

On the Performance Evaluation of the Chinese Container Liner Shipping Companies: A Case Study on COSCON, CSCL, and Sinolines by Applying an AHP Model

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Abstract : This study aims at helping Chinese container liners keep constant competitiveness in the heated competition. Analytic Hierarchy Process (AHP), a mathematics-based, multi-criteria decision analysis methodology is applied in the study to the performance evaluation on the three biggest Chinese container liners: COSCON, CSCL, and Sinolines. Through the final results of AHP model, we completely learn the current situation of Chinese liners, therefore they are able to enhance the competitive advantage from modifying operation strategy and competition strategy in accordance with the shipping market.

Key words : COSCON, CSCL, Sinolines, AHP (Analytic Hierarchy Process), performance evaluation

1. Introduction

With the fast growth of China's economy and trade, in the near future China will surpass U.S.A and become the biggest market for circulation of the containers in foreign trade. Moreover, China's entrance into the World Trade Organization (WTO) results in lessen restriction from the Chinese government in entering the Chinese shipping market. At this proper time, most of foreign shipping giants have rushed in and set up their own container liner branches in Mainland China one after another, which have intensified the competition on the Chinese market. Facing the competition pressure from the strong rivals, that what should Chinese container liner shipping companies do at first is to make a comprehensive performance evaluation on the current situation of themselves.

The aim of this study is to apply Analytic Hierarchy Process (AHP) to the performance evaluation on Chinese container liners. After finding advantages and disadvantages during the evaluation, we are able to take the suitable strategies so that Chinese container lines companies will keep up an unassailable position in the heated competition.

In view of its prestige in the marine industry and its own scale, COSCON, CSCL, and Sinolines are general acknowledged as the representatives of Chinese container

liners that have rich competition strength. Data in Figure 1 shows the weight of these three companies. Taking COSCON, CSCL, and Sinolines for example, this study introduces the application of Analytic Hierarchy Process.

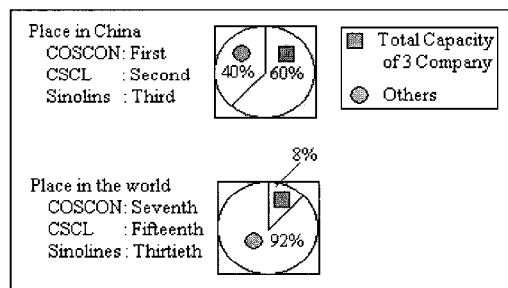


Fig. 1 Current Place of the Objects

2. Research Methodology

2.1 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP), as the main research methodology in this study, is a mathematics-based, multi-criteria decision analysis methodology that allows subjective as well as objective factors to be considered in the progress. Satty(1980) developed AHP in the early 1970s to help decision-makers deal with the complexity inherent in multi-criteria based decisions.

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By using a systematic hierarchy structure, complex estimation criteria can be represented clearly and definitely. Ratio scales are utilized to make reciprocal comparisons for each element and each layer. After completing the reciprocal matrix, one can obtain comparative weights for each element.

Table 1 Definition of Numerical Values for AHP

Numerical Values	Definition
1	Equally more important or preferred
3	Slightly more important or preferred
5	Strongly more important or preferred
7	Extremely more important or preferred
9	Most important or preferred
2,4,6,8	Intermediate values to reflect compromise
Reciprocals	Used to reflect dominance of the second alternative as compared with the first

Let's consider the criteria $C_1, \dots, C_i, \dots, C_j, \dots, C_n$ some one level in hierarchy. One wishes to find their weights of importance, $w_1, \dots, w_i, \dots, w_j, \dots, w_n$, on some elements in the next level. Allow a_{ij} , $i, j=1, 2, \dots, n$ to be the importance strength of C_i when compared with C_j . The matrix of these numbers a_{ij} is denoted A , or

$$AW = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{i1} & a_{i2} & \dots & a_{ij} & \dots & a_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nj} & \dots & a_{nn} \end{bmatrix}_{m \times n}$$

Where $a_{ij} = 1/a_{ji}$, that is, A is reciprocal. If one's judgment is perfect in all comparisons, then $a_{ik} = a_{ij} \times a_{jk}$ for all i, j, k and one calls the matrix A consistent.

An obvious case of a consistent matrix A is its elements

$$a_{ij} = w_i / w_j, \quad i, j = 1, 2, \dots, n.$$

Thus, when matrix A is multiplied by the vector formed by each weighting $w = (w_1, w_2, w_n)^T$, one gets:

$$AW = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_j & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_j & \dots & w_2/w_n \\ M & M & & M & & M \\ w_i/w_1 & w_i/w_2 & \dots & w_i/w_j & \dots & w_i/w_n \\ M & M & & M & & M \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_j & \dots & w_n/w_n \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ M \\ w_j \\ M \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ M \\ w_j \\ M \\ w_n \end{bmatrix} = nw$$

Because a_{ij} is the subjective rating given by the

decision-maker, there must be a distance between it and the actual values w_i / w_j . Thus, $Aw = nw$ can not be calculated directly. Therefore, Saaty(1980) suggested using the maximum eigenvalue, λ_{max} , of the solution of matrix A to replace n , then

$$Aw = \lambda_{max} w. \quad \left(\lambda_{max} = \sum_{i=1}^n \frac{(AW)_i}{n W_i} \right)$$

By this method, one can obtain the characteristic vector, referred to as the priority vector. The closer λ is to a n (the number of attributes/elements), the more consistent the result is.

Besides λ_{max} , the other consistency ratio, denoted by CR, also measures the consistency of the judgment. It is the ratio of the consistency index (CI) of the comparison matrix to the consistency index of a randomly generated reciprocal index from scale 1 to 9 with both matrices being of the same order (i.e., the same n). A consistency ratio of 0.10 or less is considered acceptable.

Table 2 Values of the Random Index (RI)

Order n:	1	2	3	4	5	6	7	8	9	10
Value of RI:	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

2.2 Questionnaire

Since there are subjective criteria that are difficult and/or describe exactly, a questionnaire that conducted in August 2003, from which we can get specialists' opinions depending on their experience and professional knowledge is used as the sub-methodology in the study.

The target populations are 50 well-experienced experts working in different departments of COSCON, CSCL, Sinolines and forwarding companies that are regarded as the representatives of cargo owners who have close relationship with these three Chinese container lines companies. Since the headquarters of COSCON, CSCL, and Sinolines are located in Shanghai, this survey was carried out in Shanghai. 38 of 50 made meaningful response to the questionnaire. So the final response rate was 76 percent of the original samples.

3. Application of AHP

3.1 Evaluation Criteria Selection

- 1) Criteria of management performance

All the transportation is operated on company's own shipping line. Sales ability determines company's transport

volume. Internal organization situation means the organ structure of the company. Human resource management is one of the basic functions of business management.

2) Criteria of customer service quality (CSQ) performance

Based on the references to many scholars' opinions, I identified six service quality attributes. Punctuality means that vessels sail following its schedule. Freight rate is very sensitive when customers choose a liner. Shipping quality reflects the transport competence of shipping companies. Post-sale service means the continuous service after the transportation. Response ability to accidents plays an important role in the fluctuant shipping market. E-service helps customers get their cargo information through internet.

3) Criteria of financial performance

Financial performance directly reflects the structuring profit and efficiency of a company, so most companies use a financial index to represent their performance. Financial structure shows the characteristics of the company. Intangible assets, to some degree, is equal the potential profit. The higher the reputation of a company is, the more opportunities the company will have.

Table 3 Performance Evaluation Criteria

Criteria no.	Evaluation criteria	Example and statement
Management Performance Criteria (C ₁)	C _{1 1} Line service	Shipping routes
	C _{1 2} Sales ability	Sales' sincerity Experience Negotiation ability
	C _{1 3} Int'l organization situation	Reasonable internal organization structure Administration efficiency
	C _{1 4} HR management	Staff education Staff assessment Staff management
CSQ Performance Criteria (C ₂)	C _{2 1} Punctuality	Sailing on schedule
	C _{2 2} Freight rate	Price of service
	C _{2 3} Shipping quality	Safety of cargo transportation
	C _{2 4} Post-sale service	After sale service Customer tracing
	C _{2 5} Response ability to accidents	Response action and speed of the company when there is sudden change in the market
	C _{2 6} E-service	Tracing cargo information on internet
Financial Performance Criteria (C ₃)	C _{3 1} Profit-making ability	Financial index
	C _{3 2} Financial structure	Transparency & Modernization of financial system
	C _{3 3} Intangible assets	Company's reputation

3.2 Model Building

The framework of AHP model is shown in Fig. 2. The top level of the hierarchy represents the overall objective of the process. In the approach discussed in this paper, this top level is "Performance evaluation on container liner shipping company" (A), then the overall objective of the process is broken down into components: management performance criteria (C₁), CSQ performance criteria (C₂), financial performance criteria(C₃). These factors compose the second level, which is named as criteria level. Subsequently, each element in the second level spans a group of sub elements in the third level named as sub-criteria level: from line service (C_{1.1}) to intangible assets (C_{3.3}). The final level named as decision level represents the array of possible outcomes. In this case, the outcome is the array of COSCON, CSCL, and Sinolines.

3.3 Scale of Criteria Decision

Nine-point ratio scale is a very vague and subjective definition way, so the scale could be changed to any numbers of personal or group preference. A new nine-point ratio scale, which is derived from the original one and is more suitable for the application of AHP method in this study, is explained in Table 4.

Table 4 New Nine-point Ratio Scale

Numerical Values	Definition in Case Study	Original Definition
1	Difference of ratio(DR) between two companies equals zero.	Equally important
2	DR lies in the interval between 0.001 and 0.125*	Intermediate value between 1 and 3
3	DR lies in the interval between 0.126 and 0.250	Slightly important
4	DR lies in the interval between 0.251 and 0.375	Intermediate value between 3 and 5
5	DR lies in the interval between 0.376 and 0.500	Strongly important
6	DR lies in the interval between 0.501 and 0.625	Intermediate value between 5 and 7
7	DR lies in the interval between 0.626 and 0.750	Extremely important
8	DR lies in the interval between 0.751 and 0.875	Intermediate value between 7 and 9
9	DR lies in the interval between 0.876 and 1.000	Most important
Reciprocals	Used to reflect dominance of the second alternative as compared with the first (A)	The same as A

* There are 8 levels between 1 and 9, when 1 unit is divided by 8, we get the result of 0.125. So the increase of every 0.125 is regarded as the increase of each scale.

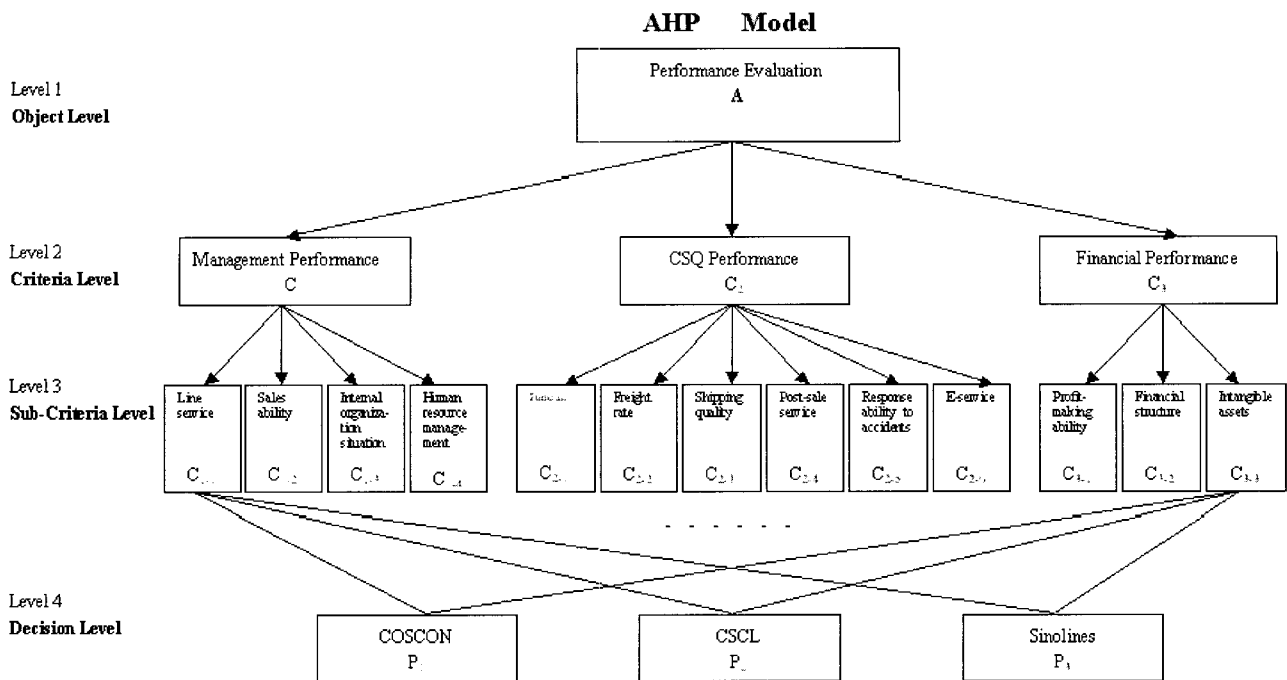


Fig. 2 AHP Model

COSCON, CSCL, and Sinolines will be scored respectively on each criterion. We regard the highest score of each criterion as 1 unit, and then we calculate the ratio of these three companies, to the third decimal, according to each criterion. After we know the ratio, the difference of ratio will work out naturally. At last, choose the corresponding scale of each criterion shown in Table 6 according to the difference of ratio.

All criteria are divided into two groups: objective criteria and subjective criteria.

1) Questionnaire for subjective criteria

The questionnaire consists of three parts. The first part is made to determine the relative importance of COSCON, CSCL, and Sinolines derived from each subjective criterion in level 3 of AHP model. The second part is made to determine the relative importance of all elements in level 3 derived from each single criterion in level 2 of AHP model. The third part is made to determine the relative importance of all elements in level 2 derived from the single element in level 1 of AHP model.

The receivers were asked to give a score rating, with 10-point scale, to each of the factors listed on questionnaire according to their working experience. Based on all received response sheets, the average value of each factor was calculated. These average values which are estimated to become closer to the actual condition will be utilized as the base data in the study.

In arranging the received grading scores of the experts the following steps are taken:

- Step 1 : Count up the number of people choosing each scale.
- Step 2 : Calculate average value of each factor.
- Step 3 : Calculate the value of COSCON:CSCL:Sinolines.
- Step 4 : According to Table 6, determine the pairwise comparison matrix of each subjective criterion in the third level of AHP model.

2) Data analysis for objective criteria

There are three objective criteria, i.e. line service, punctuality, and freight rate in the AHP model. The scale of each criterion is determined on the base of data analysis. The objective criteria and the subjective criteria should be weighted with the same yardstick, that is to say,

- Step 1 : Get the data of each objective criterion.
- Step 2 : Regard the best score as 1 unit, and then calculate the ratio of these three companies.
- Step 3 : Calculate the difference of ration.
- Step 4 : Make pairwise comparison matrix for each objective criterion.

3.4 Criteria Weights Computation

Based on the AHP method, final weights result is shown in Table 5.

Obviously, COSCON ranks first, Sinolines the second,

Table 5 Final Rank Result

W	A(1)													Total Weight (W _{py})	Rank
	C ₁ (0.297)				C ₂ (0.540)						C ₃ (0.163)				
	C ₁₋₁ 0.413	C ₁₋₂ 0.292	C ₁₋₃ 0.187	C ₁₋₄ 0.108	C ₂₋₁ 0.308	C ₂₋₂ 0.173	C ₂₋₃ 0.228	C ₂₋₄ 0.102	C ₂₋₅ 0.137	C ₂₋₆ 0.052	C ₃₋₁ 0.482	C ₃₋₂ 0.214	C ₃₋₃ 0.304		
W _{c_j}	C ₁ C ₁₋₁ 0.123	C ₁ C ₁₋₂ 0.087	C ₁ C ₁₋₃ 0.056	C ₁ C ₁₋₄ 0.032	C ₂ C ₂₋₁ 0.166	C ₂ C ₂₋₂ 0.093	C ₂ C ₂₋₃ 0.123	C ₂ C ₂₋₄ 0.055	C ₂ C ₂₋₅ 0.074	C ₂ C ₂₋₆ 0.028	C ₃ C ₃₋₁ 0.079	C ₃ C ₃₋₂ 0.035	C ₃ C ₃₋₃ 0.050		
P _{1j} j 1 13	0.635	0.570	0.208	0.268	0.493	0.196	0.547	0.297	0.136	0.528	0.117	0.249	0.625	0.405	1
P _{2j} j 1 13	0.287	0.333	0.131	0.117	0.196	0.493	0.109	0.163	0.239	0.332	0.200	0.157	0.238	0.238	3
P _{3j} j 1 13	0.078	0.097	0.661	0.615	0.311	0.311	0.344	0.540	0.625	0.140	0.683	0.594	0.137	0.357	2

and CSCL the third. Among the three criteria, CSQ performance ranks the first, management performance the second, and financial performance the third.

$$\text{Note: } W_{P_{ij}} = \sum_{j=1}^{13} P_{ij} W_{c_j} \quad i=1,2,3$$

3.5 Result Analysis

1) COSCON

COSCON ranks first in line service, sales ability, shipping quality, punctuality, E-service and intangible assets criterion. While COSCON got low score in internal organization situation, human resource management, response ability to accident, and profit-making ability criteria. COSCON, as a long-history state-owned company, has several shortcomings, which traditional state-owned enterprise owns in common.

- Overstaffing in organizations*
- Excessive non-business personnel*
- Government interference*
- Excess capacity & less cargo*

2) CSCL

CSCL ranks highest in freight rate criterion and got high score in domestic-trade line service. In the container shipping industry, CSCL's low freight rate has strong competitive advantage. CSCL calls 12 China base ports plus most river ports along the Yangtze River, the Pearl River and their branches. The carrying capacity of CSCL has dominated the coastal transport in China. CSCL is also the strongest carrier in domestic-trade transport.

However, besides the same disadvantages as that of COSCON, CSCL does not do well in customer service. There are six sub-criteria in customer service criterion. But CSCL got the lowest scores in half of them. The product of shipping industry is service. The importance weight of CSQ

nearly doubles the weight of the next criterion, so it is the most important criterion to be considered in performance evaluation. Although CSCL provides customers with the lowest freight rate, big customers who have stable source of goods would rather choose the carriers with higher freight rate but better customer service.

3) Sinolines

Sinolines ranks first in internal organization situation, human resource management, post-sale service, response ability to accident, profit-making ability, and financial structure.

While Sinolines got lowest scores in line service, sale ability, E-service, and intangible assets. Generally speaking, the low scores are resulted from the same reason: small scale. Marine transportation is a support service of Sinotrans. The Group does not focus on container shipping so the scale development of Sinolines is limited. Sinolines taking advantages of the strong global network of Sinotrans Group which is the biggest freight forwarding company in China does not have its own sales strength. Without a complete line service, it is difficult to become well known throughout the world. In a word, Sinolines' small scale limits its growth rate.

4. Suggestions

4.1 M&A, Consolidation Strategy

1) Weak-Strong M&A

The Chinese government should encourage COSCON, CSCL, and Sinolines to merge small-scale shipping enterprises. From the viewpoint of medium, small-scale shipping enterprises, they can survive, depending on the strength of large-scale companies, in the shipping market, even if the market demand falls short of supply. From the

viewpoint of COSCON, CSCL, and Sinolines, on one hand, they can increase the source of goods and improve their service through taking advantage of acquired company's local marketing network. On the other hand, their occupation rate of the container shipping market will be increased so that they can prevent infiltration of foreign container lines companies in inland China.

2) Strong-Strong Consolidation

Also, the Chinese government should encourage these large shipping enterprises to ally in order to improve competition capability by using given asset efficiently. When we relate the strong carrying capacity of COSCON, CSCL with the sufficient source of goods of Sinolines, the profit-making ability of each company will increase a lot. At the same time, due to the economics of scale, the reduced cost, to some degree, means some profit to the cargo owner, as a reply, the increasing market share strengthens each Chinese container liner's competitive power in the container shipping market.

4.2 Domestic-trade Container Transport Development

The overall development of the national economy and implementation of the western development strategy have encouraged domestic commodities in China to circulate and afforded to take sufficient cargo shipment for the domestic waterway container transport. Meanwhile, the active promotion and the policy support of the competent government authorities have also created favorable environment for development of the domestic container transport. Moreover, Compared with foreign competitors, COSCON, CSCL, and Sinolines are much more familiar with Chinese policy, market, customer and business environment. Their way to contract goods are more suitable for Chinese market. Also, the business operation cost of these three companies is lower than that of foreign shipping companies. Under such good condition, Chinese container liners should pay great attention on the domestic-trade container service.

4.3 Relevant Strategy for WTO

The Chinese government authorities should go on providing state-owned container lines companies with preferential treatments within a certain period. It should be stipulated that state-owned container lines companies have priority to ship certain kinds of goods. Also, it is better to adopt CIF clause to export goods and FOB clause to import goods while entering into a contract. Tax reduction is also preferable. At the same time, Chinese government should,

adopting the rules of WTO and GATS, speed up the shipping legislation.

Chinese container lines companies should, referring to the successful organization structure of major foreign shipping companies, reasonably adjust their own internal organization by abolishing useless departments and working out strict and practical management rules and regulations in the company. Meanwhile, they should press forward despite the difficulties and make great efforts to provide more attractive service. The qualified service should be provided not only at home but also abroad.

5. Conclusion

The aim of the study is to apply AHP method to the performance evaluation on Chinese container lines companies. Taking COSCON, CSCL, and Sinolines for example, the way of carrying out AHP method has been introduced. During the course of evaluation, the advantages and disadvantages can be taken into account. Then the relevant suggestions are to be made to help Chinese container liners keep and unassailable position in the heated competition.

There is limitation in the study that the final result is not so accurate due to the general criteria selection and incomplete data analysis. But this weak point can be avoided when every company does self-evaluation by subdividing criterion according to the actual conditions of oneself and getting complete and exact datum for evaluation.

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