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The rationality study on capacity allocation for CSCL's Asia-Europe route

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The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

By

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Declaration

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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Abstract

Title of research paper: **The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route**

Degree: **Master of Science in International Transport and Logistics**

As we all know, fleet capacity allocation plays an important role in the fleet structure operation of a shipping company. It is not only the basic organization in running the fleet but also the core factors that influence the profits of the shipping company. Since the ship prices almost accounted for 40% of the total fleet operation cost and the general concept that larger volume the route larger size the ship, so which are the best size of the ship to optimal the fleet structure according to the current situation and have a overview prediction on the near future is the heated issue aroused in today's shipping companies. Especially the slowly picking up in current shipping market, the ship operators pay great attention on the ways to reduce the ship's operation cost and make the largest margin so as to better the cash flow and revenue of the whole company.

This thesis is stand on the perspective view of the Asia-Europe route of China Shipping Container Lines (CSCL), considering the possible supply of the transportation capacity and the potential demand of traffic volume. Because the eight 14,100 TEU new building vessels will be built this year, choosing the best choice of the ship on the Asia-Europe route to optimal the fleet structure in the coming days is necessary and in time for CSCL.

In the end of the paper, I dawn the conclusion that according to the current situation trend, the company should put more capacity on 14000 TUE container ships to achieved four 14000 TEU container ships and five 8000 TEU container ships instead of two 14000 TEU container ships and seven 8000 TEU container ships only on the Asia-Europe route.

Key words：Asia-Europe route of CSCL, fleet allocation, ship selection, economic index, AHP model

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List of Abbreviations

CSCL	China shipping Container Lines
EU	Europe Unions
AHP	Analytic Hierarchy Process
NPV	net present value
INPV	net present value index
IRR	Internal rate of return
PBP	pay back time
TEU	Twenty-foot equivalent unit

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Chapter 1 Introduction

1.1 Background

In recent years, Asia (especially China) Europe economic trade relations have maintained sound development momentum. The Europe has become China's largest trading partner and largest source of technology import, also China has become the EU's second largest trading partner. Although the 2008 financial crisis has affect the trade between two regions a lot, but with the traffic more convenient and much more exchange and cooperate, the trading volume still should be optimistic.

Asia and Europe as the world's two major markets for the economic development provides a great impetus. Almost more than 95% of the trading in goods between them is completed by maritime transport, and maritime container transport has become the most important mode of transport to protect the development of bilateral trade. Thus, the major liner companies invest a lot of capacity, leading to fierce market competition in the Asia-Europe routes. Under such circumstances, how to develop effective strategies of the fleet through rational capacity allocation to reduce operating costs, improve business efficiency is the important issues facing the shipping companies.

Nowadays, container ships are increasingly large. However, in the fierce competition in the container shipping market, the limited supply increase in current days leading liner companies of accommodation usage is generally low. In order to improve this situation, the shipping companies to use more exchange of shipping space, accommodation interaction rent, accommodation for each other to buy, etc., associate with other shipping companies, routes to reduce the pressure of the contracting business, and expand the service area.

But the most effective way is to integrate the feet allocation inside the shipping company itself. Adding the mass order of new ships will be delivered recently, it is time and necessary for the shipping company to consider the structure of their fleet in different routes, making it optimal and effectively.

1.2 Objectives of the study

On the one hand of the objective of the study, the ship size allocation is a heated topic inside CSCL as the ship size analysis is a complex project including the state of the cargo, the condition of the port, the ability of the ship, also related to the fuel prices, the ship market, national policy and many other technology parameters and operational economic factors. They are really affects the benefits of the transportation cost on the voyage. With the steadily increasing trendency of trading volume demand by Asia and Europe, the ship size decision could not be larger and larger according to the limitation of the actual feasibility. So the optimal ship size is not only suitable for the current situation but also satisfied the coming future statements by the Asia Europe market. It needs huge amount database to do the strategy for the development of the company

On the other hand, the international shipping market is a completely competitive market, and so as same for the Asia Europe route. The longer the distance and the larger volume of goods transport means the increased business risks on the sea which really shows the hazard in operating the transport route of container among the east and west. It involving the fluctuations of bunker price and freight rate, also related to the volume transit annually. So choose the best ship size of the fleet can not only reduce the transport cost but also lower the operation risks for the company. The ship size selection is the core assignment should be taken over in such amount of shipping capacity on the long voyage.

Ship demonstration is the process to select the optimal ship in a certain conditions. It contained the study of the feasibility in the technical field and the best decision-making in the economical scope. The paper comprehensively evaluates the container transport market and considers the business risks as well, provide the theory references for the development of CSCL.

1.3 Methodology

There are several methods and one software analysis being used aiming at select the best fleet allocation for CSCL on the voyage of Asia and Europe route thus optimal the fleet structure. Firstly, the paper will use the moving average method, exponential smoothing method, as well as the regression prediction method to estimate the volume of the transported trade between Asia and Europe in the coming future. Next, the ship type economic analysis method including operation cost index, economic and financial cost index and investment effect index will be introduced to have an overview about the economic feasibility on the voyage of the route. After it, the sensitive reports will analyze the business risks while the bunker price, traffic volume and freight rate are so fluctuations in the shipping market. Finally, an AHP model will be applied to make the optimal decision of the ship allocation considering variable indicators.

Regression forecast is a kind of statistical technique which aims at modeling and analyzing several variables, when predicting the future situation of the development trend and level of market phenomenon, it uses the numbers of data together with the relationship between a dependent variable and the independent variables to carry out the market prediction. So regression prediction method is an important way of analysis towards market forecast.

Economic analysis method include the voyage cost calculation such as capital costs, operation costs and voyage costs, as well as use some financial method such as net present value(NPV), net present value index (INPV), Internal rate of return(IRR), pay back time(PBT) to evaluate the result of the investment decision.

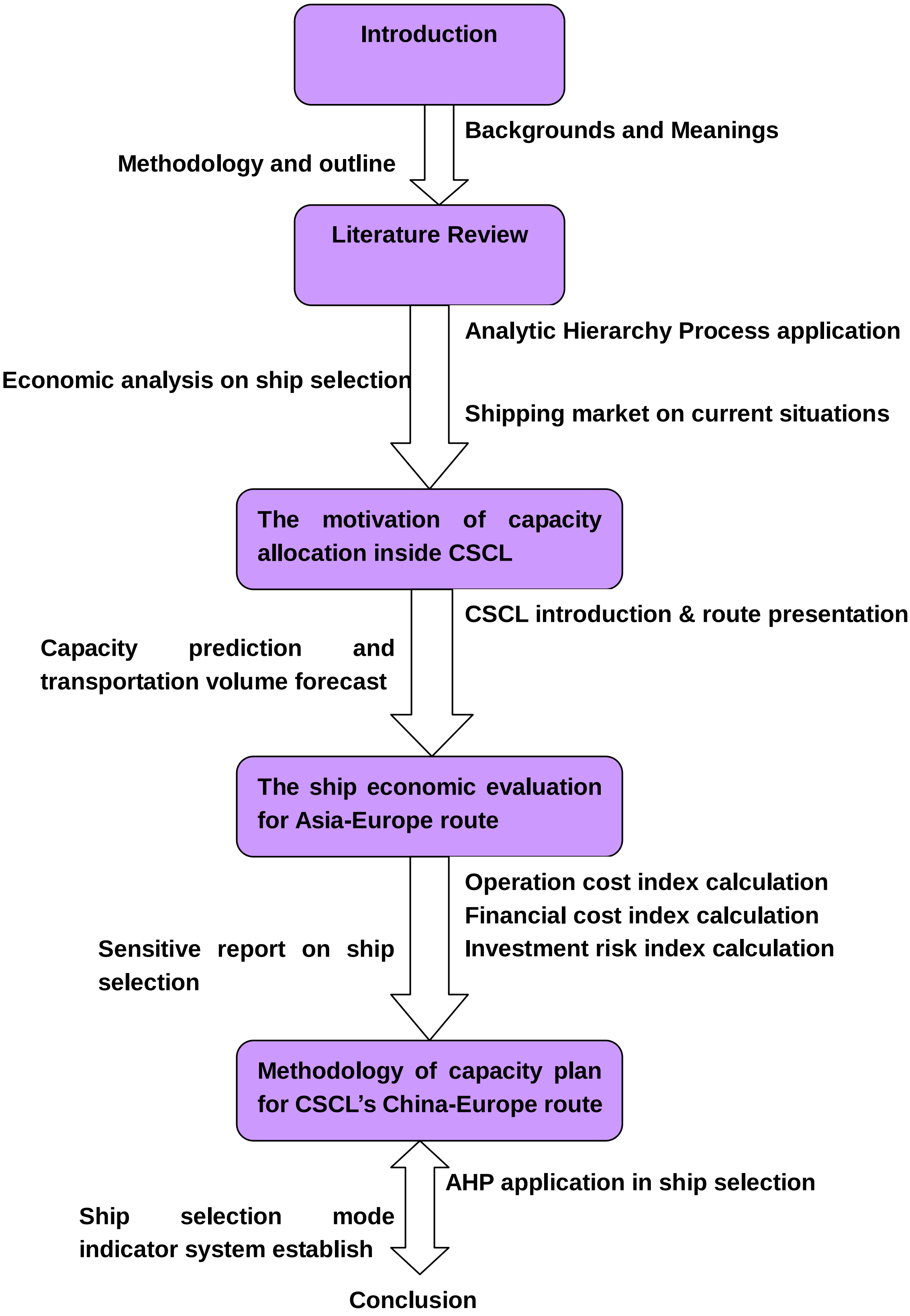
Sensitive report is the way to analysis the changes in state when output the result of the research model. In the optimization method, it is often used to analysis the stability of the optimal solution if the original data is inaccurate or changeable. Sensitivity analysis can also determine which parameters have a greater impact on the system or model.

The Analytic Hierarchy Process (AHP) was firstly innovate by Thomas L. Saaty in the 1970s.It made the decision making much more easier and has been widely used and studied in many areas. It is an ordered structure together with decision method for evaluating and solving complex decisions into simple factors. The object of the decision problem can be made a kind of hierarchy with the elements we considered in terms of the mathematics ways and psychology ways, which let the choice much obviously.

1.4 Structure of the paper

In this dissertation, it consists five chapters to find out the optimal and rational result in determine the ship type combination for CSCL company on Asia-Europe route. In the first chapter, it shows the backgrounds and the meaning of the passage, also the methodology applying in this paper. Chapter two is the literature review. It intends to review the relevant research papers on the topic. The studies and the reports discussed here illustrate the current comments on the problem on ship type selection and allocation. In chapter three, it mainly talks about the motivation and necessary to study and solve the key point of fleet structure. In chapter four, the ship type economic evaluation being analysis and what’s more, there bring in the sensitive report. Chapter four gives the general idea on the establishment on the AHP model and build the ship selection indicator system. It calculates the results and makes choice for the best combination of the ship selection.

Figure 1.1 Structure of the paper



Chapter 2 Literature Review

2.1 Research on Asia-Europe trade market

Actually in the international shipping market, the three research institutions like Clarkson, SSY, and Drewry will have market specific comments monthly in details, which analysis the latest information of current traffic conditions and forecast the shipping situation in the short coming future. Also it consist the statistics of the traffic volume and transportation capacity on the voyage of major transport routes and releases the details in new building market, second hand market, demolishing market. As Asia and Europe are the mainly world's trading superpower, the three research institutions also published the ratio of imports and exports in their magazine, which have varying degrees of periodic summary and analysis, but a smaller space, mainly from the data on the comments.

For those domestic ship trading studies, there are some special comments on the website and papers in college students. In addition, some domestic research journals often publish the study of problems arising after China joined the WTO which influence the structure of Asia-Europe trading mode. Such as trading surplus problems, the transfer location of the industry, trading policy problems and many so on like these in some magazines, which really remind us the clear statement and healthy development of the trading between Asia and Europe.

Many domestic universities, research institutions and related enterprises also do a lot of research from a different perspective on Asia Europe transport market, published many valuable papers. Zhou Li (2010), Shanghai Institute of Foreign Trade, studied the difference in huge amount of trading cost, mainly talking about reason that exist in the trading among eastern countries and western countries and analysis the effects it bring to us. Gu Yingzi (2011), Shanghai Dongsheng shipping container Company, drawing the logical landscape between the Asia-Europe route and pointed out the potential function of hubs in such long distance voyage. Wang Jie and Fan Wenbo (2011)[22]of Dlian Maritime University showing us the types and kinds of the goods transport in Asia-Europe route and predict the trendency for the future, it also discuss the economical route according to the ship size in order to lower the operation cost of the fleet.

However, those foreign and domestic articles of these studies are not combined with characteristics of the fleet factors and do not from the angle of the shipping companies in the specific route in-depth study. As Asia-Europe route is a typical competitive route and the ship transport market is relatively complicated. The long distance voyage and the relatively large voyage of tonnage makes it necessary for us to have economic cost analysis and economic index calculation for more comprehensive of the optimal ship selection, thus lower the shipping transportation business risks in the operation.

2.2 Study on ship size analysis

In academic aspect of ship size selection, Japan, the United States, Poland and other countries specializing in technical and economic feasibility of ship theory and methods from the 1950s, combined the ship's technique, operation and economic analysis together, gradually forming the new topic of ship selection.

Some scholars of the United States such as [1] John L. Everett (1972) have systematically studied the best constitute carriage of bulk cargo transport fleet and large tankers in the next 10 years in 1970s. University of Michigan [2]A. N. Perakis and W. M. Bremer (1992) have designed a scheduling system to optimize auxiliary. With the use of 0-1 integer programming on computer drawing up the supply feasibility sailing program and then find the best program in the feasibility ship scheduling scheme. Shanghai Maritime University Professor [3] Zhao Gang (1991) has pointed out the drawbacks of grid method and introduced the simplex direct search method, and with the use of software analysized the best ship size of the delivered iron ore to Beilun port of Baosteel. [4] Zhou Fu Bin (2001), who has optimize the analysis of container transport ship for China's shipping companies, with the use of statistical methods for ore ship size optimization The best choice of a ship is a multi-parameter, multi-objective optimal selection of programs and scheduling problem. Multi-objective optimization method is first proposed by economist V. Pareto in 1896.

With the ship of science and computing technology, in the process of ship design and ship demonstration by a mathematical model, taking system science optimization method, and multi-criteria evaluation methods to solve the best ship of selection have been gradually found in the research. The more commonly used methods are: data envelopment analysis (DEA) method, AHP method, fuzzy integrated method, factor

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[1] John Leveret，Arnold C. Hax，Victor A. Lewiston and Donald Nudds. Optimization of a fleet of large tankers and bulkers—a 1inear programming approach，Marine Technology. October 1972

[2] A. N. Perakis and w. M. Bremer， An Operational Tanker Scheduling Optimization System：background，current practice and model formulation，Maritime Pol icy and Mangement. 1992 V01. 19，No. 3，177—187.

3 Zhao.G and Xu ZY and Xue G, Ship type reasoning methods research and computer application software design, Shanghai Maritime Academic Journal 1991.6 No.2

4 Zhou FB. China shipping enterprise container transport ship type optimization analysis. Unpublished master's thesis, Shanghai Maritime University, Shanghai, China. May. 2001

analysis method.1978 by the U.S.A. [5] A.Charens and W. W. Cooper (1978), they firstly proposed the Date Envelopment Analysis method and model on the basic of relative efficiency concept, with the development of DEA analysis, there are C2R, C2GS2, C2W, C2WH and C2WY and other important the model of EDA have been found. University of Pittsburgh home [6] Satty.T.L. Professor (1977) has pointed out the Analytic Hierarchy Process method in the 1970s level of analysis method. [7] Xu Shubo (1988), in his book describes the principle of AHP in detail, which laid the theoretical basis for the later application. In Early 20th century Karl Pearson and Charles Spearmen proposed factor analysis, China's scholars studied factor analysis method to build a market evaluation model, and with the use of SPSS statistical software as a tool to have a comprehensive evaluation of the analysis of the market economy.

After years of continuous efforts, it have been developed a variety of specific problems of different ways to meet the needs of shipping companies to make fleet integration decisions. Especially in recent decades, the increasing trading volume and modern ports construction changed the transport networks. Changeable traffic analysis, economic theory, marginal cost explanation and other aspects of the system analysis are used in fleet structure study. So the study of ship size selection is necessary and in time with the speed development of the supply and demand between China and Europe.

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5 A. Charnels, W. W. Cooper，E. Rhodes. Measuring the efficiency of decision making units. European Journal of Operational Research，Yofume 2，Issue 6，November 1978，Pages 429—444

6 Saaty, T.L., No structure of decision making problems build a hierarchical analysis theory. The first international mathematical modeling 1977

7 Xu SB. Principle of analytic hierarchy process (AHP). Tianjin university press, 1988

2.3 AHP model application

Analytical Hierarchy Process (AHP) is an easy way for us to make choice among the various factors and results. Once we have put the considered elements into the hierarchy in ordered, we can evaluate the weight of these element according to our judgment or the result of data and make an over round decision of the plans, therefore making out the decision scientific and rationally.

In 1977, Professor Thomas L. Saaty firstly pointed out the AHP model and regarded it as a multiple decision-making methodology for the users make the simple choice on the relatively complex problem on them.

According to the above statement, we can see that although the decision made by AHP methodology can not be considering as a correct result, the AHP model helps the decision makers to choose the optimal one that best suitable for the target in terms of his understanding of the problem.

Firstly, if you want to use AHP model to resolve the decision problems, you should consider them into a kind of hierarchy comprehended sub-problems, and every sub-problems should be analyzed individually and thus making easy understanding of them. The factors of the hierarchy elements can be regard with many aspect of the problem need to consider—tangible or intangible, seriously measured or roughly predicted, socially or environmentally, technically or functionally something like that we can choose any aspect of the problem decision we think of carefully.

Secondly, the AHP users need to systematically and logically evaluate the considered elements through comparing one and the other after the set up of the hierarchy elements , and make the weights of element each of them in a hierarchy logic way. The most important thing is that when making the comparisons, the AHP users can both use the concrete data about the element and also with their judgments on the elements' relative meaning and understanding. So in the AHP methodology, it mainly pull out the sense of the judgment by human sense rather than some detail data results. The information and the experiences sense make the evaluation of hierarchy more reasonable and practical.

Thirdly, the AHP users need to converts these evaluation factors in to numerical values according to their judgments. Each element of the hierarchy must give out a numerical weight, allowing diverse and incommensurable elements to be compared to one another in a rational and consistent way. This is the way of unique capability differently from other decision making techniques but for the AHP model only.

Lastly, each of the element alternatives are calculated by numerical values. The weight of the numbers stands for how the elements are important to the aim of the decision, and according to their judgment to choose the favorite plan of with its merits and cons according to the value. It is much more obviously and simple than any other ways.

As we can see, in the international logistics area, the AHP model has been widely used among the researchers and investigator for the decision making problems. Giving example, Shrestha and Yedla (2003)[27] apply AHP methodology finding out optimal environmental-friendly traffic transportation mode of in Delhutheir with the step of hierarchy; [8] Lirn et al and Tzeng and Wang (2003) use the AHP

8 Lirn, TC. The job attractiveness of airlines to students in Taiwan: An AHP approach. Journal of the Eastern Asia Society for Transportation Studies 5:556-571

methodology to do the research Taiwan airline industry's job and point out the main attractiveness of the posotion. [9] Liang and Chou (2001) utilized this way to evaluate the current situation and analysis the performance of a shipping company. In the part of 4PL, Chu, YW use the AHP to do scientific selection of a 4PL supplier for a lot of manufacturers and major retailers, making effective way to avoid the difficulties caused by the incompatibility between the supply chain the intended for the enterprise. Zheng, ZY and Li, HX and Zhao, JJ according the principle of system and engineering and AHP process to weight the values of index effects on navigation safety to avoid the sea accidents. Min,A, Yao C and Chris,J.B (2010)[15] use fuzzy-AHP to show the significant risks that potential exit outside and give the idea to solute the danger and protect the railway system.

In the field for company decision making, the AHP model also plays an important role for the leaders make a judgment when various indicators combined together. Huang, SL and Liao, YJ (2011)[12]use AHP to reasonable allocation the company's fund to promote the development aspect effectively. Feng, XQ (2009)[8] use AHP to evaluate the factors which affect the site selection of the distribution center and obtain the optimal one. Cao, ZL (2011)[3] applied the AHP model to make the relatively lower cost and better quality of the project decision making. Nathasit, G and Dundar F.K (2007)[16], use the advantage of AHP to provide an effective way to help organizations to overcome the dynamic, flexible and operationalizable of keeping a roadmap alive.

As can been see in the above examples, the success use of the AHP model not only work out the optimal decision making in the field of transportation management,

9 Chou, TY and Liang, GS. Application of a fuzzy multi-criteria decision-making model for shipping company performance evaluation. Maritime Policy and Management 28: 375-392.

but also applied and practiced in the business judgments for the structure of the company, which really makes me decide to apply AHP methodology to evaluate importance value of different ship types allocation in the such changeable shipping industry and select the optimal mode for the aim of this paper.

Chapter 3 The motivation of capacity allocation inside CSCL

3.1 Introduction

In the previous chapter, the Literature review introduces the AHP methodology application and the ship type selection way of economic analysis, it looks back the Asia-Europe shipping industry in actuality.

In this chapter, it will mainly point out the motivation and necessity inside CSCL shipping company and analysis the ship type economic analysis for the 8000TEU ship and 14000TEU ship.

3.2 General introduction of the CSCL

China Shipping Container Lines Co., Ltd. is subsidiary of China Shipping Group. It is a diversified business enterprise which is principally engaged in container shipping and related businesses. The business scope covers the field of container transport, ship chartering, cargo canvassing, booking, transportation, customs clearance, warehousing, container yard, container manufacturing, repair, sales, trading and so on. On June 2004 and December 2007, CSCL were successfully listed on Hong Kong Stock Exchange and Shanghai Stock Exchange.

As the date of June 2011, CSCL has more than 150 vessels, the overall carrying capacity is more than 560,000 TEUs, ranking the list of the top 10 of the world's largest liner companies. It provides more than 80 international and domestic container routes which cover 100 countries around the world. In recent years, it successfully created a series of service quality route that makes CSCL service more competitive in the shipping market. In addition, CSCL has more than 300 global agency networks, fully realized the marketing network and service integration

CSCL owns dozens of companies such as China Shipping Terminal, Puhai Lines, Continental Maritime, Yangshan storage, Dalian Wanjie and so on, integrating a variety of resources including fleet, docks, truck, warehousing, rail, air, forming the sea and railway transport, sea and air transport, water transport, water and land transport and other modes of transport, and successfully build a complete chain of integrated shipping and logistics industry, can provide full door - the door "service to customers around the world.

Future, the company will adhere to the scientific concept of development, careful organization, fine management, to create first-class fleet and team to become world-class container shipping and logistics enterprises, providing high quality service for customers around the world.

3.3 Quantitative forecast the transporting volume of Asia-Europe route

3.3.1 Current situation on Asia-Europe route

According to the statistics of the Container Trades Statistics, the current situation of container transportation are on the slowly recovery period. As for CSCL on east west route from January to August, 2011, container traffic from far east to Europe route up 5.3% and return volume increase of 6.4%. Compared to the relatively slow growth of demand in quantity, the growth of supply quantity expansion much larger than that of demand. Firstly, the 2011 delivery of large container ships is basically investment in the Asia-Europe route, the Asia-Europe route transport capacity will increase by 12%; Secondly, the gradual release of free capacity. During the 2010 of January and February, the container capacity free rate reached the peak at about 12%. With the capacity being released this year, it may increase 12%-14% of the effective capacity.   Supply growth rate increasing sharply and demand slowdown leading to container structure a big gap. So, we should calculate and estimate the accurate demand in the next years on Asia-Europe route, and then with the new capacity provided to make the reasonable configuration for the whole fleet.

Here is the annually transported volume on Asia-Europe route in CSCL

Year	Annual transported volume on Asia-Europe	compared with previous year	Total annual transported volume	compared with previous year
2003	571,563		2,834,207	
2004	885,981	↑55.01%	3,654,767	↑28.95%
2005	1,229,289	↑38.7%	4,597,395	↑25.8%
2006	1,351,670	↑10.8%	5,657,955	↑23.1%
2007	1,457,918	↑7.9%	7,298,827	↑29.0%
2008	1,376,178	↓5.61%	6,942,148	↓4.89%
2009	1,050,079	↓23.7%	6,741,790	↓3.7%
2010	1,183,421	↑12.7%	7,208,055	↑6.9%
2011	1,177,546	↓0.5%	7,438,002	↑3.2%

Table 3.1 Annually transported volume on Asia-Europe route in CSCL

Source: CSCL annual report

3.4.2 Predict the development of Asia-Europe traffic volume

When it comes to traffic volume estimate, three methods will be used moving average method, exponential smoothing method and regression method. With the result of each method, we take average of them as the considered volume to allocate the fleet.

Moving Average Method

Moving average method is a traditional way for estimation. We use the actual data of recent to predict the statistics in the coming future.

Time series at a certain time interval, some observations of variable historical data chronologically up the number of columns. Such as daily, weekly or monthly sales of the sequence of time has. Time series forecasting to predict the future is based on the history of events over time. The moving average method is based on time series data segment, the order of the data points gradually goes on to calculate the average, and make predictions accordingly. When product demand is neither rapid growth nor rapid decline, and there are no seasonal changes, the moving average by a "renewal" can effectively eliminate the random changes in the forecast.

Now we have the time series y_1, y_2, L, y_t, the average moving formula is:

$$M_t^{(1)} = M_{t-1}^{(1)} + \frac{y_t - y_{t-N}}{N} \quad (3\text{-}1)$$

Or can be:

$$M_t^{(1)} = \frac{y_t + y_{t-1} + L + y_{t-N+1}}{N} \quad (3\text{-}2)$$

In above formula:

y_t——Time series value in T period

$M_t^{(1)}$——A moving average of Time series value in T period

N——number of moving average

Predict formula can be：

$$\hat{y}_{t+1} = M_t^{(1)} \tag{3-3}$$

That is the t period cycle of a moving average as the t + 1 period cycle of predictive value

As the volume of the goods transport on Asia-Europe route inside CSCL has been listed as follows, we can use the moving average method $M_t^{(1)} = \dfrac{y_t + y_{t-1} + L + y_{t-N+1}}{N}$ to calculate the transport volume in the year 2012 and 2013.

Year	Transported volume	Moving Average
2003	571563	
2004	885981	
2005	1229289	
2006	1351670	895611
2007	1457918	1155646.667
2008	1376178	1346292.333
2009	1050079	1395255.333
2010	1183421	1294725
2011	1177546	1203226
2012		1137015.333
2013		1180483.5

Table 3.2 Table of estimated transporting volume by moving average

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

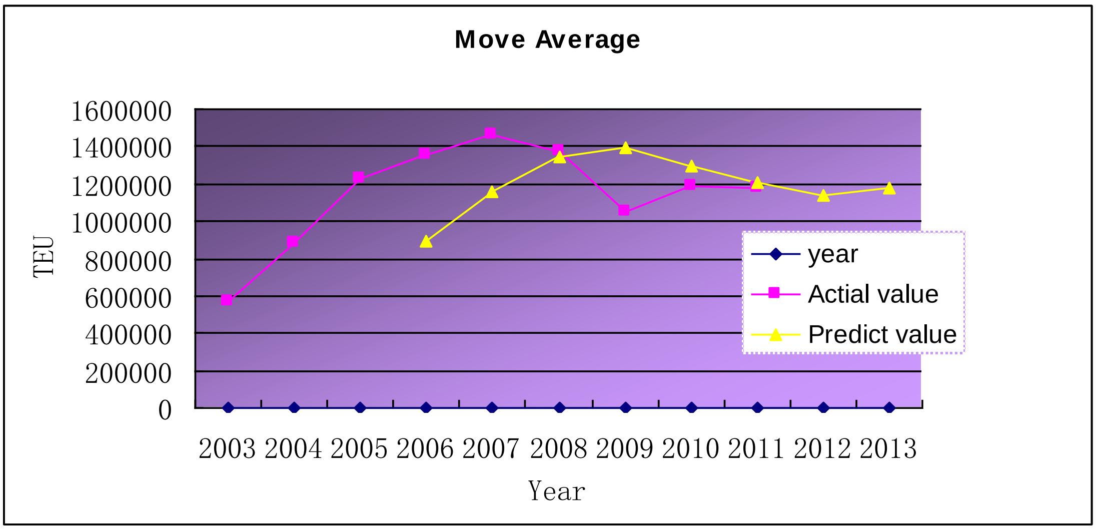

Figure 3.1 Actual value and Predict value of move average method

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

When the moving average method in practical applications, the choice of moving average number of items N is very critical, it depends on the variation of the predicted target and actual data.

When there is no obvious trend of the time series changes, once moving average will be able to accurately reflect the actual situation, the direct use of the t cycle moving average can predict the value of the t +1 cycle. But when the time series has a trend of linear movements, there will be a lag bias on the moving average prediction .

Exponential Smoothing Method

Exponential smoothing method is also a time series prediction. Short-term forecast in the most effective way is the exponential smoothing method. The method is very simple, just need to get a small amount of data can be used continuously. Exponential smoothing similar prediction is considered the most accurate and fundamental changes in the forecast data also can self-adjust. Exponential smoothing is a moving average method, just give the observed values of the past is not the same weight, the weights of the observed values of the weights of the more recent observations is relatively long-term. The basic idea is: the predictive value of the previously observed value of the weighted sum, and given different weights on different data, new data to the larger weight, the old data to a smaller weight.

This geometric weighting method can be a simple expression, the expression involves only the most recent forecast and the current actual demand. In this way, the next issue of the forecast demand can be list as follow:

Prediction Value =α*Actual Value + (1-α)*Previous Prediction Value

In the formula, αis a weighting, often referred to as the exponential smoothing factor, which value ranging between 0 and 1. It should be noted that all the historical factors are included in the predictive value and at any time, simply to maintain the numbers represent the history of demand. .

$$F_{t+1} = \alpha A_t + (1-\alpha) F_t \tag{3-4}$$

Where: t ——time

α ——exponential smoothing factor

A_t ——Actual value in t time;

F_t ——Prediction value in t time;

F_{t+1} ——Next prediction value in t+1 time

Year	Transported volume	Exponential Smoothing
		Alpha=0.1
2003	571563	885981
2004	885981	603004.8
2005	1229289	857683.38
2006	1351670	1192128.438
2007	1457918	1335715.844
2008	1376178	1445697.784
2009	1050079	1383129.978
2010	1183421	1083384.098
2011	1177546	1173417.31
2012		1177133.131
2013		117713.3131

Table 3.3 Table of estimated transporting volume by exponential smoothing

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

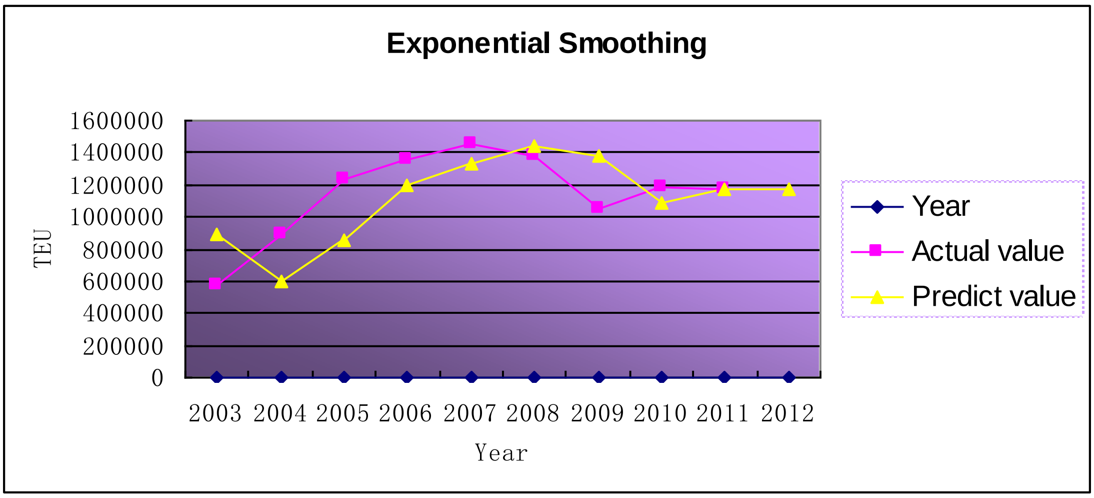

Figure 3.2 Actual value and Predict value of exponential smoothing method

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

When selecting the appropriate value of the exponential smoothing factor, the higher the value, the greater the number of recent demand weighting value and the faster the model will be able to respond to changes in the time series. On the other hand, The smaller of alpha, the greater weights to the needs of historical data to predict the future demand in the response level of demand fundamental changes in the longer time lag in demand. Generally, compromising the value of the range between 0.01 and 0.3 is more reasonable expected changes such as depression, positive but temporary promotions to occur, or rarely grasp the sales history data or no data to start the forecasting process, the short-term predict the high value to predict. Find a suitable value is an important principle to make the prediction model able to track significant changes in the time series while balancing the random fluctuations.

Regression prediction method

Regression prediction method is kind of regression analysis. In the process of economic development, the economic variables are not isolated, but mutual interdependence, and this relationship is often the performance of non-deterministic relationship. This non-deterministic relationship between the two variables of the study referred to as a regression, you should collect one list of data as the dependent variable, and the left list of data as the independent variables to make analysis and find out the relationship in the form of between them. That is to determine an appropriate mathematical model to approximate the expression of the average change in the relationship between the variables. The dependent variable in the expression performance as a function of the independent variables, known as the linear regression equation, otherwise known as the non-linear regression equation. Regression forecast can consider the many possible factors that affect the dependent variable.

A linear regression method is also called the least squares method is used to deal with a linear relationship between two variables. The steps of this method:

Step1: According to the X, Y, the existing data and statistics, consider X and Y as a known quantity, looking for suitable A and B for the regression coefficients.

Step 2: Determine the regression equation based on the regression coefficients.

Step3: Using the derived regression equation to draw a trend change in a straight line and the distance of the points on this straight line corresponding to the actual data minimum. So that this line can best represent the actual changes in the data as a basis for prediction.

Let X, Y two variables to meet the trend of changes in the linear equation: Y = a + bX, where X is the independent variable, Y is the dependent variable or predictor; a, b, can be the determining equations in the geometry which is equivalent to seeking the intended co-scatter curve. This fitting process is usually carried out in accordance with the square of fitting error and the minimum least squares method

X	**Year**	**Transported volume**
1	2003	571563
2	2004	885981
3	2005	1229289
4	2006	1351670
5	2007	1457918
6	2008	1376178
7	2009	1050079
8	2010	1183421
9	2011	1177546
10	2012	1391155.56

Table 3.4 Table of estimated transporting volume by regression method

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

SUMMARY OUTPUT

Regression statistic	
Multiple R	0.49353485
R Square	0.24357665
Adjusted R Square	0.13551617
Standard error	256446.721
Observed value	9

Variance analysis	df	SS	MS	F	Significance F
Regression analysis	1	1.4824E+11	1.4824E+11	2.25408	0.176955758
Residual	7	4.6035E+11	6.5765E+10		
Sum up	8	6.0859E+11			

	Coefficients	Standard error	t Stat	P-value
Intercept	894098.889	186304.224	4.79913376	0.00197
X Variable 1	49705.6667	33107.1293	1.5013584	0.17696

In the calculation, a=894098.889, b=49705.6667

So the formula should be Y=894098.889+49705.6667*X

When x= 10, Y=1391155.56

Prediction Result	
move average method	1137015
exponential smoothing method	1177133
regression method	1391156
Total average	1235101

Table 3.5 Table of estimated transporting volume result

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

Summary

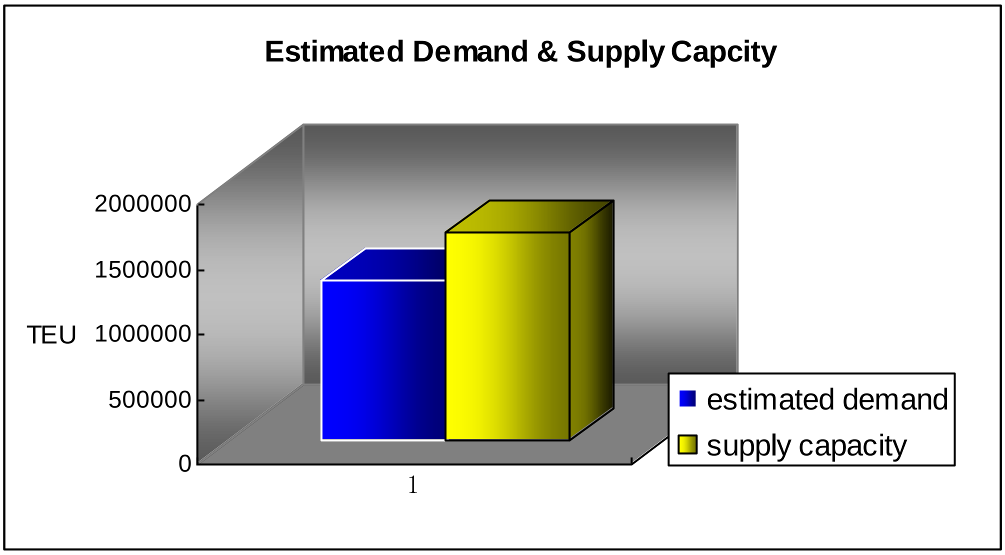

Figure 3.3 Estimated demand and Supply capacity

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

As can be seen in the above figure, the current maximum transportation capacity on the Asia Europe route of CSCL is already over 130% of the forecasting the development of traffic volume being calculated. Consequently, it can be considered that before 2013 the top priority task for CSCL is to allocate the fleet arrangement in order to better the shipping structure and meet the need of the market.

Chapter 4 The ship economic evaluation for Asia-Europe route

4.1 Introduction

In the previous Chapter, it mainly introduced the CSCL company and use three ways to estimate the total volume of CSCL on Asia-Europe route in near future. Especially with the recovery of the shipping market, it is time and necessary for the company to have a ship type structure adjustment to make sure the better economic benefits.

So, in this chapter, we will have a economic calculation for the different ships on the Asia-Europe route, and do a sensitive report when the ship price, the freight rate and the bunker price are fluctuated, make out the relatively economic and lower risk ship style for next year fleet planning.

4.2 Background analysis and data selection

The background analysis survey is conducted by the technical, operational, and economic conditions of the argument object. Ship constraints and special requirements through the analysis of supply routes, the port situation, ship price, etc., in order to grasp the demonstration ship in which the objective environment and the basic raw data to make the necessary forecasts and assumptions. Its purpose is to provide a basis for programming, data for the calculation of economic indicators.

This paper is mainly discussed about the optimal combination of the fleet on the

Asia-Europe route inside CSCL. With the rapid development of the larger container ships and the concept of longer routes with larder container ships, there are only two ship styles running between the Asia and Europe. So we consider 8000TEU and 14000TUE ships as the objective ships being evaluated.

The main voyage we choose as follows:

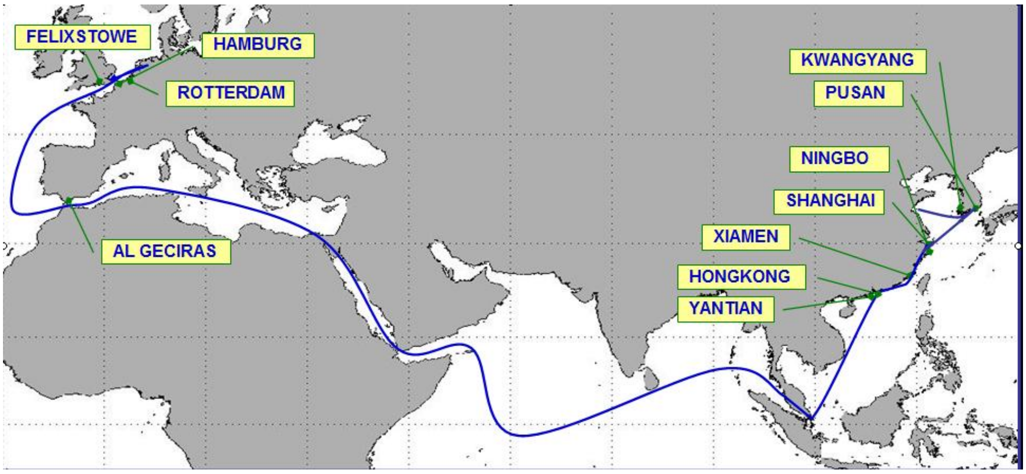

Figure4.1 Asia-Europe route for CSCL

Source: Asia-Europe route of CSCL in 2011, unpublished PPT

The port rotation as follows:

ROTATION	KAN	PUS	NGB	SHA	XMN	HKG	YTN	ALG	HAM	FXT	RTM	SIN	KAN
	Kwangyang	Pusan	Ningbo	Shanghai	Xiamen	Hongkong	Yantian	Al Geciras	Hamburg	Felixstowe	Rotterdam	Singapore	Kwangyang
WINDOW	SAT	SUN	TUE	WED	FRI	SUN	MON	SUN	THU	MON	WED	SAT	SAT

Figure4.2 Port rotation on Asia-Europe route

Source: Asia-Europe route of CSCL in 2011, unpublished PPT

Namely: KAN---PUS---NGB---SHA---XMN---HKG---YTN---ALG---FXT---HAM ---RTM----SIN---KAN

4.3 The ship economic evaluation calculation

Purposes of the calculation of operational indicators is to estimate the transport capacity of the ship put into operation can be achieved, including speed, fuel consumption, the annual freight volume.

Calculate the economic and financial indicators, including: the ship cost estimates, revenue, expenses and profits.

Investment performance metrics calculation including: whether to consider the time value of money is divided into: Static evaluation indicators, such as profit rate of investment, payback period, investment profit rate; Dynamic evaluation, such as net present value, net present value rate, the net annual value, internal rate of return. Classify by the result of calculation can be divided into: Type of value, such as net present value, net annual value; Benefit type, such as profit rate of investment, internal rate of return, net present value rate, Time type, such as payback period, the loan repayment period and so on.

4.3.1 Operation index calculation

1. Voyage Time

Tv=L/(24*V) (4-1)

Tv-----voyage time

V----actual sailing speed of the vessel

L---- the distance between loading and discharging port

As CSCL is mainly engaged liner container trading, the sailing routes and the calling ports are regular and specific. According to the shipping schedule, the altogether distance between Asia AA port and Europe EE port is 22825Nautical miles, the economic sailing speed is 18.1 Knots/hour.

2. Voyage anchor time

Tp=Q1/M1+Q2/M2+Tp1 (4-2)

Tp---- Voyage anchor time

Q1、Q2----transportation volume in a singe trip (TEU)

M1、M2----total productivity of loading and discharging cargoes in the ports (TEU/day)

Tp1----Waiting time

Actually, we regard Q1 and Q2 as 95% of the total volume of the ship. And M1 and M2 are the productivity of loading and discharging cargoes including the con production tine and the auxiliary operation time.Tp1 is the waiting time in every calling port, we choose the average time of 6 days.

3. Operation time

To=Tv+Tp (4-3)

To----operation time

4. Annual freight volume for a single vessel

ATC=CW*Nw (4-4)

Nw=annual operation days/To

ATC---Annual transport capacity

In this formula, the actual transport volume of the ship, we select 95% the maximum transport capacity. For the annual operation days, we choose the average about 90% of the calendar days, which means 365*90%=328days.

5. Annual fuel consumption per single vessel

Host fuel consumption every voyage days (OCM)=host power*host fuel consumption rate*24*10^{-6} ton/day

Auxiliary fuel consumption every voyage days (OCG) is 10% as the host does. That is OCG=0.1*OCM

Auxiliary and boilers fuel consumption every anchor days =0.8OCG

Then we can suppose that during the voyage period, 70% of the time consumes heavy oil while the rest of time uses up light oil. All the auxiliary and boilers expend light oil.

Then the consumption of the heavy oil can be calculated as follows:

Heavy oil: Wh=0.7*Tv* Nw *OCM (4-5)

Light oil: Wl=(0.3*Tv*Nw*OCM+0.1*Tv*Nw*OCM+0.8*Tp*Nw*OCG

=0.4*Tv*Nw*OCM+0.08 Tp*Nw*OCM

=(0.4*Tv+0.08*Tp)* Nw*OCM (4-6)

4.3.2 Economic and financial index calculation

1. Capital price P

Capital price is the expenditure the shipping company pays for the ship.

2. Annual freight income

Annual freight income = Annual transport capacity* Fright rate

Income=ATC*FRR (USD)

3. Annual operation cost

(1). Cost of capital and depreciation S1

Usually we use the straight-line depreciation method to calculate it. Suggest the use of container ship is set to 20 years, the residual value is 6% of the original value Then depreciation charges S1 is:

$$S1 = (P-L) / N = P (1-6\%) / N \tag{4-7}$$

Where:

S1---- depreciation charges (USD)

P----the investment amount of the ship (USD)

L----the salvage value of a ship

N----depreciation period, usually the expected useful life time for the ship

(2). Crew costs and additional fees S2

Costs of crew means all the expenditures happens to the people who works on a ship. It includes the costs of training staff, crew wages, various subsidies and allowance, welfare, travel and other incidental charges.

(3). Cost of repairing the ship S3

The ship daily maintenance cost of the repairs happens to recurrent maintenance costs and repairing ship on a regular basis. We extract the ship repairing price as three percentage of the ship price:

$$S3 = P \times 3\% \tag{4-8}$$

(4) The annual premium S4

The premium is the essential cost that the owner should pay for the marine insurance of the ship, such as hull insurance, freight insurance, crew insurance and so on. According to the underwriting of insurance companies, the insurance premiums in this article take 0.8% of the ship price:

$$S4 = PX\ 0.8\%. \tag{4-9}$$

(5). Annual fuel costs S5

As the oil prices are so fluctuate in current situation, it rapidly get to the new standard. In this paper of March the 2012, we select 780 USD/t for the heavy oil while 1120 USD/t for the light oil:

$$S5 = 780Wh + 1120Wl \tag{4-10}$$

(6). Lube oil fee S6

Lube oil cost is usually take 7%-10% of the fuel cost, here we choose 8%:

$$S6 = S5 \times 8\% \tag{4-11}$$

(7). Materials cost S7

Generally, the material cost account 10% of the fuel cost:

$$S7 = S5 \times 10\% \tag{4-12}$$

(8). Annual port charges S8

The port costs include harbor dues, agency fees, tug fees such like these the cost produce when the ship berthing in the port:

$$S8 = \text{port charges of average voyage} \times Nw \tag{4-13}$$

(9). Management fees and other expenses S9

As a matter of experience, the management fees in general is about 18% of the total operating costs:

$$S9=(S2 + S3 + S4+ S6 + S7)\ X\ 18\% \tag{4-14}$$

(10).Annual total operating costs Y

$$Y= S1+ S2 + S3 + S4+ S5+S6 + S7+S8+S9 \tag{4-15}$$

(11). Taxes

Sales tax = 3.3% of freight revenue

Annual income tax = (freight revenue - total cost - sales tax) X 33%

4.3.3 Investment effect index calculation

When shipping companies deal with the business operations, the ship operators should not only estimate and assess the static economic indicators in the production of the process, but also pay greater attention to the dynamic assessment indicators of the time value of investment. In this paper, there are five indicators commonly selected for to evaluate. They are: net present value (NPV), Net Present Value Index (NPVI), payback period (PBP), internal rate of return (IRR) and the necessary freight rate (RFR).

(1). The net present value NPV

It is the year earnings and residual value discounted at the benchmark rate of return compared with the total investment of the ship, the difference of which stands for the net present value. It the net present value is positive, then it shows the plan is feasible, and the greater number of net present value the better for the scheme; when NPV is zero, it means just to achieve the desired investment benchmark rate of return; If the net present value is negative, it indicate that the program is not feasible. The various elements adopted compounded benchmark rate of return factor under the calculation. In the meanwhile, i as the benchmark yield, is critical to general technical and economic feasibility in the project. Before the project in the process of technical and economic evaluate, we should select pre-specified minimum allowed by the project as a benchmark rate of return, in this paper, i = 12%. Assume that the annual revenue is equal. We can formulate as follows:

$$NPV = NA \cdot (P / A, i, n) + L (P / F, i, n) - P \tag{4-16}$$

Look-up table: (P / A, i, n) = (P / A, 12%, 20) = 7.469

(P / F, i, n) = (P / F, 12%, 20) = 0.1037

NA =Income-Y

L = 0.06P

NA----Annual profit of the ship

n----depreciation period, in this case take 20 years

L----salvage value of a ship, select 6% of the ship

P----ship price

(2). The net present value index

The net present value index (NPVI) is equal to the net present value (NPV) divided by the initial investment (P). When select the net present value index in a program, if the net present value index is positive, the program shows desirable, and the largest program of the net present value index as the preferred option. Calculated as follows:

$$NPVI = NPV / P \tag{4-17}$$

(3). Pay back period (PBP)

Payback period means that you should payback the investment to the same amount of financial budging of the original investment in a certain period of time. It is an easy way and well understanding for us all to take use of it.

The shorter the payback period is the shorter the better for the program as it take rather lower risk of the investment. The formula can be listed as follows:

$$N = \lg\left(\frac{NA}{NA - Pi}\right) / \lg(1+i) \tag{4-18}$$

Where:

P----capital price

NA----annual profit of the ship

i-----discount rate, i=12%

(4). Internal rate of return (IRR)

The internal rate of return stands for the discount rate when the total amount of money into the present value is equal to the total amount of money out of the present value and also the net present value is zero. Easy understanding, IRR is to analysis the investment to produce the value of cash flows under considering the time value. With the higher score of the internal rate of return the better the choice for the investment, which means that you invest with less money but you get more profits.

The formula can be listed as follows:

$$\mathbf{NPV} = \sum_{t=1}^{n} \frac{C_t}{(1+irr)^t} - P_s = 0 \qquad (4\text{-}19)$$

Where:

NA----annual profit of the ship

n----depreciation period, in this case take 20 years

P----ship price

(5). Necessary freight rate (RFR)

Necessary freight rate means the unit volume minimum income freight rates when achieving the desired return on investment. That is, the average annual cost-sharing per ton of cargo. The present value of the investment with compound interest apportioned equally to each year, plus the average annual operating costs is the average annual cost.

Necessary freight rates: RFR = AAC / ATC

The average annual cost: AAC = (P-L) • (A / P, i, n) + L • i + Y (4-20)

Annual traffic volume of: ATC

P----ship price

L----salvage value of a ship, select 6% of the ship

Y----annual total operation cost

i-----discount rate, i=12%

Look-up table: (A / P, i, n) = (A / P, 12%, 20) = 0.1339

The RFR minimum value of the program is the optimal solution. This indicator is concise and intuitive, closely linked with the market situation, therefore, become the container cargo and other ships of ship argument is frequently used in an evaluation.

The operation index of the statistics as shown in 4.1

The economic and financial index of the statistics as shown in 4.2

The investment effect index of the statistics as shown in 4.3

Ship size	TEU	8000	14000
Operation index	Unit		
Voyage time	day	52	52
Voyage anchor time	day	18	18
Operation time	day	70	70
Sailing speed	KN	18.1	18.1
Annual operation days	/	4.69	4.69
Annual transport capacity	TEU	33737.14	59040.00
Host fuel consumption every voyage days	ton/day	90	150
Annual heavy oil consumption	ton	15350.4	25584
Annual light oil consumption	ton	9378.925714	15631.5429

Table 4.1 operation indexes calculation result

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL’s Asia-Europe Route

Ship size	TEU	8000	14000
Economic and financial index	Unit		
Capital price P	USD	91,000,000	130,000,000
Annual freight income	USD	60726857.14	106272000
Cost of capital and depreciation S1	USD	4277000	6110000
Crew costs and additional fees S2	USD	547500	620500
Cost of repairing the ship S3	USD	2730000	3900000
The annual premium S4	USD	728000	1040000
Annual fuel costs S5	USD	22477708.8	37462848
Lube oil fee S6	USD	1798216.704	2997027.84
Materials cost S7	USD	2247770.88	3746284.8
Annual port charges S8	USD	1362285.714	1784000
Management fees and other expenses S9	USD	1449267.765	2214686.28
Annual total operating costs Y	USD	37617749.86	59875346.9
Annual profit before tax	USD	23109107.28	46396653.1
Sales tax	USD	2003986.286	3506976
Annual income tax	USD	6964689.928	14153593.4

Table 4.2 economic and financial indexes calculation result

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

Ship size	TEU	8000	14000
Investment effect index	Unit		
Net present value NPV	/	82168124.27	217345462
Net present value index NPVI	/	0.902946421	1.67188817
Pay back period PBP	Year	5.644502852	3.61621866
Internal rate of return	/	25.11%	35.61%
Average annual cost AAC	USD	49726755.86	77173926.9
Necessary freight rate RFR	USD/TEU	1473.946862	1307.14646

Table 4.3 investment effect indexes calculation result

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

4.4 Sensitive report

During the ship demonstration program process, certain conditions and parameters of the selection have a great deal of uncertainty, such as ship costs, freight, fuel prices. In the demonstration process, we often assume that they are determined. In fact, to ship life cycle is about 20 years, in such a long period of time, various parameters will be issued. When these parameters change, some impact on the design of ship calculation results greatly, and some do not have a significant impact.

So-called sensitivity analysis is based on the values of these key indicators change with the change of a variable extent. Obtain factors that are sensitive and not sensitive to what factors, in order to make more exact estimation and evaluation on the selected ship program. Sensitivity analysis plays an important role in reducing project risk, improving the economic evaluation reliability, which is an essential step in the ship demonstration process.

There are many methods to deal with sensitivity analysis, commonly used linear programming, graphical methods, one by one substitution method and so on.

In this paper, we will use replacement to illustrate this problem

Select three parameters, namely shipping costs, freights, fuel prices, analysis of their change on the 8000TUE and 14000TEU ship type 's major economic indicators in net present value NPV, payback period PBP, the degree of influence of the internal rate of return IRR. The magnitude of parameter changes up and down 10% and 20%.

Input data, the outcome is the following table:

Factor: Ship Price				
Ship Style	rate of change	NPV	PBP	IRR
8000TEU	20%	51597020.8	8.337248749	19.03%
	10%	66882572.53	6.838566833	21.82%
	0	82168124.27	5.644502852	25.11%
	-10%	97453676.01	4.662403975	29.06%
	-20%	112739227.7	3.835647146	33.94%
14000TEU	20%	173672456.9	4.88868094	28.01%
	10%	195508959.4	4.212772978	31.48%
	0	217345461.9	3.616218663	35.61%
	-10%	239181964.4	3.084662559	40.63%
	-20%	261018466.9	2.607203877	46.89%

Table 4.4 analysis on sensitivity of the ship price

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

As can been seen in the table, with the decrease percentage trend of the ship price, there is an increase in the net present value and internal rate of return. While the payback period shows a drop trendency.

Factor: Freight				
Ship style	rate of change	NPV	PBP	IRR
8000TEU	20%	172881903.5	3.27100199	38.69%
	10%	127525013.9	4.136057196	31.94%
	0	82168124.27	5.644502852	25.11%
	-10%	36811234.67	9.038984972	18.04%
	-20%	/	48.7447657	10.38%
14000TEU	20%	376094575.5	2.313076283	52.03%
	10%	296720018.7	2.82022842	43.83%
	0	217345461.9	3.616218663	35.61%
	-10%	137970905.1	5.05542816	27.29%

	-20%	58596348.29	8.548764049	18.71%

Table 4.5 analysis on sensitivity of the freight price

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It shows that when the 8000TEU ships fall 20% of the freight price, the net present value will be appear negative, meaning the plan is not flexible.

Factor: Bunker Price				
Ship style	rate of change	NPV	PBP	IRR
8000TEU	20%	41459125.29	8.500587532	18.78%
	10%	61813624.78	6.770221086	21.98%
	0	82168124.27	5.644502852	25.11%
	-10%	102522623.8	4.847691011	28.19%
	-20%	122877123.3	4.251782131	31.25%
14000TEU	20%	149497130.3	4.77758252	28.51%
	10%	183421296.1	4.115107128	32.07%
	0	217345461.9	3.616218663	35.61%
	-10%	251269627.7	3.226409194	39.13%
	-20%	285193793.5	2.913146884	42.64%

Table 4.6 analysis on sensitivity of the bunker price

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

It is obviously that with the same changing degree of the indicators, the range of variation with bunker price is lighter than the freight price indicator, but deeper degree than the ship price.

Summary

From the economic analysis of both 8000TEU and 14000TEU ships, we can draw a conclusion that the greater the ship, and the economic benefit is the better. On the contract, the smaller the ship size, the lower business risk will under take. From the sensitive report, we can see that the freight rate have the hugest implantation on the investment effect indexes and the ship price has the relatively lighter impact on net present value, payback period and internal rate of return.

Chapter 5 Methodology of capacity plan for CSCL's China-Europe route

5.1 Introduction

In the previous Chapter, it mainly analysis the operation indexes, economic and financial indexes and investment effect indexes. In the mean while, it shows the sensitive report of three uncertain indicators affect on the NPV, PBP and IRR.

In this Chapter, AHP model (Analytic Hierarchy Process) will be applied and established as a fleet type integration selection evaluation indicator system. Also the weights of each indicator will be evaluated in terms of the calculation of the indicators and the experts' suggestions.

5.2 AHP model application in allocation ratio selection

5.2.1 AHP model introduction

It often happens that it is a difficult choice for the decision maker to choose the optimal plan for one thing including thinking so much alternative factors. But with the help of Thomas Saaty's Analytic Hierarchy Process (AHP) we can score them among the multiple situation and bring out the solution easily.

AHP, stands for Analytic Hierarchy Process, is presented by American operations research professor T. L. Saaty in the early 1970s, AHP is a flexible and practical multi-criteria decision making approach towards simple quantitative analysis of the qualitative issues. It is characterized in that making complex issues in a variety of factors by dividing the ordered hierarchy of interlinked, so that principled, based on the subjective judgment of the structure of a certain objective reality (mainly pairwise comparisons) expert opinion and analysis to objectively judge the results directly and effectively combine the level of the hierarchy elements pairwise comparison the importance of quantitative description. Then, using mathematical methods to calculate the weights reflect the relative importance of each level element order, calculating all the elements of the relative weight and sort through all levels between the total rankings.

For example, someone ready to buy a refrigerator. After his understanding of the different types of refrigerators on the market, the decision he made is not often directly compared because there are many factors that are not comparable but to select some intermediate indicators to conduct investigations. The factors can be considered such as the capacity of the refrigerator, cooling level, price, type, power consumption, the outside world reputation, after sales service. And then consider the pros and cons of various models of refrigerators in the above-mentioned intermediate standard sort. With this order, and ultimately make purchasing decisions. In the decision-making, six kinds of refrigerators for the pros and cons of each intermediate standard sort generally are inconsistent, therefore, policymakers should firstly think of these seven standards importance for an estimate, given an ordering, and then six kinds of refrigerators were sort of a standard weight to find out, and finally the integration of these data, and buy refrigerators for the overall objective of sort weights. With this weight vector, the decision-making is very easy.

However, not all the problems can be drawn when meeting the multi-decision makings. So here are some preconditions should be satisfy when applying the AHP model. Firstly, we should command both the orders and the content of the influenced factor for the hierarchy.

Secondly, it must be made sure that the all the indicator in the same level of the hierarchy should be mutually independent and no relationships. Thirdly, there would be some ways to qualify the factors in every hierarchy and then they can be calculated into numerical value. With the above requirements we can establish the AHP indicator weighting system.

So here I will take use of Analytic Hierarchy Process to illustrate and evaluate the condition for choosing the optimal ship type combination as the fleet optimal integration structure is a multi-decision making problems not only qualitative but also quantitative, it is satisfied by all the preconditions mentioned above and have successfully applied in the international transportation and logistics decision making problems.

5.2.2 AHP procedure

When we start to build an AHP model, there are five steps to be considered. First step, build AHP model; Second step, checking for consistency; Third step, determine the scores of each alternative on each criterion; Fifth step, calculate an overall score for each project & determining the best alternative. Here illustrate the process of applying AHP in details: (Source:Yuan, Q. (2011). *Decision-making techniques.* Unpublished lecture handout, World Maritime University, Malmo, Sweden.)

Step 1: Build AHP model

In the beginning step of building AHP model, we should find out the hierarchies in orders and logically, thus to make easy and simple understanding of the importance each factor with the decision problem. There are four ordered levels can be designed in this hierarchy formation. The beginning is the objective of the decision problem. Next level is the elements and sub-elements. The bottom is the alternatives of the corresponding sub-element. They can be figured out below just like family tree.

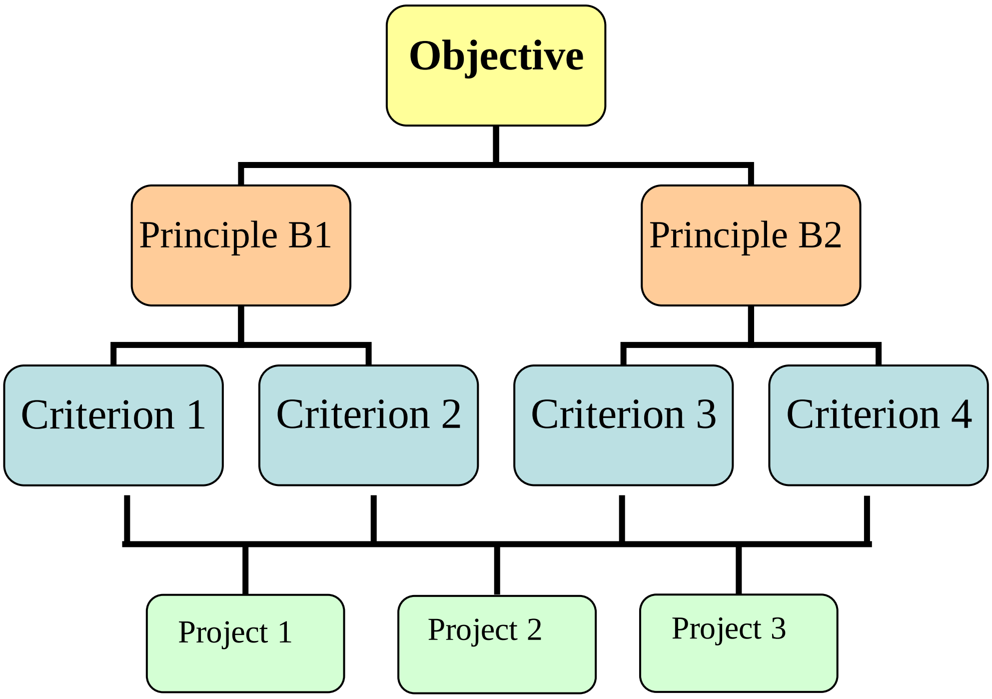

Figure5.1 hierarchical structure of AHP model

Source: Yuan, Q. (2011). *Decision-making techniques.* Unpublished lecture handout, World Maritime University, Malmo, Sweden

Step 2: Determine each criterion's weight

Once the hierarchy has been built, we should focus on comparing each elements of the decision problem and determine the weight among them.

1) Building Pairwise comparison matrices:

In order to get the weights of each alternative, we should firstly get the pairwise comparison matrix. So we should evaluate the significance of the elements shown out and give the numerical value from one to nine as the degree of the significance. The illustration can be listed as follows:

Value of a_{ij}	Interpretation
1	Objective i and j are equally significant
3	Objective i is slightly more significant t than j
5	Objective i is strongly more significant than j
7	Objective i is very strongly more significant t than j
9	Objective i is absolutely more significant than j
2,4,6,8	Between those two proximal boundary value of weights above

Table5.1 The significance meaning of pairwise comparision

Source: Yuan, Q. (2011). *Decision-making techniques.* Unpublished lecture handout, World Maritime University, Malmo, Sweden

2) Normalized pairwise comparison matrices *A* to get *A:**

As the pairwise comparison matrix is sighed as A, we use A to divide the sum of the column in order to form a new matrix sighed as *A**. This step making the format in the column add up is one.

3) Weight estimate of element *i*:

In order to get the measure of the weights for element *i* , we can do the average of the A* of row *i* to get the estimation.

Step 3: Check consistency

Next, a mathematical way should be applied in the normalization after estimating the weight of element *i* .But actually there may be rise inconsistency in the pairwise comparison matrix. So here is the solution for checking the inconsistency of the matrix.

1) Calculate *A•W*.

We should calculate the eigenvector (ω) of in the list and figure out the largest eigenvalue (λmax) of the matrix.

2) Calculate Lambda max(λmax):

The lambda max is equal to the sum of the element of AW divide the relative weight W. The formula can be list as below:

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nw_i} \tag{5-1}$$

Only that the pairwise comparison matrix is consistent can we normalize each matrix and thus to make out the weight.

3) Compute the constancy index (CI):

The constancy index is equal to the value of lambda max minus number of elements to divide the value of number of elements minus one. This step is the checkout step for the right calculation of AHP model.

$$\mathrm{CI} = \frac{\lambda_{\max} - n}{n-1} \tag{5-2}$$

4) Compute the constancy ratio (CR):

Here is the random index reference and we can calculate the constancy ratio according to the constancy index and random index.

n	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Table 5.2 constancy ratio list

The final consistency ratio (CR) is equal to the consistency index (CI) divided the random index (RI):

$$CR=CI/RI \tag{5-3}$$

When the number of consistency ration is lower than 0.10, then the consistency is acceptable for the matrix, pointed out by the Saaty. If the consistency is not under the numerical value of 0.1, we must check up what we had done before and de modulation of the data to make sure everything is right.

Step 4: Determine each elements' grade:

We can use the same way to compare the pairwise matrix of each plans according to the considered elements.

Step 5: Determining the optimal choice:

In the overall results, we can choose the higher grade of the score to be the optimal choice fir the decision problems.

5.3 Establish evaluation indicators system

As we all know, shipping industry is a kind of high valued and high risky business that the changeable situation made us need to adjust the fleet structure to satisfy the current demands of the tonnage. The first and the most important measure for the shipping company to do is to consider an over-around decision-making to integrate optimal combination of the fleet in a specific route. As the timely decision will directly and obviously affects the company's economical benefits and operating efficiency. So, we must establish a reasonable evaluation indicator system to figure the factors accurately.

Here is the evaluation indicator system of the ship selection mode:

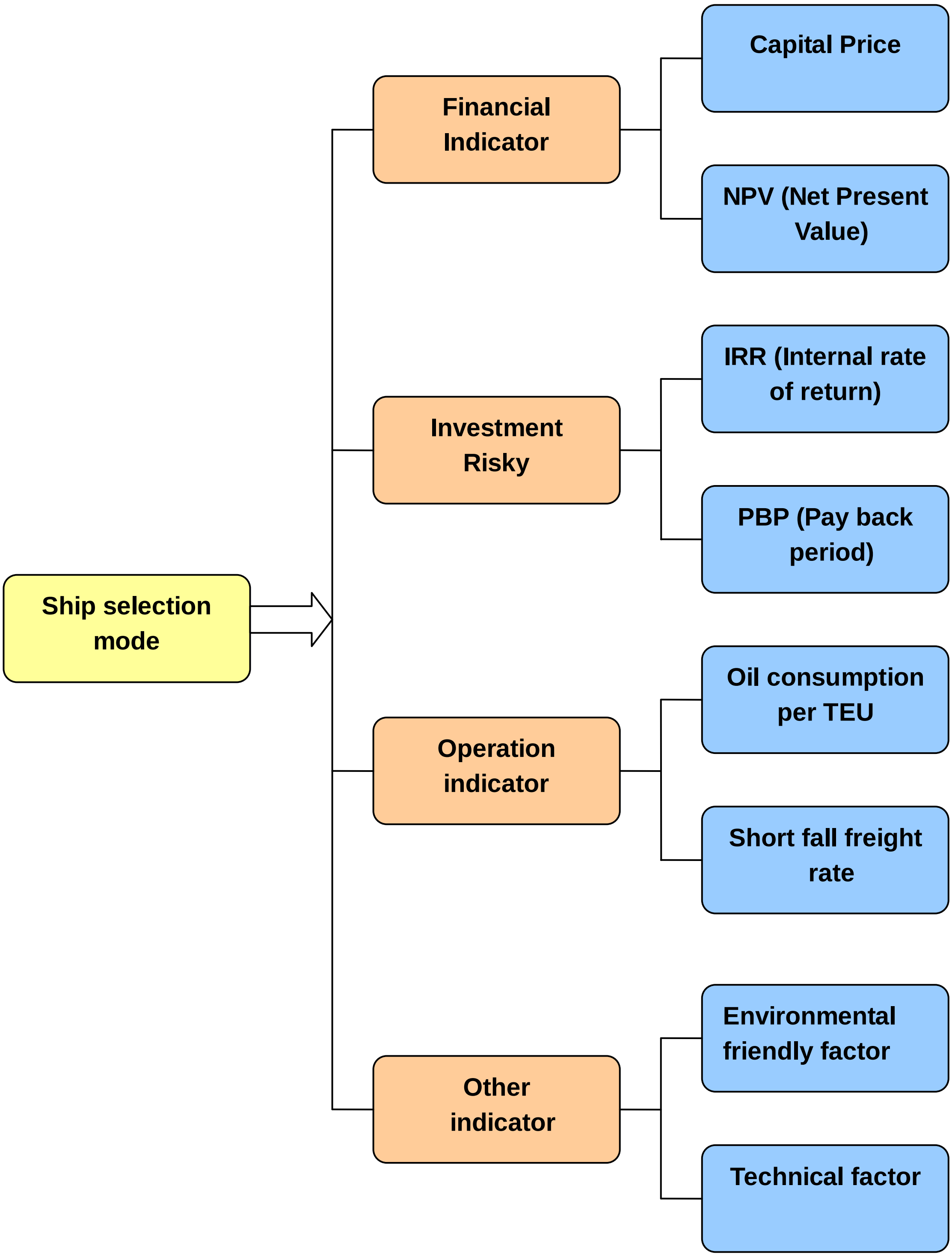

Figure 5.2 evaluation indicator system on ship selection mode

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The

The first level is the objective that the ship selection mode established. In the second level, it consists of four indicators to be considered for the ship type selection, they are namely financial indicator, investment risky, operation indicator and other indicators. Each of the indicators possess their opposite sub-indicators in the third level respectively.

Financial indicator:

The financial indicator of the ship selection mode is made up by two sub-indicators: ship cost and net present value, we can weight the capital cost and NPV into the value among number one to nine to show the degree of this factor. The higher the numerical value the better economic effect on the ship selection mode will take account.

(1) Capital cost

Here the capital cost is mainly stands for the ship price. Actually in choosing different ship type will result in different capital cost. And the higher the numerical valued equals to the higher cost of the ship price.

(2) NPV (Net Present Value)

The arising of the cash flow cannot be considered as the earning of the investment as value is not only regard to money but also the period of time. If you invest the same amount of money currently and in future, it will be more worthy if you do it now because you have more chance to get the return in this period of time while if you don't , the mount of money will stay same or lose value in future date. So

the net present value is the sum of net cash flows investment discounted by a specified discount rate. The bigher the numerical value of net present value, the well-paid the investment is.

Investment risky indicator:

Once the financial factors to be considered in ship selection mode, the investment risky of it should also be think of. This indicator shows the control of the market risk business in shipping industry. The investment risky indicator can be supposed by two sub-indicators, called IRR (internal rate of return) and PBP (pay back period). The lower the numerical valued of the indicator the better choice for ship type selection.

(1) IRR

As we can see, the investment's IRR means the discount rate of negative cash flows of the investment is equal to the positive cash flows of the invest which has been profited. As the internal rate of return is not only the yield of the investment, but also the rate quantity of its return as well as the symbol of the efficiency of the cash flows. So the higher number value of the internal rate of return, the more favorite to undertake the investment.

(2) PBP

Pay back period can be illustrated as the pay in the financial investment of the mount value to the original investment in a certain period of time. Of course, the shorter time period of the pay back investment, the lower risky of the ship type to choose.

Operation indicator:

As we see the shipping business is an over around management. In the actual operation of the business, we should not only discuss about the financial indicator and risk indicator, the operation factor also plays an important role in the management in the management and decision-making of the ship selection. Operation indicator can be regard as two sub factors: fuel consumption per TEU and short fall freight rate. The lower the numerical valued of each indicator the idle choice for selection.

(1) Fuel consumption per TEU

It is obviously can be seen that the fuel takes a huge amount of the operation cost, especially in current situations. The fast increase of the fuel charge makes us to think about how to reduce the fuel consumption to achieve the best and most efficiency in operation and management of the ship. So, the lower numerical valued of the fuel consumption per TEU, the better choice for the ship to be selected.

(2) Short fall freight rate

As we all know, it is not reasonable for a ship to take full of the goods every time, therefore the short freight rate appears. The short fall freight rate is just a fluctuated ration in terms of the ship industry statement and the ship type we choose in that time. Generally, the larger the size of the ship, the high numerical valued of short fall freight rate will turn up.

<u>Other indicators:</u>

In order to choose the optimal ship size in today's shipping industry, we not only consider the economic problems, the risk evaluation, the operation and management indicator, but we also should put some other invisible but same important factors under consideration. Here two criteria indicate on the environment and technical side for the ship selected mode.

(1) Environmental friendly factor

As we all know, the Maersk Line has carry out the ‘3E’ concept of ship, 3E stands for economic, efficient and environment. So the environmental-friendly factor is as important as the economic and efficient factor. As for a ship sailing on the sea, it is inevitable to break the ecological deterioration, the oil consumption, the pour of waste water such like these. Hence, the higher numerical valued of the environmental friendly factor, the better choice for ship selection.

(2) Technical factor

Technical factor is an invisible factor that can be reflected in the financing activity and operation period. The technical factor is mainly including the technical parameters such as the stability of the ship, rate of power, laden fraught and so on. The higher the numerical valued of the technical factor the better choice for ship selection.

The above explanation make clear for the third level of the criteria we considered and pave the way for the AHP model application.

5.4 AHP model calculation

As the eight indicators have been listed in the above ship model selection system, and I determined the ship price, net present value, payback period, internal rate of return, fuel consumption per TEU, short fall freight rate, environmental friendly and technical indicator as criteria one, criteria two…to criteria eight respectively.

Then I invited several experts who work in the field of shipping planning to pairwise compare criteria from one to eight in the ship selection evaluation indicators system, obtaining the range-pairwise comparison matrix as follows:.

$$\begin{bmatrix} 1 & 5 & 3 & 3 & 5 & 6 & 9 & 4 \\ 1/5 & 1 & 1/3 & 1/3 & 1 & 2 & 5 & 2 \\ 1/3 & 3 & 1 & 1 & 3 & 4 & 7 & 5 \\ 1/3 & 3 & 1 & 1 & 3 & 4 & 7 & 1 \\ 1/5 & 1 & 1/3 & 1/3 & 1 & 2 & 5 & 1/2 \\ 1/6 & 1/2 & 1/4 & 1/4 & 1/2 & 1 & 4 & 2 \\ 1/9 & 1/5 & 1/7 & 1/7 & 1/5 & 1/4 & 1 & 1/3 \\ 1/4 & 1/2 & 1 & 1 & 2 & 1/2 & 3 & 1 \end{bmatrix}$$

After it, I unitary normalize the range-pairwise comparison matrix by the excel, obtaining the matrix below：

$$\begin{bmatrix} 0.385 & 0.352 & 0.479 & 0.425 & 0.318 & 0.304 & 0.220 & 0.253 \\ 0.077 & 0.070 & 0.053 & 0.047 & 0.064 & 0.101 & 0.122 & 0.126 \\ 0.128 & 0.211 & 0.160 & 0.142 & 0.191 & 0.203 & 0.171 & 0.316 \\ 0.128 & 0.211 & 0.160 & 0.142 & 0.191 & 0.203 & 0.171 & 0.063 \\ 0.077 & 0.070 & 0.053 & 0.047 & 0.064 & 0.101 & 0.122 & 0.032 \\ 0.064 & 0.035 & 0.040 & 0.035 & 0.032 & 0.051 & 0.098 & 0.126 \\ 0.043 & 0.014 & 0.023 & 0.020 & 0.013 & 0.013 & 0.024 & 0.021 \\ 0.096 & 0.035 & 0.032 & 0.142 & 0.127 & 0.025 & 0.073 & 0.063 \end{bmatrix}$$

Then, average the unitary normalize by transversal vector, obtaining the column vector as below:

$$\begin{bmatrix} 0.342 \\ 0.083 \\ 0.190 \\ 0.159 \\ 0.071 \\ 0.060 \\ 0.021 \\ 0.074 \end{bmatrix}$$

Later, I do the consistency index inspection like this:

$$\begin{bmatrix} 1 & 5 & 3 & 3 & 5 & 6 & 9 & 4 \\ 1/5 & 1 & 1/3 & 1/3 & 1 & 2 & 5 & 2 \\ 1/3 & 3 & 1 & 1 & 3 & 4 & 7 & 5 \\ 1/3 & 3 & 1 & 1 & 3 & 4 & 7 & 1 \\ 1/5 & 1 & 1/3 & 1/3 & 1 & 2 & 5 & 1/2 \\ 1/6 & 1/2 & 1/4 & 1/4 & 1/2 & 1 & 4 & 2 \\ 1/9 & 1/5 & 1/7 & 1/7 & 1/5 & 1/4 & 1 & 1/3 \\ 1/4 & 1/2 & 1 & 1 & 2 & 1/2 & 3 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0.342 \\ 0.083 \\ 0.190 \\ 0.159 \\ 0.071 \\ 0.060 \\ 0.021 \\ 0.074 \end{bmatrix} = \begin{bmatrix} 3.006 \\ 0.714 \\ 1.685 \\ 1.387 \\ 0.602 \\ 0.515 \\ 0.180 \\ 0.633 \end{bmatrix}$$

Then, find the ratio of each element of *AW* to the corresponding weight in *W* and averaging there ratios:

$$\begin{bmatrix} 3.006 \\ 0.714 \\ 1.685 \\ 1.387 \\ 0.602 \\ 0.515 \\ 0.180 \\ 0.633 \end{bmatrix} \div \begin{bmatrix} 0.342 \\ 0.083 \\ 0.190 \\ 0.159 \\ 0.071 \\ 0.060 \\ 0.021 \\ 0.074 \end{bmatrix} = \begin{bmatrix} 8.788 \\ 8.635 \\ 8.859 \\ 8.749 \\ 8.506 \\ 8.563 \\ 8.415 \\ 8.529 \end{bmatrix}$$

$$\lambda_{max} = \text{the average of } \begin{bmatrix} 8.788 \\ 8.635 \\ 8.859 \\ 8.749 \\ 8.506 \\ 8.563 \\ 8.415 \\ 8.529 \end{bmatrix} = 8.630$$

Then, calculate the constancy index as follows:

$$CI = \frac{\lambda_{max} - n}{n-1} = \frac{8.630 - 8}{8-1} = 0.090$$

Then, check the random index in the table. As the value of number is 8, so the CI is

1.41. The consistency ratio equals to the consistency index divide the random index. Calculate as below:

$$CR=CI/RI=0.90/1.410=0.064$$

The result is that the number of consistency ratio is lower than 0.1 and meet the requirement of taking AHP model to analysis.

After all, the importance of each element can be known as below:

$[0.342 \quad 0.083 \quad 0.190 \quad 0.159 \quad 0.071 \quad 0.060 \quad 0.021 \quad 0.074]$ For the ship price indicator, net present value, payback period, internal rate of return, fuel consumption per TEU, short fall freight rate, environmental friendly and technical indicator.

5.5 Determining the Best Alternative

As the aim of the paper is to integrate the fleet of their ship size as in the situations of the new container ships are largely delivery by the end of 2011 and forecast the transport volume on the route of Asia-Europe for better decision.

NO.	Fleet combination
1	5 14000TEU with 4 8000TUE ships
2	4 14000TEU with 5 8000TUE ships
3	3 14000TEU with 6 8000TUE ships
4	2 14000TEU with 7 8000TUE ships
5	1 14000TEU with 8 8000TUE ships

Criterion 1	Ship cost
Criterion 2	Net present value
Criterion 3	Payback period
Criterion 4	Internal rate of return
Criterion 5	Fuel consumption per TEU

Criterion 6	Short fall freight rate
Criterion 7	Environmental friendly
Criterion 8	Technical indicator

Table 5.3 Plans and criterions

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Pairwise comparisons among plans on c1					
Plan	**1**	**2**	**3**	**4**	**5**
1	1.00	0.20	0.20	0.50	0.50
2	5.00	1.00	1.00	4.00	4.00
3	5.00	1.00	1.00	4.00	4.00
4	2.00	0.25	0.25	1.00	1.00
5	2.00	0.25	0.25	1.00	1.00

Plan	**Normalized matrix**					**Scores**	**Product**	**Ratios**
1	0.067	0.074	0.074	0.048	0.048	0.062	0.311	5.01
2	0.333	0.370	0.370	0.381	0.381	0.367	1.859	5.06
3	0.333	0.370	0.370	0.381	0.381	0.367	1.859	5.06
4	0.133	0.093	0.093	0.095	0.095	0.102	0.511	5.02
5	0.133	0.093	0.093	0.095	0.095	0.102	0.511	5.02
Max								5.036
CI								0.009
RI								1.120
CI/RI								0.008

Table 5.4 Pairwise comparisons among plans on ship cos

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Pairwise comparisons among plans on c2					
Plan	1	2	3	4	5
1	1.00	5.00	6.00	4.00	5.00
2	0.20	1.00	2.00	0.50	1.00
3	0.17	0.50	1.00	0.33	0.50
4	0.25	2.00	3.00	1.00	2.00
5	0.20	1.00	2.00	0.50	1.00

Plan	Normalized matrix					Scores	Product	Ratios
1	0.550	0.526	0.429	0.632	0.526	0.533	2.747	5.16
2	0.110	0.105	0.143	0.079	0.105	0.108	0.545	5.02
3	0.092	0.053	0.071	0.053	0.053	0.064	0.324	5.04
4	0.138	0.211	0.214	0.158	0.211	0.186	0.946	5.08
5	0.110	0.105	0.143	0.079	0.105	0.108	0.545	5.02
Max								5.065
CI								0.016
RI								1.120
CI/RI								0.015

Table 5.5 Pairwise comparisons among plans on net present value

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Pairwise comparisons among plans on c3					
Plan	1	2	3	4	5
1	1.00	5.00	5.00	3.00	6.00
2	0.20	1.00	1.00	0.33	2.00
3	0.20	1.00	1.00	0.33	2.00
4	0.33	3.00	3.00	1.00	4.00
5	0.17	0.50	0.50	0.25	1.00

Plan	Normalized matrix					Scores	Product	Ratios
1	0.526	0.476	0.476	0.610	0.400	0.498	2.582	5.19
2	0.105	0.095	0.095	0.068	0.133	0.099	0.500	5.03
3	0.105	0.095	0.095	0.068	0.133	0.099	0.500	5.03
4	0.175	0.286	0.286	0.203	0.267	0.243	1.246	5.12
5	0.088	0.048	0.048	0.051	0.067	0.060	0.303	5.05
Max								5.082
CI								0.020
RI								1.120
CI/RI								0.018

Table 5.6 Pairwise comparisons among plans on payback period

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Pairwise comparisons among plans on c4					
Plan	1	2	3	4	5
1	1.00	0.17	0.17	0.33	0.33
2	6.00	1.00	1.00	4.00	4.00
3	6.00	1.00	1.00	3.00	3.00
4	3.00	0.25	0.33	1.00	1.00
5	3.00	0.25	0.33	1.00	1.00

Plan	Normalized matrix					Scores	Product	Ratios
1	0.053	0.063	0.059	0.036	0.036	0.049	0.246	5.02
2	0.316	0.375	0.353	0.429	0.429	0.380	1.946	5.12
3	0.316	0.375	0.353	0.321	0.321	0.337	1.712	5.08
4	0.158	0.094	0.118	0.107	0.107	0.117	0.588	5.04
5	0.158	0.094	0.118	0.107	0.107	0.117	0.588	5.04
Max								5.059
CI								0.015
RI								1.120
CI/RI								0.013

Table 5.7 Pairwise comparisons among plans on internal rate of return

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Pairwise comparisons among plans on c5					
Plan	1	2	3	4	5
1	1.00	0.33	0.33	0.50	0.17
2	3.00	1.00	1.00	2.00	0.25
3	3.00	1.00	1.00	2.00	0.25
4	2.00	0.50	0.50	1.00	0.20
5	6.00	4.00	4.00	5.00	1.00

Plan	Normalized matrix					Scores	Product	Ratios
1	0.067	0.049	0.049	0.048	0.089	0.060	0.303	5.04
2	0.200	0.146	0.146	0.190	0.134	0.163	0.829	5.08
3	0.200	0.146	0.146	0.190	0.134	0.163	0.829	5.08
4	0.133	0.073	0.073	0.095	0.107	0.096	0.484	5.02
5	0.400	0.585	0.585	0.476	0.536	0.517	2.667	5.16
Max								5.074
CI								0.019
RI								1.120
CI/RI								0.017

Table 5.8 Pairwise comparisons among plans on fuel consumption per TEU

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Pairwise comparisons among plans on c6					
Plan	1	2	3	4	5
1	1.00	0.50	2.00	1.00	3.00
2	2.00	1.00	3.00	2.00	5.00
3	0.50	0.33	1.00	0.50	2.00
4	1.00	0.50	2.00	1.00	2.00
5	0.33	0.20	0.50	0.50	1.00

Plan	Normalized matrix					Scores	Product	Ratios
1	0.207	0.197	0.235	0.200	0.231	0.214	1.080	5.05
2	0.414	0.395	0.353	0.400	0.385	0.389	1.962	5.04
3	0.103	0.132	0.118	0.100	0.154	0.121	0.611	5.04
4	0.207	0.197	0.235	0.200	0.154	0.199	1.003	5.05
5	0.069	0.079	0.059	0.100	0.077	0.077	0.386	5.03
Max								5.041
CI								0.010
RI								1.120
CI/RI								0.009

Table 5.9 Pairwise comparisons among plans on short fall freight rate

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

Pairwise comparisons among plans on c7					
Plan	1	2	3	4	5
1	1.00	0.20	0.20	0.50	0.33
2	5.00	1.00	1.00	4.00	3.00
3	5.00	1.00	1.00	4.00	3.00
4	2.00	0.25	0.25	1.00	0.50
5	3.00	0.33	0.33	2.00	1.00

Plan	Normalized matrix					Scores	Product	Ratios
1	0.063	0.072	0.072	0.043	0.043	0.058	0.294	5.02
2	0.313	0.359	0.359	0.348	0.383	0.352	1.798	5.10
3	0.313	0.359	0.359	0.348	0.383	0.352	1.798	5.10
4	0.125	0.090	0.090	0.087	0.064	0.091	0.457	5.02
5	0.188	0.120	0.120	0.174	0.128	0.146	0.738	5.07
Max								5.063
CI								0.016
RI								1.120
CI/RI								0.014

Table 5.10 Pairwise comparisons among plans on environmental friendly

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Pairwise comparisons among plans on c8					
Plan	1	2	3	4	5
1	1.00	0.20	0.20	0.50	0.33
2	5.00	1.00	5.00	4.00	3.00
3	5.00	0.20	1.00	4.00	3.00
4	2.00	0.25	0.25	1.00	1.00
5	3.00	0.33	0.33	1.00	1.00

Plan	Normalized matrix					Scores	Product	Ratios
1	0.063	0.072	0.072	0.043	0.043	0.058	0.340	5.82
2	0.313	0.359	1.796	0.348	0.383	0.640	3.207	5.01
3	0.313	0.072	0.359	0.348	0.383	0.295	1.515	5.14
4	0.125	0.090	0.090	0.087	0.128	0.104	0.583	5.61
5	0.188	0.120	0.120	0.087	0.128	0.128	0.719	5.60
Max								5.437
CI								0.109
RI								1.120
CI/RI								0.098

Table 5.11 Pairwise comparisons among plans on technical indicator

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For each plan, its overall score is a weighted sum of the scores. In the end, the overall scores for those 5 plans are obtained and shown below:

Matrix of scores									Overall
Plan\Criterion	1	2	3	4	5	6	7	8	scores
1	0.062	0.533	0.498	0.049	0.06	0.214	0.058	0.058	**0.190**
2	0.367	0.108	0.099	0.38	0.163	0.389	0.352	0.640	**0.304**
3	0.367	0.064	0.099	0.337	0.163	0.121	0.352	0.295	**0.251**
4	0.102	0.186	0.243	0.117	0.096	0.199	0.091	0.104	**0.143**
5	0.102	0.108	0.06	0.117	0.517	0.077	0.146	0.128	**0.128**

Table 5.12 Matrix of scores of the plans

Source: Drawn by author: ©Copyright Zhou Yan,WMU-ITL Shanghai,(2012) by The Rationality Study on Capacity Allocation for CSCL's Asia-Europe Route

As the result, plan2 shows the highest score among them, which indicate that the fleet combination with four 14000TEU ships and five 8000TEU ships running between the Asia-Europe route is the optimal and economic plan in terms of the company statement and the current shipping environment.

Summary

In this chapter, I build an AHP model to handle the ship combination problem of the paper, establish the ship selection mode and five plans with eight indicators. And the result shows if add two more new delivery 14000TEU ships will be more suitable for today's situation.

Conclusion

After all, we can draw the conclusion in the below four point:

(1) During the financial crisis time, the financial industry is so weak and stagnant that really affects many other industries. When it comes to the shipping industry, it really influenced a lot, especially on Asia-Europe route, suffered severely from the sharp decline of global financial market. For those shipping companies should take all measures to avoid the shrink from the market and also get ready for the recovery of the gloomy state.

(2) For China shipping container lines, with eight more 14000TEU new building container ships will be delivered in hands of one year and slowly release of the capacity makes a need to allocation of the fleet integration. As the fleet structure and ships allocation are the main business of leading a shipping company, finding the most suitable mode of the fleet to our shipping company under the background of the construction of shipping center before year 2020 definitely pour the fresh blood and power to the development of Chinese shipping industry

(3) In the procedure of the rationality study on capacity allocation, we should consider the potential demand in the next future and the current capacity together, to planning out the high reward and low risk combination of the fleet. So a lot of financial data should be calculated to find out the exactly pros and cons of each ship type on the specific route. The CSCL should seize the chance to have the structural adjustment to reach the best profits and prospect in the next few years and build a modernization first-class fleet.

(4) As all the data calculated and situation analysis, four 14000TEU with five 8000TUE ships on this specific route between Asia and Europe is optimal.

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