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Evaluating Strategic Leadership based on the Method of Fuzzy Analytic Network Process

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Abstract: We apply the method of Fuzzy Analytic Network Process (ANP-Fuzzy) to evaluate strategic leadership, because its indexes are complex, inter-relationship, and fuzzy. First, construct indexes system of strategic leadership ,which constitutes of personal abilities and organizational abilities. Second, interpret the fitness of ANP-Fuzzy for strategic leadership and the method's implication steps of ANP structure, pairwise comparisons and priority vectors, super matrix formation and transformation, and fuzzy evaluation. Final, design ANP structure of strategic leadership , calculate priorities, and analyse empirically strategic leadership of candidates for promotion by fuzzy evaluation. Results show that the method is feasible, because it can get not only the whole status of strategic leadership but also of personal abilities and organizational abilities, which gives significant decision support.

Keywords: Fuzzy Analytic Network Process (ANP-Fuzzy), evaluate, strategic leadership

1 Introduction

Competition in the ages of global economy is more complex, changing more quickly, more unpredictable, brings more and greater new challenges to organization management, which means more threats and simultaneously more opportunities. Strategic leadership plays vital role for organizations dealing with variations and retaining competitive advantages[1,2]. For organizations, effective strategic leadership can help them adapt better to new environment[3], so that they may improve performance and enhance competitive power in turbulent environments. And evaluating strategic leadership of persons are significant for choosing leaders or understanding their advantages and disadvantages of strategic leadership to mend the capacity, organizations to adapt themselves better to environment.

There is comparatively a rich body of literature on strategic leadership concept or type[4,5,6], and its effect or path[7,8,9], while research on assessing strategic leadership is scant. Drawing on related literature, we discuss the concept of strategic leadership and construct the indexes system. Then describe the method of fuzzy analytic network process (ANP-Fuzzy), present the empirical analysis procedure and conclude with

discussion about ANP-Fuzzy evaluating strategic leadership.

2 Indexes System

Strategic leadership focuses on executives who have overall responsibility for an organization[10]. As the top leaders of organization, they must establish a strategy by properly analysing the interior and exterior environment in which the organization exists, implement the right strategy at the right time, evaluate and act the appropriate behavior that is suitable for the current environment. The activities associated with strategic leadership means the leaders should have some strategic qualities that related with personal style[11]. Especially in the circumstances where the change is experience rapidly and the completion lasts around the world, strategic leadership ability becomes a necessity.[9]

Basic responsibility of the top leaders is all about the existence of the organization and maintenance of its competitive advantage by definition. So forward-looking, directive ability and features matter.[12]That is, strategic leaders should have not only personal abilities but also organizational abilities.[13,14]

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The personal abilities show that the essence of strategic leadership is the creation and maintenance of strategic thinking, absorptive capacity, adaptive capacity and managerial wisdom. Strategic thinking refers to thinking in a long run and not content with the existing conditions[15]. If the top leader has not a competence in strategic thinking, they would be unable even to see the need to change direction[16]. Absorptive capacity refers to the ability to learn, mainly involving the capacity to recognize new information, assimilate it and apply it to new circumstance. Adaptive capacity refers to the ability to change. In turbulent environment, organizational success depends upon strategic flexibility, because it allows for the attainment of performance goal and the options to take advantage of future opportunities. And the strategic flexibility derives from the top leaders, so they must have ability to be adapted to change. Wisdom refers to abilities to come up with ideas, make a decision, influence others or balance interest, and so on. In a word, wisdom is the capacity to take the right action at the right time and place.

The organizational abilities include five indexes as follows. Strategic focusing[17] is the ability to be strategically oriented, making the leader link visions to daily work, assuring strategy objective. On that base, leaders should turn strategy into operational terms[18], which means identifying some projects that need to be carried out to move the organization toward state that strategy describes. At the same time, leaders should pay more attention to aligning individuals to the organization through shared values[3], which is the way to build connection between vision and action by influencing others. Strategy generally meaning vision and direction, demands appropriate moment for strategic change in organization, called effective opportunity points. The point is the key to strategy implement. In addition, it's important for organization to develop sustainably, so the top leader should have the ability to develop organizational core competencies[19].

On the basis of relevant research the evaluation index system is designed (see Table 1).

Table 1: Index system

Strategic leadership(P)	
Personal abilities (P_1)	strategic thinking (P_{11})
	absorptive capacity (P_{12})
	adaptive capacity (P_{13})
	managerial wisdom (P_{14})
Organizational abilities (P_2)	strategic focusing(P_{21})
	turning strategy into action(P_{22})
	aligning individuals to the organization(P_{23})
	effective opportunity points(P_{24})
	developing organizational core competencies(P_{25})

3 The Method of ANP-Fuzzy

3.1 Fitness of ANP-Fuzzy for Strategic Leadership

Because of multi-dimensions, strategic leadership evaluation indexes system is a complex decision system. Not only are there different indicators, but also there exist inter-relationships among indicators. We choose ANP-Fuzzy to evaluation strategic leadership, which is one of multi-criteria decision techniques that are most appropriate for solving complex decision-making problems.

ANP-Fuzzy is a synthetic method to the alternative selection and justification problem by using the concept of analytic network process (ANP)and Fuzzy set theory. On the hand, the ANP allows for complex inter-relationships among decision levels and attributes. And its feedback approach is networks, in which the relationships between levels are not easily represented as higher or lower, dominant or subordinate, direct or indirect. The importance of the alternatives and the alternatives may have impact on each other. So ANP with net structure is more suitable for a complex system. And on the other hand, decision maker usually find that it is more confident to give interval judgements than fixed value judgements, because usually he is unable to explicit about his preferences due to the fuzzy nature of the comparison process.

3.2 Implication Steps

We evaluate strategic leadership with ANP-Fuzzy as following steps.

Step 1: ANP structure. ANP structure is made up of criteria level and network level. The former includes target and criteria level. The latter is a network where nodes respectively correspond to clusters. The elements in a cluster influence all the elements in another cluster. These relationships are represented by arcs with directions. Also the relationships among elements cluster can exist and be represented by a loop arc. Fig.1 shows the ANP structure.

Step 2: pairwise comparisons and priority vectors. Pairwise comparisons are made for interdependency among elements inside and outside clusters. Cluster weights are required to weight the supermarket at the next step, so clusters are also compared with each other. The relative importance values are determined with a sale of 1-9, where a score of 1 indicates equal importance between two elements and 9 represents the extreme importance of one element compared to the other one. Then a reciprocal value is assigned to the inverse comparison, so there is $a_{ij} = 1/a_{ji}$, and a_{ij} denotes the importance of the ith element compared to the jth element. The eigenvector method is employed to obtain
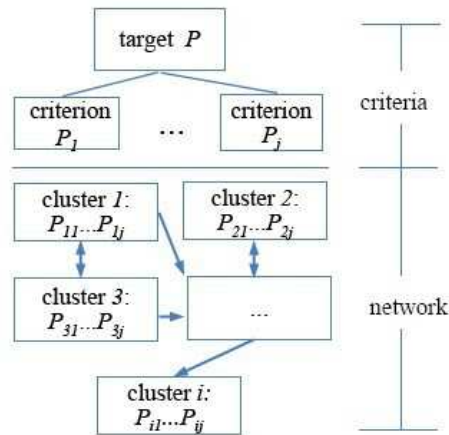
Fig. 1: ANP structure

local priority vectors for each pairwise comparison matrix.

Step 3: super matrix formation and transformation. The local priority vectors are entered into the appropriate columns of a super matrix, which is a partitioned matrix where each segment represents a relationship between two clusters. The super matrix of a system of two clusters is denoted as formulation (1):

$$
W = \begin{array}{c} \\ P_1 \\ \\ P_2 \\ \\ \\ P_m \end{array}
\begin{array}{c}
P_{11} \\ \vdots \\ P_{1j} \\ P_{21} \\ \vdots \\ P_{2j} \\ \vdots \\ P_{m1} \\ \vdots \\ P_{mj}
\end{array}
\begin{bmatrix}
W_{11} & W_{12} & \cdots & & W_{1m} \\
W_{21} & W_{22} & \cdots & & W_{2m} \\
\vdots & \vdots & & & \vdots \\
& & & \ddots & \\
W_{m1} & W_{m2} & \cdots & & W_{mm}
\end{bmatrix}
$$
(1)

P_i is the *ith* cluster $(k = 1, 2, ..., m)$ which has j elements denoted as $P_{i1}, \& P_{i2}, ..., \& P_{ij}$. A matrix segment W_{ij}, represents a relationship between the *ith* cluster and the *jth* cluster. Each column of W_{ij} is a local priority vector obtained from the corresponding pairwise comparison, representing the importance of the elements in the *ith* cluster on an element in the *jth* cluster. If there is no relationship between clusters, the corresponding matrix segment is a zero matrix. The super matrix is transformed into the weighted super matrix, whose columns sum to one. Then the weighted super matrix is transformed into the limit super matrix to confirm priority

of P_{ij}, shown in formulation (2):

$$
W^{\infty} = \lim_{i \to \infty} \left(\frac{1}{m}\right) \sum_{i=1}^{m} \overline{W_i}
$$
(2)

Where the column stochastic feature allows convergence to occur and the finial priorities of elements are found in the corresponding columns in it.

Step 4: Fuzzy evaluation. We obtain p_i evaluation matrix through fuzzy linear transformation p_{ij}, as shown in formulation (3):

$$
r_{ij} = \frac{f_{ij}}{\sum\limits_{j=1}^{n} f_{ij}}
$$
(3)

Where f_{ij} denotes times that P_{ij} is evaluated at one scale, and r_{ij} is the membership degree corresponding with P_{ij} scale evaluated. We can calculate the evaluation vector B_i of P_i according to P_{ij} priorities and P_i evaluation matrix. B_i is denoted as following:

$$
\begin{aligned}
B_i &= W_{ij} \circ R_{ji} \\
&= \left(\omega_{i1}, \omega_{i2}, ..., \omega_{ij}\right) \circ
\begin{bmatrix}
r_{11} & r_{12} & \cdots & r_{1t} \\
r_{21} & r_{22} & & r_{2t} \\
\vdots & & \ddots & \vdots \\
r_{j1} & r_{j2} & \cdots & r_{jt}
\end{bmatrix} \\
&= \left(b_{i1}, b_{i2}, ... b_{it}\right)
\end{aligned}
$$
(4)

Membership degree theory tell us that the scale corresponding to the max membership degree is the performance of B_i. According to B_i, we construct the total evaluation matrix B, as shown in formulation (5):

$$
B = \begin{bmatrix} B_1 \\ B_2 \\ \vdots \\ B_m \end{bmatrix} =
\begin{bmatrix}
b_{11} & b_{12} & \cdots & b_{1t} \\
b_{21} & b_{22} & & b_{2t} \\
\vdots & & \ddots & \vdots \\
b_{j1} & b_{j2} & \cdots & b_{jt}
\end{bmatrix}
$$
(5)

Then based on W and B, the total evaluation vector U can be obtained, as shown in formulation (6):

$$
U = W \circ B = \left(u_1, u_2, ..., u_l, ..., u_t\right)
$$
(6)

Where the scale that the max u_l is corresponding to is the leader's strategic leadership level.

4 Empirical Analysis

There is one state-enterprise, who wants to assess managers of departments for promotion. The promotion pays more attention to strategic leadership. We use ANP-Fuzzy to evaluation three candidates' strategic leadership.
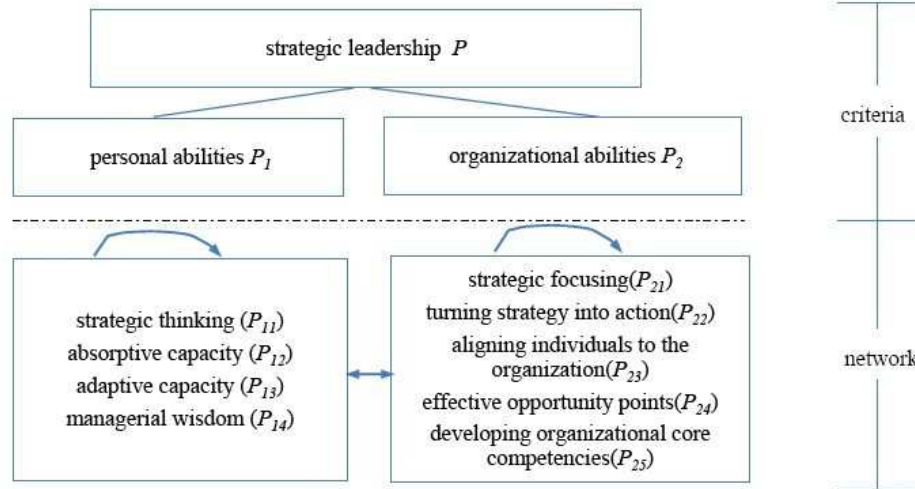
Fig. 2: ANP structure of strategic leadership

4.1 Priorities

First we construct ANP structure of strategic leadership according to its index system in Super Decisions. As shown in Fig.2.

The criteria include strategic leadership P, personal abilities P_1 and organizational abilities P_2. The network constitutes of nodes P_{1j} and P_{2j} respectively correspond to clusters P_1 and P_2. There exist three basic relationships between nodes of P_{1j}, between nodes of P_{2j}, and between clusters. The elements in cluster P_1 influence all the elements in cluster P_2. Second, invite related leaders, experts to score the index system of strategic leadership. In the ANP structure, evaluate the relationships between P_{ij} in criteria P_i, and construct judgement matrix, for example Table 2. We use rule of nine, 1-9 mean one index

Table 2: Judgement matrix of P_1

Criterion P_1	P_{11}	P_{12}	P_{13}	P_{14}
P_{11}	1	4	3	2
P_{12}	1/4	1	3	1/2
P_{13}	1/3	1/3	1	1/3
P_{14}	1/2	2	3	1

has influence on other one from small to large. The final judgement matrix adopts the mean of all the scores. Its CR is $0.032(< 0.1)$, and that the matrix has rational consistence. In the similar way, the judgement matrix of P_2 and P. The CR are respectively 0.019 and 0.057. Then compute ANP super matrix, weighted super matrix and limit matrix. The limit matrix is convergent and single, so the column involves the finial priorities of elements:

$$W = (0.63, 0.37)$$

$$W_1 = (0.243, 0.112, 0.091, 0.183)$$

$$W_2 = (0.106, 0.054, 0.047, 0.071, 0.089)$$

4.2 Fuzzy Evaluation

We choose related leaders and important followers to measure strategic leadership elements of candidates for promotion. Linguistic values, the mean of fuzzy numbers and measurement frequency of three candidates are shown in Table 3.

The next step is to construct an evaluation matrix (see K_{11}) according to measurement frequency. For example, the evaluation matrix of candidate $1(C_1)$'s personal abilities can be denote as:

$$R_{11} = \begin{bmatrix} 0.000 & 0.667 & 0.333 & 0.000 & 0.000 \\ 0.333 & 0.667 & 0.000 & 0.000 & 0.000 \\ 0.000 & 1.000 & 0.000 & 0.000 & 0.000 \\ 0.333 & 0.667 & 0.000 & 0.000 & 0.000 \end{bmatrix}$$

Then evaluation vector B_{11} of C_1's personal abilities can be computed as follow:

$$B_{11} = W_1{}^{\circ}R_{11}$$

$$= \begin{pmatrix} 0.098 & 0.450 & 0.243 & 0.000 & 0.000 \end{pmatrix}$$

In the same way we can get other vectors, shown as table 4.

Table 4 shows that the strategic leaderships of 3 candidates are all good. There in, personal abilities are all good, and organizational abilities of C_1 are better than others. Research outcomes shows that C_1 is appreciably good candidate.

Table 3: Frequency of linguistic values

Linguistic values		Very good	Good	Better
	P_{11}	0	2	1
	P_{12}	1	2	0
	P_{13}	0	3	0
	P_{14}	1	2	0
C_1	P_{21}	2	1	0
	P_{22}	1	1	1
	P_{23}	2	1	0
	P_{24}	1	2	0
	P_{25}	1	2	0
Linguistic values		Very good	Good	Better
	P_{11}	0	2	1
	P_{12}	0	1	2
	P_{13}	0	1	2
	P_{14}	0	0	3
C_2	P_{21}	0	1	2
	P_{22}	0	1	2
	P_{23}	0	1	2
	P_{24}	0	1	1
	P_{25}	0	1	2
Linguistic values		Very good	Good	Better
	P_{11}	0	2	1
	P_{12}	0	1	2
	P_{13}	0	1	2
	P_{14}	0	0	3
C_3	P_{21}	0	1	2
	P_{22}	0	1	2
	P_{23}	0	1	2
	P_{24}	0	1	1
	P_{25}	0	1	2

Table 4: Results of evaluating strategic leadership

Candid-ates	In-dex	Evaluation vector					Res-ults
		Very good	Good	Better	Gen-eral	Not good	
	P	.126	.349	.160	0.0	0.0	good
C_1	P_1	.098	.450	.243	0.0	0.0	good
	P_2	.175	.175	.018	0.0	0.0	Very good
	P	.189	.350	.009	0.0	0.0	good
C_2	P_1	.229	.400	0.0	0.0	0.0	good
	P_2	.122	.221	.024	0.0	0.0	good
	P	.190	.344	0.0	0.0	0.0	good
C_3	P_1	.223	.406	0.0	0.0	0.0	good
	P_2	.134	.238	0.0	0.0	0.0	good

5 Conclusion

Strategic leadership is a key ability of a leader for organization in dynamic and changeable environment, so it's important and necessary to evaluate strategic leadership.

We construct the indexes system, constituting of personal abilities and organizational abilities,where the former includes strategic thinking, absorptive capacity, adaptive capacity and managerial, and the letter includes strategic focusing, turning strategy into action, aligning individuals to the organization, effective opportunity points and developing organizational core competencies. Because of the complex of strategic leadership, we choose the method of ANP-Fuzzy to evaluate it: calculates priorities of elements by ANP and computing strategic leadership evaluation outcomes by fuzzy. Then we test the method by empirical research, and results show that the method can not only obtain the whole outcome of strategic leadership, but also show meanwhile details in aspects of personal abilities and organizational abilities, which provide significant decision support.

Acknowledgement

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