

# Small and Medium-Sized Enterprise Supply Chain Supplier Assessment Based on AHP

**Xianwu Hu**

*City college of Wenzhou university, Wenzhou 325035, Zhejiang, China*

## Abstract

For evaluating suppliers in supply chain management, in this paper, we establish the evaluation index system, then use AHP to determine the weight of each evaluation index. Finally, we use Linear Weighting Method to research on supplier performance from perspective of quantitative research and give the measurement process. The empirical research proves the method is scientific and feasible.

Key words: SUPPLY CHAIN, PERFORMANCE EVALUATION, INDEX SYSTEM, AHP, DECISION METHOD

## 1. Introduction

In today's fierce competitive environment, in order to maintain the existing market share, the construction of supply chain and strengthen the supplier management is necessary. Competition between individual enterprises has gradually transformed into competition between supply chains, enterprises realize that success will depend on its ability to build and manage the supply chain network as well. One of the most important link in the reconstruction of supply chain is to select the appropriate suppliers.

At present, the most widespread way to study the theory of supplier management is how to selection and evaluation supplier. Through the analysis we find that the current research focus on the supplier selection method, less from the system level to explore; Other literature research rarely differentiate supplier selection evaluation and performance evaluation of research in later period. PRTM, a research institute of supply chain, has put forward 11 indexes, which are delivery performance, order fulfillment, the perfect order fulfillment, response time of supply chain, production flexibility, total logistics management cost, value-added productivity, warranty cost, cash flow turnaround time, inventory turnover days of supply chain and asset turnover, to measure supply chain performance[1]. Bemano has established the system of supply chain performance evaluation from

3 aspects. Resource indexes include: total cost, distribution cost, manufacturing cost, inventory cost and return on investment; output indexes include: sales, profits, order fulfillment rate, on-time delivery, stockout, customer response time, manufacturing lead time, shipping errors and customer complaints; flexibility indexes include: time flexibility, quantity flexibility, product flexibility and mix flexibility[2]. Brewer and Speh review supply chain performance from 4 aspects, which are targets of supply chain management, the interests of end customers, financial benefits and the development of supply chain management [3]. Professor Roger thinks customer service quality is the most important index to evaluate overall performance of supply chain [4]. Supply chain performance evaluation is conducted from 10 aspects. Supply indexes: reliability of the supplier and supplier's lead time; transformation indexes: process reliability, processing time and completion status against schedule; transport indexes: order fulfillment rate, replenishment lead time and transport days; demand management indexes: the total inventory cost of supply chain. Mercer, a management consulting company, suggests adopting the following 7 indexes to evaluate performance of the third-party logistics and the third-party suppliers. Those indexes are on-time transportation; on-time delivery; transport accuracy; order fulfillment rate; project fulfillment rate;

inventory accuracy and damage rate [5].

The purpose of this paper is to research performance evaluation systems and methods based on the existing domestic and international theories of supply chain performance evaluation. According to features of SMEs' participation in supply chain operation, evaluation index system of supplier selection in supply chain has been established. Finally theories and methods of supply chain performance evaluation of SMEs have been applied to some small enterprise and the result has provided some decision support for upstream partner selection of supply chain of the small enterprise.

## 2. Establish the hierarchical model of supplier's performance evaluation

In the operating environment with keen competition, the complete supply chain management is an important tool for SMEs to increase their competitiveness. An ideal supplier will bring huge benefits to the supply chain organization. Quality of suppliers will have direct influence over the operating cost of supply chain organization. The daily issue of supply

chain management faced by SMEs is to set up an objective and targeted evaluation index system as well as an evaluation model with comprehensive evaluation capacity so as to evaluate good suppliers and develop long-term partnership with them.

Hierarchical model of supplier performance evaluation fit for SMEs as in Figure 2-1 has been built according to empirical research on supplier selection of the supply chain of SMEs as well as the hierarchical model of supplier performance evaluation based on the balanced scorecard. Evaluation indexes of SMEs on suppliers generally focus on several parameters such as quality, price, delivery, after-sales service, etc., which can be regarded as the first-class evaluation indexes. Accordingly, second-class evaluation indexes include Product acceptance rate, Ratio of rework or return, suppliers' price advantages, Price of supplier-offered products, transportation cost of products, on-time delivery rate, order fill rate, Customer complaint resolution time, customer complaint treatment satisfaction ratio, etc.

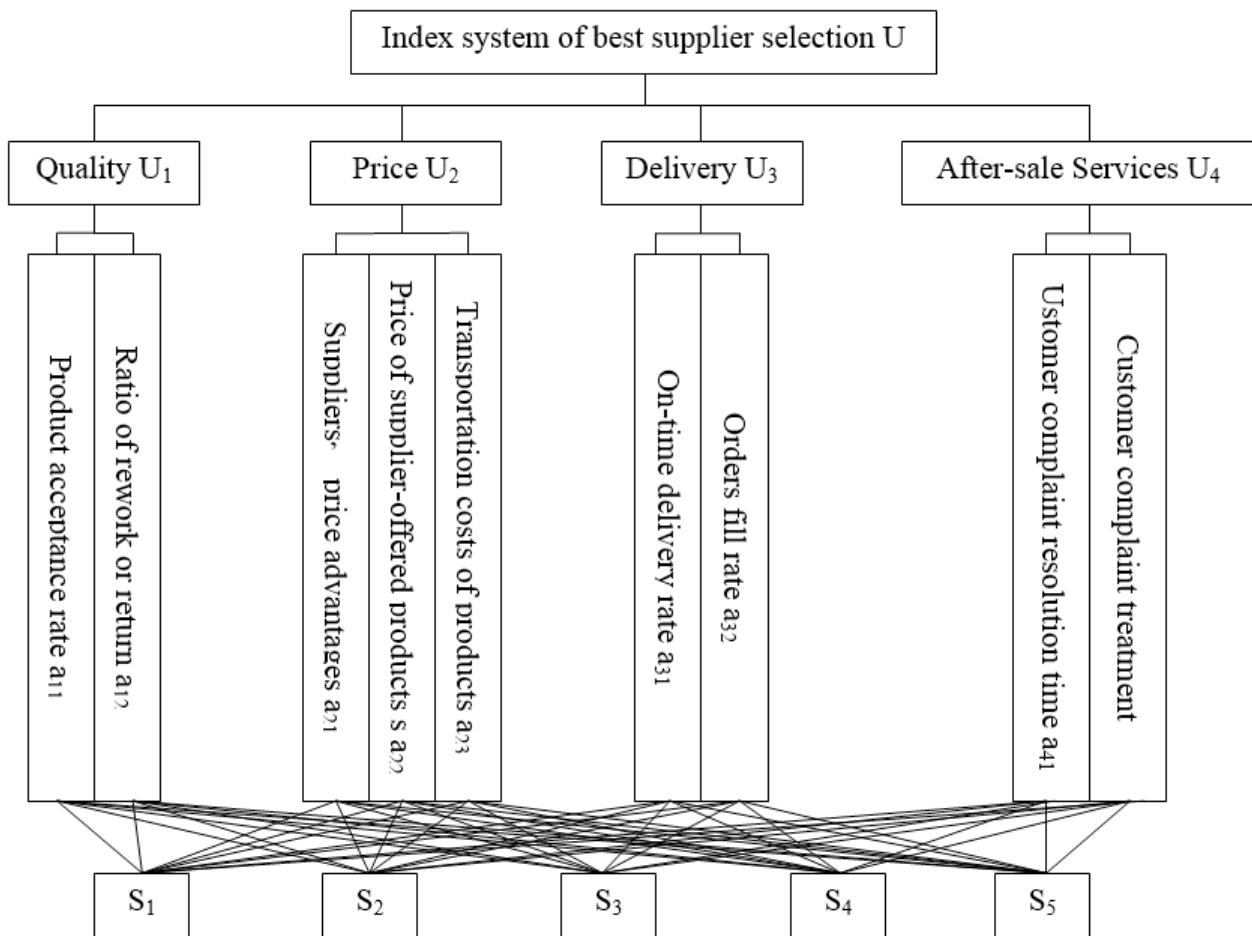


Figure 1. the hierarchical model of supplier's performance evaluation

**3. Supplier selection evaluation based on AHP and linear weighting method**

Index systems of performance evaluation above are taken into consideration to calculate weights relative to targets hierarchically and to build hierarchical judgment matrix. Moreover, by matrix multiplication, evaluation on the degree of implementation of the target is made hierarchically from low level to high level, from the index to the criteria, and finally to the highest goal. Consistency check on hierarchical sequencing and judgment matrix should be conducted repeatedly until the result is satisfying. Evaluation value of supply chain performance is the sum of product of relative priority ordering of all kinds of indexes considered or the weight of supply chain performance evaluation and the corresponding index.

**4. Empirical research on supplier selection evaluation**

Hangzhou Tianshun Urban Landscape Engineering Co., Ltd. is a professional construction enterprise with the second-class Qualification of Urban Landscape Greening Enterprises. The company has the administrative and finance department, quality and safety department, project management department, landscape design department, business department, nursery base, etc. and there are almost 100 permanent staff who engage in landscape greening design, construction, maintenance and management, etc. For supplier selection evaluation, 5 nursery stocks suppliers are selected as samples to be compared and analyzed. The questionnaire is designed according to established index system and AHP software yaahp Version 0.5.1 is adopted to process some data of empirical research.

Suppose some enterprise adopts 4 indexes, quality, price, delivery and after-sales service, to evaluate suppliers. Alternative suppliers are S1, S2, S3 and S4. Among them,

S1: Hangzhou Xiaoshan Xinjie Qingfang Horticultural Farm  
 S2: Hangzhou Xiaoshan Xinjie Colorful Horticultural Farm

S3: Zhejiang Yuyao Siming Honest Landscaped Field

S4: Hangzhou Runtu Horticultural Technology Co., Ltd.

S5: Shengzhou Shengda Landscaped Sales Department

1~9 scaling methods are adopted here to determine the relative importance of index (as in Table 4-1)

**Table 1.** 1~9 grading scales

Score	Meaning
1	Two targets are of equal importance
3	One target is more important than the other one
5	One target is obviously more important than the other one
7	One target is much more important than the other one
9	One target is extremely more important than the other one

If the result of comparison is between two scales, 2, 4, 6 and 8 can be adopted.

The following calculation can be made first according to data gained to determine weight of each index. Calculate all the following data to three decimal places.

1) First figure out sum of each column of pairwise comparison matrix to get the following Table 4-2, Table 4-3, Table 4-4, Table 4-5 and Table 4-6:

**Table 2.** Total computation table

U	U <sub>1</sub>	U <sub>2</sub>	U <sub>3</sub>	U <sub>4</sub>
U <sub>1</sub>	1	1/2	2	2
U <sub>2</sub>	2	1	3	3
U <sub>3</sub>	1/2	1/3	1	1
U <sub>4</sub>	1/2	1/3	1	1
Σ	4.000	2.167	7.000	7.000

**Table 3.** Quality computation table

U <sub>1</sub>	a <sub>11</sub>	a <sub>12</sub>
a <sub>11</sub>	1	3
a <sub>12</sub>	1/3	1
Σ	1.333	4.000

**Table 4.** Price survey

U <sub>2</sub>	a <sub>21</sub>	a <sub>22</sub>	a <sub>23</sub>
a <sub>11</sub>	1	2	4
a <sub>12</sub>	1/2	1	3
a <sub>23</sub>	1/4	1/3	1
Σ	1.750	3.333	8.000

**Table 5.** Delivery computation table

U <sub>3</sub>	a <sub>31</sub>	a <sub>32</sub>
a <sub>31</sub>	1	3
a <sub>32</sub>	1/3	1
Σ	1.333	4.000

**Table 6.** After-sales service survey

U <sub>4</sub>	a <sub>41</sub>	a <sub>42</sub>
a <sub>41</sub>	1	3
a <sub>42</sub>	1/3	1
Σ	1.333	4.000

2) Calculate the mean value of each column of standard pairwise comparison matrix with each element of pairwise comparison matrix divided by the sum of corresponding column. These mean values are weights of all programs in upper hierarchy as in Table 4-7, Table 4-8, Table 4-9, Table 4-10 and Table 4-11:

**Table 7.** Total computation tables

U	U <sub>1</sub>	U <sub>2</sub>	U <sub>3</sub>	U <sub>4</sub>	Weight
U <sub>1</sub>	0.250	0.231	0.286	0.286	0.263
U <sub>2</sub>	0.500	0.462	0.429	0.429	0.455
U <sub>3</sub>	0.125	0.154	0.143	0.143	0.141
U <sub>4</sub>	0.125	0.154	0.143	0.143	0.141

**Table 8.** Quality computation table

U <sub>1</sub>	a <sub>11</sub>	a <sub>12</sub>	Weight
a <sub>11</sub>	0.750	0.750	0.750
a <sub>12</sub>	0.250	0.250	0.250

**Table 9.** Price survey

U <sub>2</sub>	a <sub>21</sub>	a <sub>22</sub>	a <sub>23</sub>	Weight
a <sub>21</sub>	0.571	0.600	0.500	0.557
a <sub>22</sub>	0.286	0.143	0.300	0.100
a <sub>23</sub>	0.375	0.125	0.320	0.123

**Table 10.** Delivery computation table

U <sub>3</sub>	a <sub>31</sub>	a <sub>32</sub>	Weight
a <sub>31</sub>	0.750	0.750	0.750
a <sub>32</sub>	0.250	0.250	0.250

**Table 12.** Indexes of consistency check

Order Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58

$$CR = \frac{CI}{RI} = \frac{0.003}{0.89} = 0.003 < 0.1$$

So judgment matrix is proved to be acceptable. Similarly, other judgment matrixes are also acceptable.

**Table 11.** After-sales service survey

U <sub>4</sub>	a <sub>41</sub>	a <sub>42</sub>	Weight
a <sub>41</sub>	0.750	0.750	0.750
a <sub>42</sub>	0.250	0.250	0.250

3) Consistency check. First, multiply the pairwise comparison matrix being tested by its Eigen vector, the result of which is called weighted sum vector. For example,

$$\begin{bmatrix} 1 & \frac{1}{2} & 2 & 2 \\ 2 & 1 & 3 & 3 \\ \frac{1}{2} & \frac{1}{3} & 1 & 1 \\ \frac{1}{2} & \frac{1}{3} & 1 & 1 \end{bmatrix} \begin{bmatrix} 0.263 \\ 0.455 \\ 0.141 \\ 0.141 \end{bmatrix} = \begin{bmatrix} 1.055 \\ 1.827 \\ 0.565 \\ 0.565 \end{bmatrix}$$

Secondly, divide component of each weighted sum vector by component of the corresponding eigen vector respectively.

$$\frac{1.055}{0.263} = 4.011 \quad \frac{1.827}{0.455} = 4.015$$

$$\frac{0.565}{0.141} = 4.007 \quad \frac{0.565}{0.141} = 4.007$$

Then, calculate the mean value of result of the second procedure.

$$\lambda_{max} = \frac{4.011 + 4.015 + 4.007 + 4.007}{4} = 4.010$$

Next, calculate the coincidence index CI.

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{4.010 - 4}{4 - 1} = 0.003$$

Finally, figure out the coincidence rate CR. CR=CI/RI

Saaty gives RI, the mean value of consistency check. Figure out the arithmetic mean value of 1000 maximum eigenvalue of random judgment matrix to gain the following mean random indexes of consistency check, as in Table 4-12.

4) Hierarchical total sequencing

Weights corresponding to each index of supply chain performance evaluation are:

Suppliers' price advantages

$$a_{21}: 0.557 \times 0.455 = 0.253$$

$$\text{Product acceptance rate } a_{11}: 0.750 \times 0.263 = 0.197$$

Price of supplier-offered products a22:  
 $0.320 \times 0.455 = 0.146$

On-time delivery rate a31: $0.750 \times 0.141 = 0.106$

Customer complaint resolution time  
a41: $0.750 \times 0.141 = 0.106$

Return rate a12: $0.250 \times 0.263 = 0.066$

Transportation cost of products  
a23: $0.123 \times 0.455 = 0.056$

Orders fill rate a32: $0.250 \times 0.141 = 0.035$

Customer complaint treatment satisfaction ratio

a42: $0.250 \times 0.141 = 0.035$

The above calculation is manual calculation while the following result is gained from processing by the AHP software yaahp Version 0.5.1.

It shows that weights of price and quality are heavier. Customers relatively pay more attention to suppliers' price advantages, Product acceptance rate, Price of supplier-offered products, on-time delivery rate and Customer complaint resolution time.

Weight vector corresponding to index layer:

$$\omega = (a_{11}a_{12}a_{21}a_{22}a_{23}a_{31}a_{32}a_{41}a_{42})^T$$

$$= (0.197 \ 0.066 \ 0.253 \ 0.146 \ 0.056 \ 0.106 \ 0.035 \ 0.106 \ 0.035)^T$$

Evaluation formula:

$$y = 0.197 \times 1 + 0.066 \times 2 + 0.253 \times 3 + 0.146 \times 4 + 0.056 \times 5 + 0.106 \times 6 + 0.035 \times 7 + 0.106 \times 8 + 0.035 \times 9$$

Evaluation results :

Scores and the calculated result equal to 3.7220 of Hangzhou Xiaoshan Xinjie Qingfang Horticultural Farm

Scores and the calculated result equal to 3.2878 of Hangzhou Xiaoshan Xinjie Colorful Horticultural Farm

Scores and the calculated result equal to 3.4836 of Zhejiang Yuyao Siming Honest Landscaped Field

Scores and the calculated result equal to 3.3839 of Hangzhou Runtu Horticultural Technology Co., Ltd.

Scores and the calculated result equal to 3.1463 of Shengzhou Shengda Landscaped Sales Department

It shows the performance evaluation rank.

Hangzhou Xiaoshan Xinjie Qingfang Horticultural Farm> Zhejiang Yuyao Siming Honest Landscaped Field> Hangzhou Runtu Horticultural Technology Co., Ltd>Hangzhou Xiao Shan Xinjie Colorful Horticultural Farm> Shengzhou Shengda Landscaped Sales Department.

### 5. Conclusion

According to actual situation, there are a lot of problems. The project manager of Hangzhou Tianshun Urban Landscape Engineering Co., Ltd. pointed out deficiency of 1~9 scales when filling in the questionnaire. There is fuzziness and uncertainty in comparison of index and score chart and some adjustment has been done later. It shows that much improvement of traditional AHP need to be done.

Researching supplier selection evaluation of SMEs from the angle of partnerships and coordination, setting up a set of indexes of objectivity and accuracy referring to the balanced scorecard, adopting AHP to determine the index weight and choosing the supplier by simple linear weighting are feasible. By empirical analysis on supplier selection in landscaped projects, it is found that suppliers' price advantages,

Product acceptance rate, Price of supplier-offered products, on-time delivery rate and Customer complaint resolution time are valued.

When conducting supplier selection evaluation, enterprises often consider many evaluation indexes and different enterprises pay attention to different indexes. Referring to the balanced scorecard, this research divides supplier evaluation standard into 4 aspects, quality, price, delivery and after-sales service, including 9 quantitative and qualitative evaluation indexes. Selection and definition of each evaluation index can be reference for relevant future research.

Data processing function of the AHP software yaahp Version 0.5.1 brings convenience to writing and plays a role in the process of supplier selection. At last, Hangzhou Xiaoshan Xinjie Qingfang Horticultural Farm, which relatively conforms to the purchase situations in actual operation, has been selected.

At present theoretical researches on supply chain performance evaluation are relatively dispersive and there is no systematical theory. Researches on supply chain evaluation methods are relatively fewer. Research on supply chain performance evaluation of SMEs can not only promote further enrichment and improvement of supply chain theory but also provide decision support for supply chain management of SMEs.

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## Analysis of Stock Market Value Based on Equity Valuation

**Li Shen**

*School of Finance, Zhejiang University of Finance & Economics, Zhejiang, China*

**Xuedong Zheng**

*School of Mathematics and Statistics, Zhejiang University of Finance & Economics, Zhejiang, China*

### Abstract

This paper uses data of smelting industry of ferrous metal in stock market to check the explanatory capacity of mathematical model of modern residual income on Chinese stock price, and adopts  $cr_{10}$  as the substitution variable of non-accounting information variable  $v$  and CAPM model to calculate the capital cost. Choose 2% and 6% respectively as the risk premium, taking into consideration the influence of capital cost difference of the model. The analysis shows that the explanatory capacity of the residual income model on stock price is better than that of the residual income model derived from the assumption of linear information dynamic excluding net asset.

Key words: EQUITY VALUATION, RESIDUAL INCOME MODEL, CHINESE STOCK MARKET

### 1. Introduction

Equity valuation is a big theoretical issue [1-2]. The rapid development and inflation of global stock market has exacerbated the trend of asset bubble,

which makes the bubble explanation and research an urgent task of the financial theory research in the new century. The equity valuation is the beginning and an important composition in the bubble research of stock