice certain comment level to show it. Under the same level of all the indexes of membership in comments level, it got a fuzzy relation matrix. Select a certain number of experts to constitute the jury, Evaluate factors of the second layer in the evaluation index system. We choice the questionnaire survey and analyze the result to get single-factor fuzzy judgment matrix.

$$R_i=\begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i1n} \\ r_{i21} & r_{i22} & \cdots & r_{i2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{im1} & r_{im2} & \cdots & r_{imn} \end{bmatrix} \quad (1)$$

In the formula, i mean the number of index in first class index; m is the number of target factors concentrated elements; n is the number of evaluation concentration elements.

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Make sure the index weight: In comprehensive evaluation system of material management project partner selection, various factors important degree is not the same, so it is necessary to distribute their weights. In order to overcome the weight coefficient method to determine the indicated existing scientific sent, subjectivity big defects, this study used the Analytic Hierarchy Process (AHP) established the mathematical model for solving the weight of each factor (Yan and Wen-Sheng, 2009). Specific operation process is as follows:

First, determine the evaluation factors judgment matrix. Compare partner comprehensive evaluation factors system factors and child factors and their judgment matrixes can be obtained respectively. For example, binary comparison on factor or child factors, get this matrix:

$$\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \quad (2)$$

This matrix is the judgment matrix of factors or child factors. In the matrix, a_{ij} is listed element and did the value of the elements compare. Its value standard is: Important degree equal value is 1, slightly important is 3, obviously important for 5, very important for 7, extremely important for 9, between two adjacent degrees, respectively 2,4,6,8. Conversely compared, the numbers are the reciprocals of above; those are 1-1/9.

Second, calculating the maximum eigenvalue of judgment matrix and the eigenvectors W of λ_{max}. Normalization of W for later, the value of the corresponding, W_i is representative of the evaluation factors weights or comments relative to a son factors weights of evaluation factors. This can work out management ability U_1, employee ability U_2, production capacity of U_3, financial cost U_4 factors under the weight and their weight.

Third, validate the consistency. Consistency index CR = IC/IR, type: IC (λ_{max-n})/(n-1) (n is for the evaluation factors in number or the number of child factors), IR is the relevant index n order number. If CR <0.10 judgment matrix is satisfactory consistency, or need to adjust judgment matrix.

Fuzzy comprehensive evaluation: By weight vectors and fuzzy relation matrix, make the following comprehensive evaluation:

$$B_i = W_i \circ R_i = (b_{i1}, b_{i2}, b_{i3}, b_{i4}, b_{i5}) \quad (3)$$

$$R = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \\ B_6 \end{bmatrix} \quad (4)$$

$$B = W \circ R = W \circ \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \\ B_6 \end{bmatrix} = (b_1, b_2, b_3, b_4, b_5) \quad (5)$$

In the formula, is the comprehensive evaluation value of subgoal; B is the comprehensive evaluation value of final goal. Mark "$\circ$" said the synthesis operations, generalized. Select a specific computational operation according to the actual situation.

APPLICATION EXAMPLE

Background information: ZSD-XA is a large material circulation enterprises in our country electric power industry, is one of the main supply channels in China's hydropower and thermal power production and construction. In its partner selection of one project (we called project A), ZSD-XA has to choose one from these three companies. Here we call them partner SV, partner DK and partner DF. In these three companies, SV's strength is strong. Now their subsidiaries have branches all over the country. They use advanced materials management information system based on Internet, can integrate storage, transportation, distribution various aspects resources. In the eastern and southern China, they have strong transportation and business network but have no experience on cooperation with construction enterprise. Partner DK long-term bear ZSD-XA in Shanxi area material management programs and they kept the good cooperation relations. DK and ZSD-XA have deeper cooperation relationship, the trust mechanism and customer relations have been better but they don't have advanced information system. Partner DF is a material management company founding not too long. The company has strong financial strength, staff quality level is high but compare to the above two companies, the experience is smaller. So, how to choose a better one? This is a question to ZSD–XA's company leadership group.

Comprehensive evaluation of ZSD-XA's material management project partners: First identify the evaluation index system of material management project partner. Space constraints permit longer write index system construction process. Then determine the index weight, as stated above, use AHP method (Cao and Gao, 2005). According to the characteristic of material management project partners, the evaluation index system and index weight shown in Table 1.

This study make a questionnaire survey to partner SV, DK and DF and make a single factor simulation evaluate aim at the secondary indexes according to Table 1.We select the ZSD-XA company A project team and material management relevant persons as respondents. Comments are divided into five rating. Accordingly, comments sets $V=\{v_1,v_2,v_3,v_4,v_5\}$, v_1 says very satisfied, v_2 satisfied, v_3 general, v_4 says not quiet satisfied, v_5 says not satisfied. Different comment level can reflect different satisfactory level. Through questionnaires recovery, sorting and counting, we can the single-factor fuzzy judgment membership list of partner SV. The list shows in Table 2.

According to index weights in Table 1, we can calculation comprehensive evaluation score.

From formula (3) and $W_1=(0.493,0.507)$, we can get the evaluation vector of team building ability:

$$B_1 = W_1*R_1 = (0.249, 0.449, 0.302, 0, 0)$$

In the same way, ability of team building:

$$B_2 = W_2*R_2 = (0.460, 0.250, 0.290, 0, 0)$$

- **Ability of Project plan:** $B_3=W_3*R_3=$ (0.360, 0.250, 0.290, 0, 0)
- **Ability of Project control:** $B_4=W_4*R_4=$(0.484, 0.308, 0.139, 0.068, 0)
- **Quality level of project:** $B_5=W_5*R_5=$(0.401, 0.266, 0.100, 0.233, 0)
- **Stakeholder satisfaction level:** $B_6=W_6*R_6=$(0.289, 0.406, 0.213, 0.092, 0)
- **High-level support level:** $B_7=W_7*R_7=$(0.414, 0.236, 0.235, 0.115, 0)

According to formula (5), we can get comprehensive evaluation vector:

$$B = W*R = (0.373, 0.335, 0.234, 0.058, 0.000)$$

Because of:

$$\sum_{j=1}^{5} b_j = 1$$

it isn't necessary to normalize.

Table 1: Evaluation indexes weights of ZSD-XA material management project partner

One class index	Weights	Secondary indexes	Weights
Ability of team allocation u_1	0.213	Target recognition level u_{11}	0.493
		Configuration scheme level u_{12}	0.507
Ability of team building u_2	0.173	Target recognition level u_{21}	0.501
		Construction scheme level u_{22}	0.499
Ability of Project plan u_3	0.171	Objectives decomposition level u_{31}	0.498
		Formulate management plan level u_{32}	0.502
Ability of Project control u_4	0.145	Change control level u_{41}	0.336
		Transportation cost u_{42}	0.342
		Management control cost u_{43}	0.322
Quality level of project u_5	0.134	Target accuracy u_{51}	0.337
		Target intact degrees u_{52}	0.332
		Project progress speed u_{53}	0.330
Stakeholder satisfaction level u_6	0.104	Owner satisfaction u_{61}	0.307
		Team member satisfaction u_{62}	0.368
		Project subcontractors satisfaction u_{63}	0.326
High-level support level u_7	0.060	High-level support degrees u_{71}	0.252
		Experience conformity degree u_{72}	0.254
		Team spirit u_{73}	0.248
		Team cooperation system level u_{74}	0.245

Table 2: Partners SV single-factor fuzzy judgment membership

Indexes	V_1	V_2	V_3	V_4	V_5
Target recognition level u_{11}	0.30	0.50	0.20	0	0
Configuration scheme level u_{12}	0.20	0.40	0.40	0	0
Target recognition level u_{21}	0.32	0.30	0.38	0	0
Construction scheme level u_{22}	0.60	0.20	0.20	0	0
Objectives decomposition level u_{31}	0.40	0.30	0.30	0	0
Formulate management plan level u_{32}	0.32	0.40	0.28	0	0
Change control level u_{41}	0.56	0.36	0.08	0	0
Transportation cost u_{42}	0.30	0.36	0.14	0.20	0
Management control cost u_{43}	0.60	0.20	0.20	0	0
Target accuracy u_{51}	0.50	0.20	0.10	0.20	0
Target intact degrees u_{52}	0.40	0.20	0.10	0.30	0
Project progress speed u_{53}	0.30	0.40	0.10	0.20	0
Owner satisfaction u_{61}	0.20	0.30	0.20	0.30	0
Team member satisfaction u_{62}	0.30	0.50	0.20	0	0
Project subcontractors satisfaction u_{63}	0.36	0.40	0.24	0	0
High-level support degrees u_{71}	0.30	0.30	0.24	0.16	0
Experience conformity degree u_{72}	0.42	0.28	0.20	0.10	0
Team spirit u_{73}	0.44	0.16	0.30	0.10	0
Team cooperation system level u_{74}	0.50	0.20	0.20	0.10	0

In order to facilitate comparison results, the judge set V, respectively corresponding score v_1 = 90, v_2 and v_3 = = 80 v_4 = 60, 70, v_5 = 50, so comprehensive score for:

$$V_I = B*V^T = (0.373, 0.335, 0.234, 0.058, 0.000)* (90, 80, 70, 60, 50)^T = 80.228$$

From the result we can see the partner SV between very satisfied and satisfaction. In the same way, composite scores for partners DK is V_{II}=76.346 and composite scores for partners DF is $V_?$=75.062.

See from this, the evaluation of partner SV is better than partner DF and DK. So in further cooperate, should first consideration partners SV as A project partners.

CONCLUSION

This study has introduced the fuzzy comprehension evaluation method based on fuzzy comprehensive

evaluation and its analysis process. Taking the evaluation of ZSD-XA material management as an example, the study carried out the practical application of this method. Has verified the effectiveness of fuzzy comprehension evaluation in the partner selection issue with qualitative factors which difficult to quantify.

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