2012 2nd International Conference on Industrial Technology and Management (ICITM 2012)
IPCSIT vol. 49 (2012) © (2012) IACSIT Press, Singapore
DOI: 10.7763/IPCSIT.2012.V49.43

Fuzzy Evaluation of Ability to Develop Self-owned Brands in Jiangxi Province SMEs

Bin LIU [1 +], Meilu TIAN[2] and Jie HU [3]

[1]School of Business Administration. NanChang Institute of Technology, Nanchang City, China,
[2]Director of General Office Yunnan Branch of MCC5 Group Co.Ltd., Kunming City, China,
[3]School of International Education. NanChang Institute of Technology, Nanchang City, China,

Abstract. The financial crisis in 2008 seriously affected the development of small and medium enterprises(SMEs) in Jiangxi Province，But it also provided an opportunity for the local government to guide their sound development. The government should be fair and objective in assessing SMEs, and provide preferential policy according to the assessment result. Through the Delphi method, the Triangular fuzzy number theory and FAHP method, we set up an index system in the paper to assess SMEs in Jiangxi Province.

Keywords: triangular fuzzy number; Self-owned brand; FAHP method ； linguistic variables

1. Introduction

Jiangxi province SMEs which accounted for 99% of the whole enterprises, make the contribution of GDP and the industrial sector, respectively, 54.8% and 78.7% .They play a very important role economic and social development in our province. But Jiangxi SMEs technology and equipment are mostly old, low value-added products, malignant competition of industry frequently, lack of brand and leading enterprises, these all limits Jiangxi economic development space. Not only SMEs are self-help, but also it still need form a cohesive force to overcome difficulties in the whole society especially by government. The government can use this opportunity, through the tilt of policy and resources, prompting a batch of outstanding of SEMs to develop their self-owned brand and promote their brand value, expand their brand marketing clout, becoming a famous enterprise industry to realize the Jiangxi economic sustainable development healthy and rapidly. It is on the basis of government make the title of policy resources to the scientific, fair and objective evaluation for SMEs develop self-owned brands ability. It is the problem that government is facing for policymakers.

Developing self-owned brands ability is to show that the organic integration capacity of enterprises and relevant organizations for cultivating and developing autonomous well-known brand to combine the technological innovation ability and managing innovation ability, the manufacturing capacity, marketing ability, coordinating innovation ability, output ability[1]. At present, the enterprise’s developing self-owned brands ability of evaluation methods research mostly concentrates in the AHP method, the fuzzy evaluation method, etc. In addition, the research of the evaluation method about developing studying capability of brand also caused the domestic and foreign scholars' attention[2-7]. Literature [2] is combined fuzzy evaluation method with triangular fuzzy number, developing a new evaluation method. This method overcomes the shortage that when a single number represents fuzzy degrees of evaluation objects by fuzzy evaluation method, but it are weak in the evaluation index, system index of insufficient researches. Literature [3-5] in the method of designed index system and its index weight determined is more practicable. Literature [6-7] is the abroad about the research of fuzzy evaluation method point of view, it puts forward the AHP and fuzzy

+ Corresponding author. Tel.: + (13767407864).
E-mail address: (liubin946@163.com).

mathematics, triangular fuzzy number and matrix theory of combining a basic evaluation method that suitable for many fields of enterprise management. Because of the deficiency of the above documents, this paper's evaluation method improved it and converging triangular fuzzy number theory and FAHP, applied the quantification of triangular fuzzy to evaluated a fuzzy single factor for object's evaluated natural language, applied FAHP method to judge the weights of multi-level evaluated indexes. Compared with other models, it is easier to judge for experts on the index performance and the index weight of the evaluated objects, used more convenient.

2. Establishing the Fuzzy Evaluation System

2.1 Establishing Index System of Jiangxi Province's SMEs Developing Self-owned Brand

In 2008, A batch of innovative enterprise with self-owned brands determined by Jiangxi province have been provided the preferential policies such as the enter income tax and other taxes to developing as soon as possible, for increasing Jiangxi province's self-owned brands of enterprises in the national competitiveness. This paper uses the proposed evaluation method to investigate and evaluate three enterprises on this background. Among them, establishing index system of Jiangxi province's SMEs developing self-owned brand is the result of investigation by experts be composed of the decision maker of enterprise, advisory expert, enterprise department manager:

TABLE I. JIANGXI PROVINCE SMES DEVELOPING SELF-OWNED BRAND CAPACITY OF EVALUATION INDEX SYSTEM

Goal	Level 1 index	Level 2 index
Ability to Develop Self-owned Brands in Jiangxi Province SMEs	Enterprise Hardware Ability	Enterprise Fund
		Enterprise R&d and Design
		Enterprise Product Quality
		Enterprise Productivity
	Enterprise Marketing Ability	Product Differentiation
		Advertising and Promotion
		Marketing Channel
		Customer Service
	Enterprise Management Ability	Enterprise Image management
		Technological Innovation Management
		Human Resources Management

2.2 FuzzyEvaluation and Selection of Jiangxi Province SMEs Developing Self-owned Brand Capacity

1) The fundamental theory of Triangular fuzzy number

Definition 1 The linguistic evaluation set $(i_0, i_1, \ldots, i_m, \ldots, i_n)$ denote a group of the value of the linguistic evaluation set, i_m is one of Language-based triangular fuzzy number. Language Set, which could means: $\tilde{a} = (a_l, a_m, a_n)$

Definition 2 Removing the fuzzy value of the triangular fuzzy number $\tilde{a}$.

$E(\tilde{a}) = ((1-\lambda)a_l + a_m + \lambda a_n)/2 \quad 0 \le \lambda \le 1$ λ depends on the attitude of expert, when expert is a risk indifference λ=0.5; when expert is a risk preference $\lambda \succ 0.5$; when expert is a risk averter $\lambda \prec 0.5$.

2) The fuzzy evaluation process of Jiangxi province SMEs developing self-owned brand capacity

Based on Triangular fuzzy number in the fuzzy evaluation system, it evaluated object used natural language to single-factor fuzzy evaluation, for the weight of multi-level evaluation indexes using binary comparison to judge [9]. It mainly includes the following eight steps:

Step 1: To determine the comprehensive evaluation indexes and linguistic value evaluation set, constructing the matrix of weighting prior relation. To determine the evaluation index system (table 1) and use definition 1 to measure the valuation of language variables and their corresponding Triangular fuzzy number (table 2).

TABLE II. EVALUATION OF THE LANGUAGE SET AND ITS TRIANGULAR FUZZY NUMBER）

the evaluation value of the language set	The triangular fuzzy number
Very Poor	（0，0，0.2）
Poor	（0，0.1，0.3）
Below Average	（0.1，0.2，0.4）
Average	（0.3，0.5，0.7）
Upper Average	（0.6，0.7，0.8）
Good	（0.7，0.8，0.9）
Very Good	（0.8，0.9，1）
Superior	（0.9，1，1）

To structure weights of evaluation indexes the fuzzy order optimum relation: matrix $B = (b_{ij})_{mm}$. Among them, b_{ij} show the important degree of the next index of same level i and index j. During the evaluation of SMEs's ability, it build the two index of comparison for expert judge easily. The description of relative importance can accord to table 3 to give quantity scale.

TABLE III. IMPORTANT DEGREE OF WEIGHT AND ITS QUANTIFICATION TABLE）

Indicators	Definition
0.5	The same important
0.6	A little more important
0.7	Obviously important
0.8	More important
0.9	Absolutely important
0.1，0.2，0.3，0.4	by contraries:（$b_{ji} = 1 - b_{ij}$）

Step 2: Expert group measure level 2 factors A_{im} by sing factor evaluating, then we have the result which is Triangular fuzzy number matrix. Suppose there are *n* expert to evaluate the level 2 factors set $(A_{i1}, A_{i2}, \cdots, A_{im})$, the result is $C_i^k = (C_{i1}^k, C_{i2}^k, \cdots, C_{im}^k)$, $k = 1,2,\ldots,n$, C_{im}^k is the result that *k* expert evaluate A_{im}, that expert give the evaluating result is a Triangular fuzzy number by table 2.

Step 3: determine the weight of level 2 factors A_{im}. For all level 2 factors set, we construct a Priority matrix $B = (b_{ij})_{mm}$, *B* is a Fuzzy Complementary Matrix, then Fuzzy Complementary Matrix *B* is changed to Fuzzy consistent matrix and calculate its eigenvector by , finally normalize Fuzzy consistent matrix and get $(w_1^k, w_2^k, \cdots, w_m^k)$, $k = 1,2,\ldots,n$, w_i^k is that expert *k* evaluate the weight of all level 2 indicators of A_i

Step 4: calculate the results of A_i Based on the result of the evaluation matrix and weight matrix fuzzy of step3 and step4, the results of A_i: $\tilde{D}_i^k = \frac{1}{m} A_i^k \bullet w_i^k = \sum_{i=1}^{m} A_{il}^k \otimes w_{il}^k$, $\otimes$ means fuzzy multiplication operator, obviously, $\tilde{D}_i^k$ is a Triangular fuzzy number.

Step 5: repeat step 3, 4, 5, calculate the evaluating result of $(A_1, A_2 \cdots, A_n)$: $\tilde{D}^k = (\tilde{D}_1^k, \tilde{D}_2^k, \cdots, \tilde{D}_n^k)$, $\tilde{D}_n^k$ is the result of expert k to evaluate indicator A_n^k.

Step 6: repeating step3, calculate the weight of A_i: $w^k = (w_1^k, w_2^k, \cdots, w_n^k)$, $k = 1,2,\ldots,l$, w_i^k is the weight of expert *k* to evaluate A_i.

Step 7: calculate the synthetic results of *A* Based on the result of the evaluation matrix and weight matrix fuzzy of step3 and step4, the results of *A*:

$\tilde{E}^k = \sum_{i=1}^{n} \times \tilde{D}_1^k \bullet w^k = (\tilde{D}_1^k \otimes w_1^k \oplus g_2 \times \tilde{D}_2^k \otimes w_2^k \oplus \cdots \oplus \times \tilde{D}_n^k w_n^k)$, $\otimes$ means fuzzy multiplication operator, obviously, $\oplus$ means Fuzzy addition operator, $\tilde{E}^k$ is a Triangular fuzzy number.

Step 8: use Definition 2 to Remove the fuzzy value of $\tilde{E}^k$, we get the result E^k, then determine the expert weight T^k, the final result $U_i = \sum_{k=1}^{n} T^k \otimes E^k$. Finally, we sort the result.

3. An Example

We make the example by the specific data of a enterprise evaluating of Graduate from Marketing Faculty.

1) Measure the marketing graduate evaluating result. In our study, we suppose three experts evaluating of all level 2 indicators of level 1 indicator A_1 of three marketing graduates. The evaluating result is based on table 1:

$$\tilde{C}_1^1=\begin{bmatrix}(0,0.1,0.3) & (0.3,0.5,0.7) & (0.6,0.7,0.8) & (0.3,0.5,0.7)\\ (0.6,0.7,0.8) & (0,0.1,0.3) & (0.3,0.5,0.7) & (0.3,0.5,0.7)\\ (0.3,0.5,0.7) & (0.3,0.5,0.7) & (0.3,0.5,0.7) & (0.3,0.5,0.7)\end{bmatrix}$$

$$\tilde{C}_1^2=\begin{bmatrix}(0.7,0.8,0.9) & (0.3,0.5,0.7) & (0,0.1,0.3) & (0.6,0.7,0.8)\\ (0.6,0.7,0.8) & (0,0.1,0.3) & (0.3,0.5,0.7) & (0.3,0.5,0.7)\\ (0.3,0.5,0.7) & (0.6,0.7,0.8) & (0,0.1,0.3) & (0.3,0.5,0.7)\end{bmatrix}$$

$$\tilde{C}_1^3=\begin{bmatrix}(0.9,1,1) & (0.8,0.9,1) & (0,0.1,0.3) & (0.9,1,1)\\ (0.6,0.7,0.8) & (0.7,0.8,0.9) & (0.6,0.7,0.8) & (0.7,0.8,0.9)\\ (0.6,0.7,0.8) & (0.3,0.5,0.7) & (0.7,0.8,0.9) & (0.3,0.5,0.7)\end{bmatrix}$$

2) Intercom pare all level 2 indicators of level 1 indicator $\tilde{A}_1$ *,which lead to the result of fuzzy weight priority matrix B, and change it to Fuzzy consistent matrix R:*

$$B_1^1=\begin{bmatrix}0.5 & 0.7 & 0.7 & 0.5\\ 0.3 & 0.5 & 0.5 & 0.3\\ 0.3 & 0.5 & 0.5 & 0.3\\ 0.5 & 0.7 & 0.7 & 0.5\end{bmatrix} \quad B_1^2=\begin{bmatrix}0.5 & 0.5 & 0.5 & 0.3\\ 0.5 & 0.5 & 0.5 & 0.3\\ 0.5 & 0.5 & 0.5 & 0.3\\ 0.7 & 0.7 & 0.7 & 0.5\end{bmatrix}$$

$$B_1^3=\begin{bmatrix}0.5 & 0.7 & 0.7 & 0.7\\ 0.3 & 0.5 & 0.5 & 0.5\\ 0.3 & 0.5 & 0.5 & 0.5\\ 0.3 & 0.5 & 0.5 & 0.5\end{bmatrix} \quad R_1^1=\begin{bmatrix}0.5 & 0.6 & 0.6 & 0.5\\ 0.4 & 0.5 & 0.5 & 0.4\\ 0.4 & 0.5 & 0.5 & 0.4\\ 0.5 & 0.6 & 0.6 & 0.5\end{bmatrix}$$

$$R_1^2=\begin{bmatrix}0.5 & 0.5 & 0.5 & 0.4\\ 0.5 & 0.5 & 0.5 & 0.4\\ 0.5 & 0.5 & 0.5 & 0.4\\ 0.6 & 0.6 & 0.6 & 0.5\end{bmatrix} \quad R_1^3=\begin{bmatrix}0.5 & 0.6 & 0.6 & 0.6\\ 0.4 & 0.5 & 0.5 & 0.5\\ 0.4 & 0.5 & 0.5 & 0.5\\ 0.4 & 0.5 & 0.5 & 0.5\end{bmatrix}$$

Then calculate the fuzzy consistent matrix *R*'s eigenvector and eigenvalue:

$w_1^1=(0.283,0.217,0.217,0.283)$, $w_2^2=(0.233,0.233,0.233,0.3)$ $w_1^3=(0.3,0.233,0.233,0.233)$

3) Based on the data of step 1 and step 2, fuzzy calculate the evaluating result of $\tilde{A}_1$ *:*

$$\tilde{D}_1^1=\tilde{C}_1^1\otimes w_1^1=\begin{bmatrix}(0.2802,0.4302,0.6085)\\ (0.3198,0.4698,0.6415)\\ (0.3,0.5,0.7)\end{bmatrix}$$

$$\tilde{D}_1^2=\tilde{C}_1^2\otimes w_1^2=\begin{bmatrix}(0.413,0.5362,0.6827)\\ (0.5793,0.7092,0.8158)\\ (0.5062,0.6061,0.7293)\end{bmatrix}$$

$$\tilde{D}_1^3=\tilde{C}_1^3\otimes w_1^3=\begin{bmatrix}(0.6661,0.766,0.8359)\\ (0.646,0.7459,0.8458)\\ (0.4829,0.6294,0.7759)\end{bmatrix}$$

4) Repeat the fuzzy calculating process, calculate $\tilde{A}_2$ *,* $\tilde{A}_3$ *,* $\tilde{A}_4$ *of three expert evaluating result:*

$$\tilde{D}_2^1=\begin{bmatrix}(0.2335,0.3735,0.5568)\\ (0.5199,0.6332,0.7532)\\ (0.523,0.6564,0.7865)\end{bmatrix} \quad D_2^2=\begin{bmatrix}(0.5363,0.6362,0.7494)\\ (0.5827,0.7126,0.8425)\\ (0.5339,0.6594,0.7859)\end{bmatrix}$$

$$D_2^3=\begin{bmatrix}(0.4166,0.5232,0.6612)\\ (0.5628,0.6942,0.7942)\\ (0.6138,0.7562,0.8562)\end{bmatrix}$$

$$D_3^1=\begin{bmatrix}(0.3849,0.4915,0.6415)\\ (0.4519,0.5519,0.6802)\\ (0.4302,0.5085,0.6585)\end{bmatrix} \quad D_3^2=\begin{bmatrix}(0.4663,0.5895,0.736)\\ (0.5793,0.7092,0.8158)\\ (0.5062,0.6061,0.7293)\end{bmatrix}$$

$$D_3^3 = \begin{bmatrix} (0.4991, 0.5992, 0.6976) \\ (0.4487, 0.5705, 0.714) \\ 0.5922, 0.714, 0.8358 \end{bmatrix}$$

5) Use the method of step 3, calculate all level 1 indicators $(\tilde{A}_1, \tilde{A}_2, \tilde{A}_3, \tilde{A}_4)$ *of three expert evaluating result:*

$$w^1 = (0.268, 0.367, 0.367) \quad w_2^2 = (0.333, 0.433, 0.234) \quad w^3 = (0.433, 0.234, 0.333)$$

6) Use the method of step 8, we have the result of three graduates triangular fuzzy number synthetic evaluating result:

$$\tilde{D}^1 = \begin{bmatrix} (0.3066, 0.4384, 0.6073) \\ (0.4255, 0.5447, 0.6239) \\ (0.4081, 0.546, 0.7093) \end{bmatrix} \tilde{D}^2 = \begin{bmatrix} (0.4665, 0.5820, 0.7174) \\ (0.5199, 0.6599, 0.7944) \\ (0.4256, 0.5575, 0.7049) \end{bmatrix}$$

$$\tilde{D}^3 = \begin{bmatrix} (0.3749, 0.5066, 0.6500) \\ (0.2885, 0.4099, 0.5856) \\ (0.3564, 0.4959, 0.6548) \end{bmatrix}$$

7) Blur values to evaluation results of three experts

First of all, according to three experts, it give three experts the evaluation of data weights, Expert $1: \lambda = 0.75$， Expert 2: $\lambda = 0.5$， Expert 3: $\lambda = 0.25$.

Secondly, the above weights time the evaluation data (6) results. expert 1 evaluate the result of three graduates:（0.4852,0.5591,0.59）; expert 2 evaluate the result of three graduates: （0.4415,0.4935,0.422）; expert 3 evaluate the result of three graduates:（0.4650，0.3863，0.4635）.

Finally, to blur values for three evaluating results: That result means: the expert weight time the result of the evaluation is the ablity of three SMEs, in turn, （0.4639，0.4983，0.4975）.

According to the above results we know, the sort of developing three self-owned brand enterprise's ability: the development of Jiangxi Enterprise 2's self-owned brand ability is better than enterprise 1 and 3. Enterprise 2 in hardware ability and management ability is obviously superior to Enterprise 1 and 3. Enterprise government shall determine Enterprise 2 as the self-owned brand of innovative enterprise and provide policy inclination and support, further enhance its brand competition ability in the nationwide to establish brand competitive advantage.

4. Conclusions

This paper is based on Jiangxi SMEs of index system. Comparing FAHP evaluation method of Triangle fuzzy numbers and traditional AHP method, it is easier for the expert use fuzzy language to evaluate and more close to the practical that the degree of actual operation is higher. This paper adapted two-level index system, in practice it also can be extended to the application of multi-level index system. In this paper, the experience about the invisible knowledge of SMEs self-owned brands ability is not enough rich, and need to further research.

5. REFERENCE

[1] Renqian Zhen, Pengying. Strategic Thinking of Development in Jiangxi Province Small and Medium-sized Enterprise[J]. Jiangxi Social Science, 2007,10(1): 235-238

[2] Xiaoyuan Zhang, Kaihua Chen. Research on Comprehensive Evaluation System Based on Triangular Fuzzy Number[J]. China Scientific Papers Online, 2006.12(10)1: 317-324

[3] Xiaohong Chen, Xi yang. A method of Multi-attribute Decision-making Based on Triangle Fuzzy Numbers[J]. Systems Engineering and Electronics, 2008, 13(2): 278-282

[4] Zhoutian Fan. Fuzzy matrix theory and application [M]. Beijing: Science Press, 2006: 219-219.

[5] Xing Pan, Jun Wang, Lu Liu. Fuzzy Comprehensive Evaluation Method of Knowledge Level in Aviation Manufacturing Enterprise [J]. 2007. 13(10):145-155.

[6] Adem G., Esra K.. A fuzzy model for competency-based employee evaluation and selection [J]. Computer & Industrial Engineering 2007,5(4):143-161.

[7] Drigas A., Kouremenos S., Vrettaros s., et al. An expert system for job matching of the unemployed [J]. Expert Systems with Applications, 2004, 26(12): 217-224.

[8] Kahraman C., Ruan D.. Fuzzy group decision-making for facility location selection [J]. Information Sciences, 2003, 157(9): 135-153.

[9] Lai Y.. Ineractive multiple objective system technique [J]. Journal of Operational Research Society, 1995, 46(1): 958-976.

[10] Liu D., Shih. Inergrating AHP and data mining for product recommendation based on customer lifetime value[J]. Information and Management, 200523(3):387-400.

[11] Mickey R., Parsaei H.. A fuzzy linguistic approach to implementing a strategy for computer integrated manufacturing [J]. Fuzzy sets and Systems, 1998, 42(3):191-204.