

A New Approach to Combined PROMETHEE with AHP Methods with Application to Business Costs in SME of Shanghai Analysis

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Abstract: *The purpose of this paper is effectively resolving the issue of simplification and assignment evaluation index system on business costs of Shanghai Small and Medium Enterprises (SME). This article deals critically with existing Analytic Hierarchy Process (AHP) measurement to determine the attribute weights, taking into account the elements of demand, technological innovation, policy-oriented, market operation aspects, is a multi-target areas. We develop and test six sets of evaluation indexes system and hypothesis using of a sample of 36 enterprises. PROMETHEE and GAIA are multi-criteria decision aid methods belonging to the family of outranking methods. We extend this research by presenting in Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) method and Geometric Analysis for Interactive Aid (GAIA) to verify the system for business cost evaluation. They conclude with a plea for taking account of crucial importance of these features in evaluation index system on business cost in SMEs of shanghai. Finally, we find that proposals to help developing of SMEs and manage business costs.*

Keywords: *Business costs, SMEs of Shanghai, AHP, PROMETHEE*

1. INTRODUCTION

The studying of business cost originated from “Fortune”, world's best business city ranking in the mid-1990s. It is widely used in a comparative study on business environment applications, used to describe a cost, must immediately make a corresponding decision whether to investment. A number of research institutions and internationally renowned consulting companies also have carried out business cost of the investigation and investment environment. For example, CEBR(Centre for Economics Business Research, JETRO (Japan External Trade Organization, Nikkei PC, Arthur Andersen, KPMG, Ministry of Industry surveys of Australia, MMK Consulting firm of Canada and Andy Holloway. However, there is no professional organization in china

In 2002, JIANG Yi-ren, Vice Mayor of Shanghai, the opening meeting of the third speech Economist Roundtable on Shanghai on February 28, said Shanghai will strive to reduce the cost of doing business for investors^[1]. Since then Scholars set off on a wave of study on business cost in Shanghai. Facing of labor costs, land and real estate prices continue to rise, a lot of foreign capital inflow into surrounding cities phenomenon such as the topic Shanghai project focuses on "Controlling business costs and industrial development in Shanghai"^[2].

Currently, there are about the business cost research methods can be divided into three situations in China. First, one of kind is a comparative analysis method, a representative is Fu Jun-wen, Tu Jin-fang, (2003), To comparison Beijing and Shanghai business cost study; Fu Yong-jun, Sheng Jing-zhi (2003), comparative study of Shanghai and neighboring cities cost of doing business; Ann Lai Wei, Li -feng, Zhao Shu-dong (2004) , Nanjing, Wuxi , Kunshan, Ningbo , Shanghai 's business cost comparison study; Zhejiang enterprises investigation Team (2004), comparing Jiangsu, Zhejiang , Shanghai , Guangdong, Fujian satisfaction business costs ; An Shu- Wei , Wei Hou-kai (2005) , Beijing , Shanghai , Tianjin, Guangzhou, Chongqing Business Cost comparative study; Sun Jiao, Chen Ke (2005), To investigate in Xi'an , Beijing, Shanghai and Shenzhen

comparative analysis; Zhang San-feng , Yang Cai (2009), Comparative analysis of China's central and western business costs; Shaojun (2009), contrast both the eastern and western cost structure analysis; Zhou zheng-zhu , Sun ming-gui (2011), A comparative study of six eastern coastal provinces and the level of business cost structure. Not surprisingly then, recent studies have looked at mainly comparative analysis of the various regions within business costs and business costs among the various components, each component can explain the differences between regions of specific indicators. However, these indicators of studies are too specific. Although these studies have provided a good contrast of this phenomenon, the performance implications of this strategy to SMEs and regions development remain under-explored.

Second, another of kind is a comprehensive evaluation method. a). Application subjective weighting of Evaluation method, such as An Li Wei, Li Feng, Zhao Shu-dong (2004)^[3] established a system of three indicators to measure the cost of doing business, and using the Delphi method; Shi Fang (2007)^[4] selection of AHP method; Chen Ke ,Chen wei (2005)^[5] and Yao Jie(2009) experimented with Delphi method, that empower law experts established indicator system; Chen Jianjun (2010)^[6] for each factor costs and transaction costs constitute weighting factors; Cai Yi-fei et al (2010)^[7] using the cost of each component for business subjective weighting method. Empowering subjectivity is relatively strong, would lead to a factor assessment is too high or low, the true objectivity of the evaluation process is affected. b). The second is based on an objective evaluation of weighting method, such as Pan Fei et al (2005)^[8] using factor analysis, the impact of various factors on the business costs of foreign direct investment is significant; Guo Ying (2006)^[9] decomposition model of business costs, through the establishment of corporate objective function and extreme conditions established model, derived business factors affecting the survival of the soft environment for SMEs.

Third, there is a comprehensive evaluation method. Zhou Zheng-zhu(2012)^[10] applied the structural model and the DS evidence theory model used in corporate relocation decisions case application analysis; Zhou column, Wang Zu zhu, Sun Ming-gui (2013)^[11] Comprehensive Evaluation Model and Empirical Research entropy correction G1 method regional business costs based on the use of a comprehensive weighting method. Although the latter adopted an objective weighting method, this article has some instructive, too small for index classification does not reflect a comprehensive information.

In summary, this paper takes into account the cost of the Shanghai SME business goals are more related to the field of policy-oriented, technological innovation, resources and environment, market operations. We find that exporting contributes positively to reflect the cost of doing business for SMEs to evaluate the information. However, the information is not sufficient that the case does not give an accurate quantitative evaluation value, and evaluation research how to make and how to evaluate multi-attribute is relatively small. For the above-mentioned problems, this paper presents a comprehensive solution.

We explore the new approach on cost of doing business in Shanghai is divided into four main object studies, so the paper is developed in four parts. The research method background and concept of business cost to which we refer above is sketched in section 1. We introduce detailed theoretical AHP and PROMETHEE methods and procedures in section 2. Using of a sample of 36 enterprises in An Empirical Study, and extend this research by presenting mathematical statistics in AHP and PROMETHEE methods for Enrichment Evaluation to verify the evaluation indexes system in Section 3 and is dedicated to visual preference modeling through the GAIA Brains procedure. Finally, we evidenced with a plea for taking account of crucial importance of these features in evaluation index system on business cost in SMEs of shanghai. Therefore, we find that proposals to help developing of SMEs and manage business costs. Concluding remarks follow.

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2. METHODOLOGIES

2.1 AHP Analysis

Analytic Hierarchy Process (referred AHP) is a decision-making method, which is an effective combination quantitative and qualitative analysis The basic steps are as follows:

- 1) Making complex issues conceptualize and specific identify the main factors involved in the study;
- 2) Analyze the association and affiliation of each factor to build a ladder orderly hierarchical model;
- 3) At the same level, the relationship between any two factors can make judgments based on objective conditions or subjective experience and its relative importance to be quantitative. Firstly, we establish judgment matrix to determine the layer elements using mathematical methods guidelines for the weight of the layer[12].

$$A = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{pmatrix} \quad (1)$$

$$M_k = \sqrt[n]{\prod_{j=1}^n F_{jk, k=1,2,3,4,\dots,n}} \quad (2)$$

$$W_k = \frac{M_k}{\sum_{j=1}^n M_j} \quad (3)$$

- 4) 1-9 refers to with different scale and meanings in AHP, are shown in Tab. 1:1-9 scale and meaning.

Tab1 1-9 Scale and Meaning

Scale	meaning
1	Indicates two factors compared to the same importance
3	Indicates two factors compared to a slightly more important than another factors
5	Indicates two factors compared to a significantly more important than another factors
7	Indicates two factors compared to a particularly important factor than another factor
9	Indicates two factors compared to a extremely important factor other than the factor
2,4,6,8	The above determination of the value of the two adjacent
Reciprocal	Compared with the factors i and j, determine b_{ij} , j compared with I, determine $b_{ji}=1/b_{ij}$

- 5) The judgment re-matrix a calculation has been compared the relative weights of the factors on the level of the guidelines, and then consistency checking. The consistency test related to the RI values is shown in Table 2: Judgment Matrix RI[13]. Try to follow the orders and RI value specified in Tab. 2 as best as you can.

Tab2. Judgment Matrix RI

The Order	1	2	3	4	5	6	7	8	9
RI Value	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

It is important to make matrix structure consistency test. When tested for consistency, consistency ratio using the formula (4). When the consistency ratio $CR \leq 0.1$, that judgment has internal

consistency, weight coefficients reflect the relative importance of the indicators, if $CR > 0.1$, on the index will have to re-adjust the weights.

$$CR = \frac{CI}{RI} \tag{4}$$

In the formula,

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

become consistency index. Among, RI is the average random [14].

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \left(\sum_{j=1}^n A_{ij} w_j \right) \frac{1}{w_i} \tag{5}$$

2.2 PROMETHEE

Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) is also called advantage sort, BRANS proposed to establish the level is not inferior to the relationship, a multi-attribute decision making method in 1984, and PROMETHEE is a prescriptive method that enables to rank the actions according to the preferences of the decision-maker. Actually two rankings are produced: a partial ranking is built mostly on undisputable preferences and a complete, possibly less robust, ranking can also be obtained depending on the decision-makers requirements. The core idea is pair wise comparisons between programs based construction Preference Relation [15]. PROMETHEE is to provide for the decision attribute six kinds of typical preference function, and support decision-makers plan to build part of the preference relations and incomplete preference relations. a preference function has to be associated with each criterion in order to reflect the perception of the criterion scale by the decision-maker. Usually the preference function $P_j(a_i, a_r)$ is a non decreasing function of the difference $f_j(a_i) - f_j(a_r)$ between the evaluations of two actions a_i and a_r . Several typical shapes of preference functions are proposed in the literature the method defines various programs inflows, outflows and net flows. Two elements attribute preference function is d and $p_j(d)$, among $d = f_j(a) - f_j(b)$, a and b represents the difference scheme attribute value on the property of j is a preference function value, which means that from the point of view attribute j , plan b and plan a good degree than six typical preference functions include: common property, intended function, a linear relationship, grading property, with no difference in the interval linear, Gaussian attributes^[16].

In the decision attribute weights and decision matrix. We have known these data, which all values in the performance evaluation program for each attribute (or indicators) on the performance properties of the matrix composition. Policy makers determine the preference function of each property and determine the critical value of the parameter preference function required. PROMETHEE the decision is as follows.

1) In the first step, we determine the program pair wise comparisons of indices, π_{a_i, a_r} or π_{a_i} . We note w_j the weight of criterion f_j and we assume that the weights are normalized, and then computed as a weighted average of the preference functions.

$$\pi_{a_i, a_r} = \sum_{j=1}^n w_j \cdot P_j(f_j(a_i) - f_j(a_r)) \tag{5}$$

n is the number of indicators.

2) In the second step, in order to globally evaluate each action with respect to all the other ones. The leaving flow is a measure of the strength of an action a_i with respect to the other ones. Identify each program outflows. $\Phi^+ a_i$ Said outflow programs that a_i level due to the possibility of other programs. Larger value indicates $\Phi^+ a_i$ that the program a_i better. [17].

$$\Phi^+ a_i = \frac{1}{m-1} \sum_{r=1}^m \pi(a_i, a_r) = \frac{1}{m-1} \sum_{j=1}^n \sum_{r=1}^m w_j \cdot p_j(f_j(a_i) - f_j(a_r)) \tag{6}$$

the entering flow $\Phi^- a_i$ measures the weakness of action a_i with respect to the other ones:

$$\Phi^- a_i = \frac{1}{m-1} \sum_{r=1}^m \pi(a_r, a_i) = \frac{1}{m-1} \sum_{j=1}^n \sum_{r=1}^m w_j \cdot p_j (f_j(a_r) - f_j(a_i)) \quad (7)$$

the PROMETHEE rankings are based on the preference flows. They are discussed in the next section.

$$\Phi a_i = \Phi^+ a_i - \Phi^- a_i = \frac{1}{m-1} \sum_{r=1}^m \pi(a_i, a_r) - \pi(a_r, a_i) \quad (8)$$

3) In the third step, it is obvious that the best actions should have a high Φ^+ value (close to 1) and a low Φ^- value (close to 0), and thus a high positive Φ value[18].

According to plan and the inflow outflow, we are sorted, thereby partially integrated into the program sort (partial order), namely PROMETHEE I sort ^[19]. Preference relation may exist contradictions partial sort, so there is P, I, R3 kinds of preference relations.

4) And then, we determine the net flow $\Phi(a_i)$ represents a_i net flow solutions, namely the net flow value of outflows and inflows, Larger the value $\Phi(a_i)$, the better the description of the program a_i .

5) Finally, Determine complete order. Determine the level of non-inferior to the relationship, and constitute the whole sorting scheme based on the net traffic.

3. EMPIRICAL RESEARCH

3.1. Research framework Research framework

As alluded earlier, the objectives of this study are, to examine the relationship between the development of SME in Shanghai and business costs. In order to realize this objective, a research frame has been developed as illustrated in Fig.1. The framework is a simple liner model consisting of four categories. At the same time, the direct relationship the capital market and the external environment for the establishment and development of SMEs in Shanghai is the dominant force.

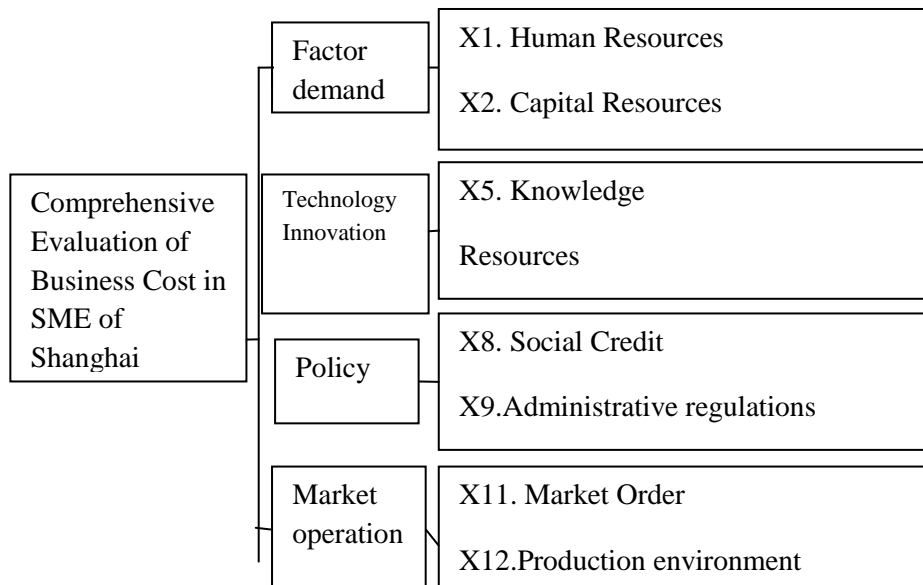


Fig1. Evaluation Structure

To test this hypothesis, we first constructed a model so that the model of development from the perspective of the development of SMEs starting a business cost management can be from people, objects, markets, government four areas to measure. Their evaluation index system is structured as follows Fig.1.

3.2. Sample Selection and Data Description

According to the above evaluation structure, we make a comprehensive evaluation system on business costs of Shanghai more scientific and operable. The scope of the study has limited within the scope of SMEs in Shanghai. We find a certain special object to research in Shanghai. According to the first batch of development funds intended for SMEs 36 projects supported research enterprise, which are supported 36 Shanghai SMEs in China in 2013, a total funding of 15.46 million RMB^[20]. The categories of funds are divided into two. The first one funds category is listed foster SME restructuring project. There are 27 companies, such us, Shanghai Leibo Electric shares a limited company, Shanghai Xiao Nan Guo source of sea food and beverage management companies. Another category of project mainly is broadening the financing channels for SMEs. There should be no less than 9 companies.

Among of 36 enterprises, we randomly selected 10 SMEs as the research object. there are Shanghai CITIC Health Pharmaceutical Co., Ltd., Shanghai Airlines Pentium construction Engineering Co., Ltd., Shanghai disainuo Pharmaceutical Co., Ltd., Shanghai ShenSi enterprise Development Co., Ltd., Shanghai Blue-ray Technology Co., Ltd, Shanghai Manhattan Aluminum Co. Ltd., Dr Quan Optoelectronics Technology Co., Ltd., Ke Boda technology Co., Ltd., Shanghai Laimei Thailand CNC machine Co., Ltd, Shanghai Gillion new software Co., Ltd. Among of them, we randomly selected five research enterprises as a sample. The survey data has a dedicated team to analyze the data evaluation.

Empirical data were obtained through a random survey in 2013 of 500 managers who had knowledge related aspects of organization, such as marketing, finance, human resources, manufacturing and administration. A total of 198 managers responded, while 103 questionnaires were returned to the researches with return to sender messages, indicating that the addresses were no longer valid. By discounting the number of return to sender mails, the final response rate accounted for 47.98%.

3.3. AHP Weight Setting

According to the index system for small and medium business costs in Shanghai, and the evaluation team rated the AHP pairwise comparison matrix structure, and AHP sorting and consistency checking. WI is the weight (0.1782, 0.4702, 0.2560, 0.0347), CR = 0.0430 < 0.1, this matrix has a satisfactory consistency. The weight of secondary each indicator was shown in Tab. 3.

Tab3. Two level index weights

WI1	WI2	WI3	WI4
0.2763	0.3073	0.5142	0.4740
0.1774	0.3420	0.0759	0.2143
0.4617	0.3089	0.0759	0.2143
0.0845	0.0418	0.3340	0.0975
CR=0.0182<0.1	CR=0.0052<0.1	CR=0.0191 <0.1	CR0.0104<0.1

Tab4. Total criteria I of I11, I12 ... I43 weights

Weight	Ri Value	Weight	Ri Value
Wi11	0.0492	Wi31	0.1316
Wi12	0.0316	Wi32	0.0194
Wi13	0.0823	Wi33	0.0855
Wi14	0.0151	Wi41	0.0289
Wi21	0.1445	Wi42	0.0131
Wi22	0.1608	Wi43	0.0252
Wi23	0.1452		

Then, two level weights calculated one level. PROMETHEE method will be used in its current weight, that level of relationship assignment. Can be obtained by the above criteria I corresponds to the total of I11, I12 ... I43 weights as shown in Tab 4.

3.4. GAIA Plane Sensitivity Analysis

BELTON put forward Geometric Analysis for Interactive Aid (GAIA), GAIA sensitivity analysis procedure enhances this analysis by showing what happens when the weights are changed within given limits. Its basic principle is to reduce the dimension of multivariate statistical analysis, matrix data analysis and decision analysis using principal component get great variance rotation property maximum separation, data that reflect the decision to use the two most important factors GAIA plane with visual output decision-making information. The area defined by the tip of the decision axis for the possible weights is drawn on the GAIA display.[21] Its position and its size give an indication on the difficulty of the decision problem.

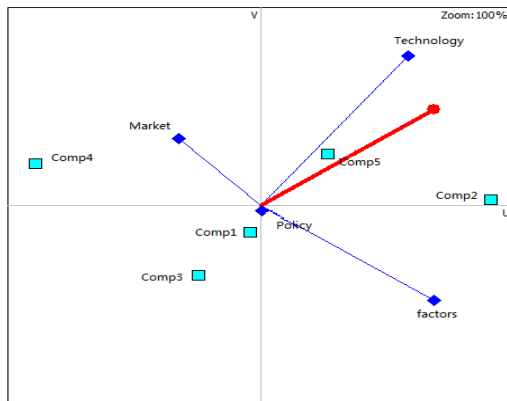


Fig3. GAIA 1

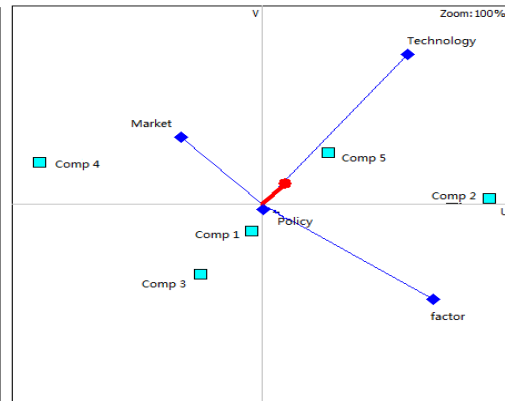


Fig4 GAIA 2

Fig.3 Market and the factors pointing to the contrary, said the conflicting relationship between the two properties. It shows a case where the decision axis stays globally in the same orientation. On the opposite, decision maker is small as few degrees of freedom are left in the decision process. Fig.4 Point program on behalf of the axes of space, with a square that its direction and the closeness of P_i on behalf of its pros and cons, and P_i optimum solution in the same direction. Worst scenario 4 furthest away from the P_i . Changes caused by the weight of evaluation results changes, thus leading to changes in the direction of P_i if the right technology is important to 0.04, the right to market weight to 0.32, a new evaluation results shown in Figure 3, GAIA plane as shown below. More difficult case even small variations of the weights could lead to quite different rankings. In such a case, the decision-maker should be very careful when assessing weights to the criteria.

4. CONCLUSIONS

In this paper, we show that prior research overestimates the concepts and components of business costs. In our investigation of Business costs for development of SMEs, we make three contributions to the corporate business cost structure. First, this study uses AHP, PROMETHEE and GAIA approach has examined and analysis a comprehensive evaluation index system of the Shanghai and cost of doing business for SMEs.

Second, as a representative covering SMEs fifteen categories, we selective the first batch of Shanghai development funds intended to support 36 small and medium enterprises in 2013. Experts have evaluated 36 projects. Survey and testing results of 5enterprise sample indicate support for the hypothesis.

Third, this article is based on two multi-attribute decision making method AHP and PROMETHEE cost of doing business for SME in Shanghai were evaluated. Different from other weight determination method AHP quantitatively determined by means of a linear programming model weights. We find that proposals to help developing of SMEs and manage business costs. decision-makers preference information on the cost of using the system in Shanghai SME business performance evaluation in terms of economy, technology, policy and market environment to provide decision support. We show how visual representations can improve both the preference modeling process and the interpretation of the analysis of a multicriteria decision problem through the PROMETHEE and GAIA methods.

Several limitations are acknowledged here. From a methodological point of view, this study is limited by the data that relies entirely on the perspective of one person. The study does not prescribe the “how” issues in changing the managerial practices. Further research in this area is likely to yield new and useful insights.

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