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Alliance Member Selection for Multi-Enterprises Project —Based on the Collaborative Network Information

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Abstract: The enterprises alliance is an effective combination for the larger project development. Type of enterprises to be selected as alliance is the key to achieve more powerful effect. The multi-index decision making method based on the collaboration network information is used to choose the potential partners of the enterprises development alliance. The priority rating for the partners was made. The linguistic variables were conducted using the triangular fuzzy numbers. The individual partner information and cooperative information were dealt with comprehensively to choose the optimal alliance members.

Keywords: The enterprises alliance; Partner-selection; Collaborative network information; Fuzzy number; Linguistic variable

Introduction

Under the background of economical globalization and fast information technology development, inter-enterprises as well as enterprises internal collaborative network information development is inevitable trend. Decision making via collaborative network information is common in the real world. Cooperation based on the network is one of the most effective methods for optimal configuration of economy resources, technology resources, and productivity factors and know lodge innovation. Up to now, the importance of collaborative network information has already drawn attention of scholars. Since 1990s, cooperation between enterprises increases by 25% every year. More than 60% of enterprises in Japan rely on external technical resources. In Australia, more than half of the research fund is invested into external technical resources. Innovation survey in European community shows that only few enterprises or organizations carry on innovation independently. Actually, most of the innovation projects were done by several organizations[2]. Therefore, network organization is known as most effective organization mode[3] in the 21st century.

However, few researches is done regarding how to make decision analysis based on collaborative network information and then work out scientific solutions. This paper studies alliance member selection based on individual member evaluation and collaborative evaluation information, offering multi-index decision making method based on the fuzzy set theory alliance selection. First transfer individual member information and collaborative information into triangular fuzzy number, which will be mapped as clear number, and then collect information and make member priority order.

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1. Multi-index decision making method based on the alliance network information

Selection of alliance member does not only consider individual information, but also considers collaborative information between members. Failure for strategic alliance may due to several reasons, but the root cause is the improper cooperation condition between main parties of collaborative network. Collaborative network organizations have complementary advantages, through proper cooperation between network main parties; they achieve "1+1>2" collaborative efficiency[4] that can not be achieved by single party.

Evaluation index in this paper is indicated in forms of linguistic evaluation (Language phrases)[4]. Linguistic variable is able to deal with the situation where definition is difficult to be made in the qualitative description. In order to further process linguistic variables given by expert, this paper transfer linguistic variables to fuzzy number for analysis. Triangular fuzzy number will be used for specific analysis.

Many researchers did studies for alliance member selection index. For example, Verma and Pullman made priority order for supplier partnership. The order is quality, timeliness, cost, delay time and flexibility[5].

Indexes given by Emden includes technical abilities, complementary resources, overlapped knowledge, unity of motivation, consistency of goal, harmony culture, long term cooperation intention[6].

Evaluation system for individual performance and complementary cooperation performance includes two types of indexes: one is individual performance; another one is collaborator index. Individual index reflects advantage of individual performance and cooperation performance shows the cooperation relationship between parties.

2. Alliance member selection mode in multi-enterprises complex project based on collaborative network information

2.1 Fuzz number formula

A Triangle fuzz number $\hat{A} = (d^L, d^M, d^R)$, its membership function is as follows, [7-9] :

$$\mu_{\hat{A}}(x) = \begin{cases} 0, x < d^L, \\ (x - d^L)/(d^M - d^L), d^L \le x \le d^M \\ (d^L - x)/(d^R - d^M), d^M \le x \le d^R \\ 0, x > d^L, \end{cases}$$

In which, d^L, d^M, d^R is real number, it satisfies $d^L \le d^M \le d^R$. Random two triangle fuzz number $\tilde{A}_1 = (d_1^L, d_1^M, d_1^R)$ and $\tilde{A}_2 = (d_2^L, d_2^M, d_2^R)$ is two positive triangle fuzz number, its addition and multiplication rule are: $\tilde{A}_1 \oplus \tilde{A}_2 = (d_1^L + d_2^L, d_1^M + d_2^M, d_1^R + d_2^R)$ $\tilde{A}_1 \otimes \tilde{A}_2 \cong (d_1^L d_2^L, d_1^M d_2^M, d_1^R d_2^R)$ $k \otimes \tilde{A} = (kd^L, kd^M, kd^R)$, $k > 0$ is clear number.

In the formula, symbol "$\oplus$" and "$\otimes$" indicates addition and multiplication of triangle fuzz number.

2.2 Conversion of Linguistic variables

Value of linguistic variable is a language phrases. Under normal condition, exact information is difficult to be determined and then linguistic variable is needed for evaluative description.

We assume language phrases set is $S=\{S_r|r=1,\cdots,g\}$. In $S_r \in S$ is No. r language phrase. S is a preset orderly language phrase set which consists of odd number of elements. Depending on the case to be studied, we assure language phrases set consist of 7 language phrases, *i.e.* S = { S_0 = *DL* (very low), S_1 = *VL* (ow), S_3 = *M* (normal), S_4 = *H* (high), S_5 = *VH*(quite high), S_6 = *DH* (very high) } .

First convert language variables to triangle fuzz number[10-12]. Language variable $S_r(S_r \in S)$ may be shown in the following triangle fuzz number formula[13]:

$\hat{d}=(d^L,d^M,d^R)=\left(\max\left\{\frac{r-1}{6},0\right\},\frac{1}{6},\min\left\{\frac{r+1}{6},1\right\}\right)$ In which, $r=0,1,\cdots,6$. According to above stated formula, correspondence relationship of language variable and triangle fuzz No. is as follows:

Table 2.1 language variable and correspondent triangle fuzz No.

Language variable	Triangle fuzz No.
Definitely Low(DL)	(0,0,0.17)
Very Low(VL)	(0,0.17,0.33)
Low(L)	(0.17,0.33,0.5)
Medium (M)	(0.33,0.5,0.67)
High(H)	(0.5,0.67,0.83)
Very High(VH)	(0.67,0.83,1)
Definitely High(DH)	(0.83,1,1)

2.3 Mode establishment

2.3.1 Symbol meaning

1) $S=\{S_r|r=1,\cdots,g\}$, in which $S_r \in S$ is No. r language phrase. S is a preset orderly language phrase set which consists of odd number of elements. In this article, it represents language evaluation information given by expert for alliance member index.

2) $E=\{E_k|k=1,\cdots;l;l\geq 2\}$, in which E is an expert group with limit numbers. E_k is No.K expert invited to made selection of members. Here, we assume experts are of same importance.

3) $P=\{P_h|h=1,\cdots,q;q\geq 2\}$, symbolizes candidate member group with limited numbers. P^* is initiator. Since initiator of course is selected, so it is not included in the Set P.

4) $I=\{I_i|i=1,\cdots,m\}$ and $C=\{C_j|j=1,\cdots,n\}$ are individual index set and collaborative index set respectively, in which, I_i stands for No. i individual index，C_j represents No. j collaborative index.

5) $\widetilde{W}_k=(\widetilde{w}_{1k},\widetilde{w}_{2k},\cdots;\widetilde{w}_{ik})$ and $\widetilde{V}_k=(\widetilde{v}_{1k},\widetilde{v}_{2k},\cdots;\widetilde{v}_{jk})$, we assume index weight vector of individual elevation and that of collaborative vector is $\widetilde{W}_k$ and $\widetilde{V}_k$. In which, $\widetilde{w}_{ik}$ and $\widetilde{v}_{jk}$ are index weight vector of individual index I_i and

collaborative index C_j, $\tilde{w}_{ik}, \tilde{w}_{jk} \in S$.

6) $D_k = [\tilde{d}_{hik}]_{q\times m}$, $k = 1,\cdots,l$. It is expression form of individual information matrix given by expert E_k. $\tilde{d}_{hik}$ is language evaluation information for individual performance of candidate given by expert E_k. $\tilde{d}_{hik} \in S$.

7) Vector $\tilde{X}_{jk} = \left(\tilde{x}_{11jk}, \tilde{x}_{22jk}, \cdots, \tilde{x}_{qqjk}\right)^T$ means collaborative information between initiator and candidates. In which, x_{hhjk} is language evaluation information of collaborative performance between initiator P^* and candidate P_h given by expert E_k based on collaborative index. $x_{hhjk} \in S$, $j = 1,\cdots,n$, $k = 1,\cdots,l$, $h = 1,\cdots,q$.

8) $\tilde{Y}_{jk} = [\tilde{y}_{hfik}]_{q\times q}$, $j = 1,\cdots,n$; $k = 1,\cdots,l$; $h, f = 1,\cdots,q$; $h \neq f$. It stands for collaborative matrix of collaborative information between any two of the candidate members. In which, $\tilde{y}_{hfjk}$ is language evaluation information, given by expert E_k based on collaborative index C_j, for collaborative performance between candidate members P_h and P_f, $\tilde{y}_{hfjk} \in S$.

9) Vector $\tilde{X}_{jk} = \left(\tilde{x}_{11jk}, \tilde{x}_{22jk}, \cdots, \tilde{x}_{qqjk}\right)^T$ means collaborative information between initiator and candidate member. In which, x_{hhjk} symbolizes language evaluation information for collaborative performance of initiator P^* and candidate P_h given by expert based on collaborative index C_j.

2.3.2 Mode calculation

First invite experts from relevant field to acquire language evaluation vector individual index weight vector $\tilde{W}_k = (\tilde{w}_{1k}, \tilde{w}_{2k}, \cdots, \tilde{w}_{mk})$ and collaborative index weight vector $\tilde{V}_k = (\tilde{v}_{1k}, \tilde{v}_{2k}, \cdots, \tilde{v}_{nk})$ as well as individual evaluation matrix $\tilde{D}_k = [\tilde{d}_{hik}]_{q\times m}$ and collaborative matrix $\tilde{C}_{jk} = [\tilde{c}_{hfjk}]_{q\times q}$. Then, convert $\tilde{w}_{ik}$, $\tilde{v}_{jk}$, $\tilde{d}_{hik}$ and $\tilde{c}_{hfjk}$ to triangle fuzz number, *i.e.*, $\hat{w}_{ik} = (w_{ik}^L, w_{ik}^M, w_{ik}^R)$, $\hat{v}_{jk} = (v_{jk}^L, v_{jk}^M, v_{jk}^R)$, $\hat{d}_{hik} = (d_{hik}^L, d_{hik}^M, d_{hik}^R)$, $\hat{c}_{hfjk} = (c_{hfjk}^L, c_{hfjk}^M, c_{hfjk}^R)$. Through the formula, $i = 1,\cdots,m.$ and $\hat{d}_{hi} = (1/l)\otimes[\hat{d}_{hi1} \oplus \hat{d}_{hi2} \oplus \cdots \oplus \hat{d}_{hil}]$, $h = 1,\cdots,q; i = 1,\cdots,m,$ calculate individual index vect $\hat{w}_i = (1/l)\otimes[\hat{w}_{i1} \oplus \hat{w}_{i2} \oplus \cdots \oplus \hat{w}_{il}]$ or in the set $\hat{W} = (\hat{w}_1, \hat{w}_2, \cdots, \hat{w}_m)$ and individual performance evaluation matrix in the set $\hat{D} = [\hat{d}_{hi}]_{q\times m}$. Relate matrix D to vector W, we get comprehensive individual performance vector $\hat{D}_{ind} = (\hat{d}_1, \hat{d}_2, \cdots \hat{d}_q)$, in

which $\hat{d}_h$ represents individual comprehensive evaluation value of candidate member P_h, *i.e.* $\hat{d}_i = (1/m) \otimes [(\hat{d}_{h1} \otimes \hat{w}_1) \oplus (\hat{d}_{h2} \otimes \hat{w}_2) \oplus \cdots \oplus (\hat{d}_{hm} \otimes \hat{w}_m)]$, $h = 1, \cdots, q$.

Use the same method to calculate collaborative index vector in the set $\hat{V} = (\hat{v}_1, \hat{v}_2, \cdots, \hat{v}_n)$ and collaborative performance evaluation matrix in the set $\hat{C}_j = [\hat{c}_{hfj}]_{q \times q}$. Relate collaborative evaluation matrix $\hat{C}_1, \hat{C}_2, \cdots, \hat{C}_n$ to collaborative index vector $\hat{V} = (\hat{v}_1, \hat{v}_2, \cdots, \hat{v}_n)$, we get comprehensive collaborative evaluation matrix, in which, $\hat{c}_{hf}$ stands for comprehensive evaluation value for collaborative performance between candidate P_h and $\hat{C} = [\hat{c}_{hf}]_{q \times q}$ P_f, *i.e.*

$\hat{c}_{hf} = (1/n) \otimes [(\hat{c}_{hf1} \otimes \hat{v}_1) \oplus (\hat{c}_{hf2} \otimes \hat{v}_2) \oplus \cdots \oplus (\hat{c}_{hfn} \otimes \hat{v}_n)]$, $h, f = 1, \cdots, q$ this index reflects collaborative performance information of candidates, which constitutes comprehensive evaluation matrix $\hat{C} = [\hat{c}_{hf}]_{q \times q}$.

Considering preference degree of decision maker for different individual performance and collaborative performance, we invent 2 importance factors α and β, for individual performance and collaborative performance. When $\alpha + \beta = 1$; $0 \le \alpha, \beta \le 1$, comprehensive performance evaluation value for candidate member P_h can be calculated by the following formula:

$\hat{\varphi}_h = \alpha \hat{d}_h + \beta \hat{c}_h$, $h = 1, \cdots, q$,

In which, $\hat{\varphi}_h$ is a triangle fuzz number, when $\hat{\varphi}_h = (\lambda_h^L, \lambda_h^M, \lambda_h^R)$, element λ_h^L, λ_h^M and λ_h^R can be calculated through the following formula:

$\lambda_h^L = \alpha d_h^L + \beta c_h^L$, $h = 1, \cdots, q$,

$\lambda_h^M = \alpha d_h^M + \beta c_h^M$, $h = 1, \cdots, q$,

$\lambda_h^R = \alpha d_h^R + \beta c_h^R$, $h = 1, \cdots, q$,

The following formula can reflect $\hat{\varphi}_h$ into a clear number,

$$\varphi_h^{def} = L + \frac{\Delta[(\lambda_h^M - L)(\Delta + \lambda_h^R - \lambda_h^M)^2 (R - \lambda_h^L) + (\lambda_h^R - L)^2 (\Delta + \lambda_h^M - \lambda_h^L)^2]}{(\Delta + \lambda_h^M - \lambda_h^L)(\Delta + \lambda_h^R - \lambda_h^M)^2 (R - \lambda_h^L) + (\lambda_h^R - L)(\Delta + \lambda_h^M - \lambda_h^L)^2 (\Delta + \lambda_h^R - \lambda_h^M)]}$$ in which, $L = \min\{\lambda_1^L, \lambda_2^L, \cdots, \lambda_q^L\}$, $R = \max\{\lambda_1^R, \lambda_2^R, \cdots, \lambda_q^R\}$, $\Delta = R - L$. Based on the comprehensive evaluation value φ_h^{def}, candidate priority list can be made to select ideal alliance partners.

3. Application of Selection model for choosing Enterprises Alliance Member

We select project-involved experts through the expert data base – experts shall be representative in the industry, and

then get linguistic evaluation information through individual index and cooperative index given by experts. Process the evaluation using Fuzzy Triangular Function to obtain triangle function for scientific calculation, and then through cooperative network model calculate comprehensive cooperative performance and make alliance member structure and priority listing.

3.1 Determine alliance member candidate

For determining those potential parties for multi-firm (project) project construction that will have more influence on project construction or are more likely to form ideal partners to achieve complementation of core competitiveness advantage, sharing of resources, lowering project construction risks, and finding optimal partner, now 5 experts (E_1, E_2, E_3, E_4, and E_5) are invited to give individual index and cooperation index on the potential allies for linguistic assessment, provided that these 5 experts are of equal importance.

Now 3 alliance partners are to be chosen out of 7 candidates. Basic information of these 7 candidates is shown in *Table 3.1*.

Table 3.1 Basic information of candidate member

Code	Candidate Enterprise	Since	Employee Nos.	Sale at 2012 /Million
1	P1	1998	196	78.5
2	P2	2003	90	17.9
3	P3	1990	12000	1808
4	P4	1998	542	78.2
5	P5	1993	1349	400.6
6	P6	2002	2980	512.8
7	P7	1995	6817	1682

3.2 Member selection criteria and language evaluation variable

(1) Individual criteria: Capital(I_1), management (I_2). Technical ability(I_3) Equipment level (I_4). Cooperative criteria: Company culture(C_1) Resources complementary (C_2) Uniformity of target (C_3) Overlapped knowledge(C_4)

3.3 Criteria importance and language variable given by expert

See *table 3.2-3.6* for criteria importance, individual criteria evaluation, and language variable for cooperative criteria evaluation is as follows.

Table 3.2 Index weight vector given by expert

Expert	Individual index				Cooperative index				
	I_1	I_2	I_3	I_4	C_1	C_2	C_3	C_4	C_5
E_1	DH	VH	VH	H	VH	DH	H	VH	VH
E_2	H	VH	VH	M	DH	DH	H	VH	H
E_3	DH	H	DH	H	DH	DH	VH	VH	H
E_4	DH	M	VH	DH	DH	DH	H	H	VH
E_5	DH	M	H	M	DH	VH	H	H	H

Table 3.3 Individual index evaluation information given by expert

Expert	Company	Individual index			
		I_1	I_2	I_3	I_4
E_1	P_1	M	H	M	VH
	P_2	DL	DH	M	VH
	P_3	DL	M	L	VH
	P_4	DL	VL	M	L
	P_5	H	M	DH	M

	P_6	M	L	M	DH
	P_7	DH	VL	H	M
E_2	P_1	L	VH	VL	M
	P_2	H	M	VL	L
	P_3	M	L	H	M
	P_4	L	H	VL	VH
	P_5	VH	H	VH	L
	P_6	H	VL	DL	M
	P_7	VH	M	VL	H
E_3	P_1	DL	DH	M	H
	P_2	L	DH	H	M
	P_3	H	VH	M	L
	P_4	H	M	L	M
	P_5	H	VH	M	VH
	P_6	VL	M	H	VL
	P_7	M	L	VH	DH
E_4	P_1	M	L	H	DH
	P_2	VH	H	M	M
	P_3	VL	H	VL	H
	P_4	M	L	DL	M
	P_5	M	DH	L	M
	P_6	H	VH	L	M
	P_7	H	DL	DL	M
E_5	P_1	H	M	L	M
	P_2	M	L	DL	H
	P_3	L	M	DL	L
	P_4	VL	M	L	H
	P_5	L	VL	H	H
	P_6	L	M	DL	VH
	P_7	L	H	VL	H

Table 3.4 Cooperative index evaluation information given by expert E_1

		P_1	P_2	P_3	P_4	P_5	P_6	P_7
C_1	P_1	H	M	H	VL	L	H	DH
	P_2	M	L	DH	M	VL	L	VL
	P_3	H	DH	VH	H	M	VH	M
	P_4	VL	M	H	M	DL	M	H
	P_5	L	VL	M	DL	M	H	L
	P_6	H	L	VH	M	H	H	VL
	P_7	DH	VL	M	H	L	VL	VH
C_2	P_1	M	L	H	M	DH	VL	M
	P_2	L	M	M	DH	L	H	DL
	P_3	H	M	VH	VH	H	L	DL
	P_4	M	DH	VH	M	M	VL	H
	P_5	DH	L	H	M	L	VH	M
	P_6	VL	H	L	VL	VH	VH	L

	P_7	M	DL	DL	H	M	L	VH
	P_1	H	H	M	L	DL	H	VL
	P_2	H	L	L	DL	M	L	VH
	P_3	M	L	H	H	M	VH	DH
C_3	P_4	L	DL	H	M	VL	H	M
	P_5	DL	M	M	VL	VL	DH	L
	P_6	H	L	VH	H	DH	M	H
	P_7	VL	VH	DH	M	L	H	H
	P_1	H	VL	VH	M	DL	H	M
	P_2	VL	M	M	VH	VL	H	L
	P_3	VH	M	VH	DH	H	VL	VH
C_4	P_4	M	VH	DH	L	M	L	H
	P_5	DL	VL	H	M	M	VL	M
	P_6	H	H	VL	L	VL	VH	VL
	P_7	M	L	VH	H	M	VL	M
	P_1	L	DH	M	L	VH	M	DH
	P_2	DH	H	M	VH	DL	H	VL
	P_3	M	M	M	L	DL	M	VH
C_5	P_4	L	VH	L	H	VL	H	M
	P_5	VH	DL	DL	VL	L	DL	DH
	P_6	M	H	M	H	DL	H	VH
	P_7	DH	VL	VH	M	DH	VH	DH

Table 3.5 Cooperative index evaluation information given by expert E_2

		P_1	P_2	P_3	P_4	P_5	P_6	P_7
	P_1	M	M	H	DH	L	M	VL
	P_2	M	L	M	L	VL	DH	M
	P_3	H	M	H	L	H	M	VH
C_1	P_4	DH	L	L	M	VH	L	M
	P_5	L	VL	H	VH	L	M	DL
	P_6	M	DH	M	L	M	H	H
	P_7	VL	M	VH	M	DL	H	DH
	P_1	M	L	M	VL	H	DH	VL
	P_2	L	VL	H	L	DL	VH	M
	P_3	M	H	H	VL	M	VH	L
C_2	P_4	VL	L	VL	M	VL	L	DH
	P_5	H	DL	M	VL	L	H	VL
	P_6	DH	VH	VH	L	H	H	M
	P_7	VL	M	L	DH	VL	M	M
	P_1	L	VL	M	H	DL	M	VH
	P_2	VL	L	VH	L	M	H	VL
	P_3	M	VH	DH	DH	VH	L	H
C_3	P_4	H	L	DH	M	M	H	M
	P_5	DL	M	VH	M	L	L	VH
	P_6	M	H	L	H	L	H	DL
	P_7	VH	VL	H	M	VH	DL	M
C_4	P_1	H	M	H	DL	VL	H	VH

	P_2	M	M	M	VL	H	DL	M
	P_3	H	M	M	H	L	DH	VH
	P_4	DL	VL	H	H	M	VH	DL
	P_5	VL	H	L	M	L	L	L
	P_6	H	DL	DH	VH	L	M	VL
	P_7	VH	M	VH	DL	L	VL	DH
C_5	P_1	M	VL	H	M	VL	L	M
	P_2	VL	H	M	VH	DL	H	VL
	P_3	H	M	H	H	M	DH	L
	P_4	M	VH	H	L	H	DL	VL
	P_5	VL	DL	M	H	M	VL	M
	P_6	L	H	DH	DL	VL	DH	DH
	P_7	M	VL	L	VL	M	DH	H

Table 3.6 Cooperative index evaluation information given by expert E_3

		P_1	P_2	P_3	P_4	P_5	P_6	P_7
C_1	P_1	H	M	VH	VL	M	L	VL
	P_2	M	L	DL	M	VH	M	DH
	P_3	VH	DL	DH	DH	L	VH	M
	P_4	VL	M	DH	M	VL	M	H
	P_5	M	VH	L	VL	L	DL	DL
	P_6	L	M	VH	M	DL	H	H
	P_7	VL	DH	M	H	DL	H	DH
C_2	P_1	H	DL	H	L	VL	VH	M
	P_2	DL	M	VH	H	L	DH	VL
	P_3	H	VH	DH	DH	L	H	VL
	P_4	L	H	DH	M	H	M	DH
	P_5	VL	L	L	H	L	VL	M
	P_6	VH	DH	H	M	VL	VH	L
	P_7	M	VL	VL	DH	M	L	VH
C_3	P_1	M	H	M	DL	VL	M	H
	P_2	H	M	DH	DL	VH	L	VL
	P_3	M	DH	H	L	H	M	DH
	P_4	DL	DL	L	H	M	VH	M
	P_5	VL	VH	H	M	H	H	VH
	P_6	M	L	M	VH	H	H	L
	P_7	H	VL	DH	M	VH	L	VH
C_4	P_1	L	L	DH	M	VL	VH	H
	P_2	L	M	M	H	L	L	VL
	P_3	DH	M	H	DH	DL	H	VH
	P_4	M	H	DH	M	VH	VL	DL
	P_5	VL	L	DL	VH	M	DL	L
	P_6	VH	L	H	VL	DL	VH	M
	P_7	H	VL	VH	DL	L	M	VH
C_5	P_1	M	H	DH	VL	DL	H	VL
	P_2	H	L	L	M	H	DL	M

	P_3	DH	L	M	DH	M	M	H
	P_4	VL	M	DH	M	VL	H	VH
	P_5	DL	H	M	VL	L	VL	H
	P_6	H	DL	M	H	VL	H	DH
	P_7	VL	M	H	VH	H	DH	M

Table 3.7 Cooperative index evaluation information given by expert E_4

		P_1	P_2	P_3	P_4	P_5	P_6	P_7
	P_1	L	L	DH	M	VL	H	L
	P_2	L	M	VL	H	M	DL	VH
	P_3	DH	VL	VL	VH	H	VH	L
C_1	P_4	M	H	VH	H	DL	H	VL
	P_5	VL	M	H	DL	VL	M	M
	P_6	H	DL	VH	H	M	H	DH
	P_7	L	VH	L	VL	M	DH	DH
	P_1	L	H	VH	M	DL	M	VL
	P_2	H	M	L	M	VL	H	M
	P_3	VH	L	VL	VH	M	VH	DH
C_2	P_4	M	M	VH	H	L	L	M
	P_5	DL	VL	M	L	VL	VL	L
	P_6	M	H	VH	L	VL	H	VH
	P_7	VL	M	DH	M	L	VH	DH
	P_1	M	H	VH	M	DL	H	L
	P_2	H	M	H	VL	M	DH	L
	P_3	VH	H	L	DH	M	L	VH
C_3	P_4	M	VL	DH	H	VL	M	DH
	P_5	DL	M	M	VL	L	DL	M
	P_6	H	DH	L	M	DL	VH	VL
	P_7	L	L	VH	DH	M	VL	H
	P_1	M	L	VH	M	L	VL	M
	P_2	L	M	H	L	DL	H	DH
	P_3	VH	H	M	M	H	DH	L
C_4	P_4	M	L	M	M	DL	H	VL
	P_5	L	DL	H	DL	M	L	M
	P_6	VL	H	DH	H	L	VH	L
	P_7	M	DH	L	VL	M	L	VH
	P_1	M	L	VH	L	M	VL	M
	P_2	L	L	H	VL	H	M	VH
	P_3	VH	H	M	DH	VL	VH	M
C_5	P_4	L	VL	DH	H	L	H	DL
	P_5	M	H	VL	L	H	DL	L
	P_6	VL	M	VH	H	DL	M	M
	P_7	M	VH	M	DL	L	M	M

Table 3.8 Cooperative index evaluation given by expert E_5

		P_1	P_2	P_3	P_4	P_5	P_6	P_7
C_1	P_1	M	VL	VH	M	DL	H	DL

	P_2	VL	M	M	H	H	VL	M
	P_3	VH	M	DH	DH	VL	VH	L
	P_4	M	H	DH	M	VH	L	VH
	P_5	DL	H	VL	VH	L	VL	H
	P_6	H	VL	VH	L	VL	H	DL
	P_7	DL	M	L	VH	H	DL	H
C_2	P_1	M	M	L	DH	VL	H	L
	P_2	M	M	DH	M	H	VL	M
	P_3	L	DH	DH	H	VL	M	DH
	P_4	DH	M	H	M	M	VH	VL
	P_5	VL	H	VL	M	L	H	VH
	P_6	H	VL	M	VH	H	H	VL
	P_7	L	M	DH	VL	VH	VL	VH
C_3	P_1	M	L	H	DL	L	VL	M
	P_2	L	M	DH	VH	VL	DL	L
	P_3	H	DH	DH	VH	M	VH	M
	P_4	DL	VH	VH	H	H	M	H
	P_5	L	VL	M	H	L	VL	L
	P_6	VL	DL	VH	M	VL	H	DH
	P_7	M	L	M	H	L	DH	H
C_4	P_1	L	M	DH	VH	M	L	DL
	P_2	M	H	DL	M	H	VL	DH
	P_3	DH	DL	H	VL	L	H	M
	P_4	VH	M	VL	H	DH	M	VL
	P_5	M	H	L	DH	M	M	DL
	P_6	L	VL	H	M	M	VH	VH
	P_7	DL	DH	M	VL	DL	VH	VH
C_5	P_1	H	H	DH	L	VL	H	DL
	P_2	H	L	M	VL	DL	L	H
	P_3	DH	M	H	M	VL	DH	M
	P_4	L	VL	M	M	VL	H	VH
	P_5	VL	DH	VL	VL	DL	DL	L
	P_6	H	L	VH	H	DL	M	DH
	P_7	DL	H	M	VH	L	DH	DH

3.4 Determine clear value and comprehensive performance of members

P	C_h			d_h		
	L	M	R	L	M	R
P_1	0.21	0.39	0.59	0.22	0.41	0.62
P_2	0.21	0.39	0.59	0.22	0.40	0.60
P_3	0.31	0.52	0.72	0.17	0.33	0.53
P_4	0.24	0.43	0.62	0.14	0.30	0.50
P_5	0.16	0.31	0.51	0.27	0.48	0.68
P_6	0.25	0.45	0.65	0.18	0.35	0.54
P_7	0.25	0.44	0.64	0.22	0.40	0.59

4. Conclusion

When α=0.2, β=0.8, value of candidate member is as shown in the *table 4.1*.

α	β	φ_h^{def}	
0.2	0.8	P_1	0.4035
		P_2	0.3981
		P_3	0.4753
		P_4	0.4074
		P_5	0.3595
		P_6	0.4291
		P_7	0.4336

Order of candidate member is *P5 < P2 < P1 < P4 < P6 < P7 < P3*. If enterprise manager pay more attention to the cooperation level between enterprises, P3, P7 and P6 can be taken as priority.

Through sensitivity analysis with different values of α and β, according to enterprise strategic target, based on preference of individual performance or cooperative performance, managers can select ideal alliance member.

Reference

1. Zhang Ailing. 1999. Enterprises Entering strategic alliance era [J]. Management Method of China and Other Countries (2): 25-26.
2. Robert E B.1995. Benchmarking the strategic management of technology [J]. Research Technology Management, 38(1): 44-46
3. Li Peilin, Liang Dong, 2003. Networked: New trend of Company Changes [J]. Social studies, 18 (2): 43-53
4. Fan Zhiping, Fengbo. 2009. Multi-index decision making method based on the network information [M].Beijing: science press
5. Verma R, Pullman M E. An analysis of the supplier selection process [J]. Omega, 1998, 26(6): 739-750
6. Emden Z, Calantone R J,Droge C. Collaborating for new product development; selecting the partner with maximum potential to create value [J]. The Journal of Product Innovation Management, 2006(23): 330-341.
7. Lin C J, Wu W W. A causal analytical method for group decision-making under fuzzy environment [J]. Expert Systems with Application.2008.
8. Bonissone P P, Decker KS. Selecting uncertainty calculi and granulary: An experiment in trading-off precision and complexity[C]. Uncertainty in Artficial Intelligenc, Kanal. L H and LemmerJ Fds.Amsterdam, The Netherlands: North-Holland. 1986.
9. Sonbaty Y E, Ismail M A.Fuzzy Clustering for symbolic data[J]. IEEE Transactions on Fuzzy System, 1998, 6(2): 195-201.
10. Kalyani M, Sushmita M. clustering and its validation in a symbolic framework[J]. Pattern Recognition Letters, 2003, 24(14): 2367-2376.
11. Yang Xubiao, Gao Yingyi.Fuzz mathematics and application [M]. Guangzhou: South China University of Technology, 2002.
12. Delgado M, Verdegay J L, Vila M A. A model for linguistic partial information in decision making problems[J]. International Journal of Intelligent System, 1994, 9(3): 365-378.
13. Jiang Y P, Fan Z P, Ma J.2008. A method for group decision making with multi-granularity linguistic assessment information [J]. Information Sciences, 2008, 178(4): 1098-1109.