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The study on the optimization for coscon fleet deployment in the Asia-Europe lane

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THE STUDY ON THE OPTIMIZATION FOR COSCON FLEET DEPLOYMENT IN THE ASIA – EUROPE LANE

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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.

(Signature): ……………………..

(Date): …………………………..

Supervised by
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ABSTRACT

Title of research paper: **The Study on the Optimization for COSCON Fleet Deployment in the Asia – Europe Lane**

Degree: **MSc**

The research paper is a study of the fleet deployment for COSCON in the Asia – Europe lane with the help of quantitative and qualitative method.

With the new recovery from the financial tsunami, the container shipping industry is going to become an extremely competitive pool as before. However, under these adverse circumstances, there has been an extensive debate about how to improve fleet management, make good use of resource, decline operating cost, and increase core competence is examined.

In order to achieve the goal, it is necessary to confirm a proper strategy for its own in accordance with the fleet scale, cargo volume and other operation condition.   Then, by the use of SWOT analysis approach, the paper can gain the result for the certain container shipping company that was proper evaluated.

Nowadays, global shipping enterprises adopting hub & spoke port structure to meet the trend of deploying large-size vessels in long-distance voyage is investigated. But, the basic port structure model has its own advantage on middle and small-size ships in daily operation.   On this basis, the scientific selection for port structure in the certain lane can play an important role on solving the specific problem in a quantitative approach.

Additionally, the author uses the method of optimization to build the model to rearrange COSCON fleet with the help of "spread sheet" as a typical case application in a qualitative method.

Finally, the concluding chapters examine the results of all the assessment to offer a number of recommendations and further vision as well.

KEYWORDS: Container Fleet Deployment, Strategic Analysis, Port Structure Model, Optimization

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

COSCON	COSCO Container Lines Co. Ltd.
TEU	Twenty-foot Equivalent Unit
FEU	Forty-foot Equivalent Unit
FOC	Flag of Convenience
M&R	Maintenance and Repair
CKYH	COSCON, K-Line, Yang Ming Line, HANJIN
CCFI	China Containerized Freight Index
SCFI	New Shanghai Containerized Freight Index
B/L	Bill of Lading
M&A	merger & Acquisitions
SOE	State - Owned Enterprise
MSC	Mediterranean Shipping Company
CSCL	China Shipping Container Line
CIF	COST, INSURANCE & FREIGHT
FOB	Free on Board

CHAPTER 1

Introduction

1.1 Background of the Dissertation

With the rapid development of container transportation technique, the container shipping plays a crucial role on the maritime transport. The proportion of ocean cargo is also increasing in the international trade year by year. However, due to the imbalance of world trade and global economic development, lots of uncertain factors lead to largely fluctuation in the international container shipping market.

So, it is critical for container shipping companies to improve their fleet management, deploy resource rationally and decrease operation cost. Only if shipping enterprises adopt scientific method, can they enhance their market competitiveness. Therefore, it is necessary to adopt a proper way to optimal container fleet deployment, especially in the use of qualitative and quantitative approach for promoting the effectiveness and efficiency.

As the top container shipping carrier in China, COSCON has a large scale of container fleet and thereby it should use a efficient way to manage vessels and also make a proper strategy to catch the opportunities that the external cargo volume will

continue increasing, though RMB is still in the process of appreciation.   In addition, the Asia – Europe lane is the main route in container cargo export.   Therefore, in the beginning of economic recovery, it is time for COSCON to redesign its strategy and rearrange its fleet deployment.

1.2 Literature Review

In 1970s, Boffery et al established a relevant computer program and accessible optimization method to deploy container fleet in North Atlantic lane.   However, due to the limitation of poor condition, the software program was not an effective tool, but a data report for shipping companies.

Till 1992, Bremer has preliminarily studied and researched for fleet deployment model in bulk and tanker shipping operation.   After that, several bachelors and experts began to study this topic from its basic characteristics.   For instance, Powell established a simple model which only involved bulk shipping between two ports in a specific period of time without considering the frequency or punctuation of vessels.

In 1991, Perakis set up an objective function based on the speed parameter and non-linear constraints as well.   Although he worked out the result in use of "Lagrange multiplier method" and non-linear programming method, the model lacked of practical usage owing to its complex calculation.   Then the model was improved in accuracy and practicality by him.   Perakis added full-loaded /empty speed factor and additional constraints, also considered the minimum cost in a voyage.   But the problem of complexity did not be solved in that time.

Seong-eheol. CHO used linear programming approach to deploy tanker, dry bulk fleet in maritime transportation in the trade of U.S in 1996. He considered four constraints: shipment movement, lane, vessel size, port limitation. The result showed that fleet cost was sensitive to port limitation rather than shipment volume itself.

In China, Yang Hualong & Zhong Ming proposed the container fleet deployment method in 1996. Prof. Zhao Gang set up the theoretical basis of optimization for container fleet deployment in 1997. In 2000, Xu Tianfang & Hu Lina studied and researched for domestic liner fleet deployment problems and concluded vital principles and approaches. Yu Shaoming, Zhang Haijian & Zhang Chao established a good example in the practical application with the help of computer language for the model optimization.

However, the current research emphasizes the academic analysis rather than model innovation. With the rapid change of market, the present model becomes out of date. In addition, most models focus on its own angles, which may lead to their partial "one-sidedness". How to invent new models fitting practical application and integrate various models' advantage is still an issue.

1.3 Research Methodology

Quantitative analysis will be used to analyze the characteristics of container fleet deployment and then the paper will analyze strategy layout of the COSCON in the "China—Northwest Europe" lane by the SWOT analysis. Apart from that, the principles for comparison and selection of port structural models are necessary, too.

The quantitative analysis only embodies the basic framework of fundamental optimization of fleet deployment, whose weakness is what can only roughly instruct the company to choose a relatively better way to improve the current management.

Qualitative analysis will be discussed in the following. According to the original data, the author adopts the simplified optimal model to resolve the present problem. The result relies on the optimal function of "spread sheet" (EXCLE) with the proper constraints as well. All in all, it is relatively precise for COSCON to adjust its current container fleet deployment theoretically.

In the process of calculation in the spread sheet, the way to gain the optimal result relies on the inside linear programming system that is a mathematics planning method. It has to contain objective function that is the goal for optimization and constraints that are more than two restrictions owing to the resource limit. After the computer calculation, the optimal result is the closest answer in the whole database. However, if you use other advanced software, the answer can be more precise without doubts.

1.4 Research Aim

The competition in current container shipping industry has become extremely fierce. To improve core competency including reducing resource redundant, and increasing management efficiency is the vital task for each shipping companies, especially world-class integrator – COSCON.

However, the former experience can not be precise enough to solve these complex

problems alone.   So, the paper will offer a proper analysis report for COSCON by an advanced technology in a comprehensive approach to meliorate daily operating effectiveness.   It is also an effective way for COSCON to enhance its leading status, enlarge fleet management and strengthen the market share.

The paper is to introduce a comprehensive analysis method to solve complex arrangement problems.   Inspired by the good news of sustainable economic recovery, there will be more often to use quantitative and qualitative approach to work out these kinds of problems, though the method is not perfect.   But, it is a relatively effective way to resolve container fleet deployment in shipping management.

CHAPTER 2

Characteristic Analysis of Container Fleet Deployment

The chapter will elaborate on the fact that many factors will have influence on the container fleet deployment, including external, internal, operation cost and etc.. The changes of any of them shall lead to the fluctuation of the utilization of fleet management for COSCON.

2.1 Basic Characteristics

2.1.1 Schedule Immobility

Vessels, ports of call, departure and arrival time and voyage cycle etc. are relatively confirmed in container liner shipping.   If there is no special situation, such typhoon, strike etc., they generally can not change it at will.   Nowadays, the precise rate of each voyage is widely viewed as a critical sign for the service and quality of liner shipping companies.   Efficient schedule must balance the daily operation, accounting requirements and customers' needs.   COSCON, as one of the top ten container shipping companies throughout the world, the fixed schedule is the basis to attract customers.   And also, the small change of the schedule will lead to big adjustment for its container fleet deployment.   The new evaluation is necessary,

even a slight change in a single branch.

2.1.2 Operation Cost Stability

Operation cost is irrelevant to the transport object. That is to say, whatever the vessel carries or how many the cargoes are, these expenses basically are stable in each voyage. For example, capital cost, fuel cost, crew's wage, port charges, premium and repair & maintenance fee etc., are 80% to 90% in the total cost. Only 10% to 20% is directly relevant to the cargo volume, such as cargo charge, container fees and agency fees etc.. The fuel cost of each vessel in a voyage in different lane is almost a constant item. Meanwhile, a few expenses are proportional with the cargo volume, such as handling charge, tallying charge and so on. Owing to the fact that main cost items are irrelevant to the cargo, thereby the operation cost in each voyage is relatively fixed. The aim at optimizing the container fleet deployment is to reduce daily operation cost for companies, certainly including COSCON.

2.1.3 Network Service Connection

Container liner transport has entered a global network era. It needs to remain closely connective among different main lines, main lines and branch lines, maritime transport and inland transport etc., so as to improve the transport efficiency as strong as possible. In the network framework, a single mistake shall impact the business of several departments. Similarly, adjustment in a single lane always affects many other lanes, so these other lanes will have to be readjusted with reconsideration. Proper network design is also important for COSCON, which is involved in capacity arrangement as well.

2.2 Necessity of Container Fleet Deployment

As we all know, maritime shipping industry has lots of potential business opportunities. So, it is necessary for a typical container shipping company who wants to earn these invisible profits in advance to utilize rational system to deploy current capacity.

Due to the relatively constant liner lanes, lane design is a strategic long term decision. In addition, it is useful to plan and deploy present shipping capacity in a qualitative method. Because the shipping market fluctuates dramatically sometimes owing to cargo demand, tariff rate, international political environment and etc., the decision makers have to shoulder the responsibility to deliberate the phased adjustment under these adverse circumstances.

However, in accordance with the former management experience, the "reaction rate" is hard for container shipping companies, even COSCON to quick respond only in the help of subjective judgement. In general, according to the experience or common knowledge, the decision makers can do the right decision only when the fleet scale is small or specialized deployment, but if feasible reports are more than one. Or with the rapid development of the fleet scale and lanes, a single man can not consider several complicated factors in one time, they should find out a new way to solve these problems. Nowadays, the quantitative and qualitative approach offers the managers an effective report to analyze the real problems, especially in complex circumstances.

Firstly, cooperation among different lanes can greatly save the cost. The surplus supply of the shipping market leads to the sharply decreasing of the tariff. So, in the poor income condition, the "internal tapping latent potentialities" is a considerable way to enhance business programme. It is important to put emphasis on the transit points and logistics channels. So, the aim to maintain the market share and save the capacity can be realized.

Secondly, avoiding the basic mistakes happened in fleet deployment is also critical. Suppose a company arranges a small-size vessel to carry cargoes in the trans-continental lanes, who also asks vessels to reach all the ports of call, it will result in more times of handling and discharging, longer delivery time, less economic of scales, and lose competition. Therefore, it must comprehensively consider the lanes and the large vessels, especially Panamax and above. By using the Hub & Spoke model to cover one or two areas except the destination, the liner fleet deployment can be more efficient and effective than before.

Finally, trying to avoid the overlap of the ports of call or deviation is a key. According to the present operation management, the manager should confirm the name of the ports of call and the order for ship arrival. The company has to adjust the arrival order of ports of call and avoid deviation so as to save voyage cycle and fuel fee in the way of vessels' condition, traffic market, route design and etc.. Meanwhile, it also must satisfy the need of container shipping in cargo volume, vessel capacity, and the schedule etc..

2.3 Cost Structure of Container Fleet Deployment

Narrowly, maritime cost is the occurred expenses of shipping companies during the transport process. It is the main evidence and basis for shipping enterprises to make a price. It is also the fundamental objective for COSCON to rearrange its container fleet deployment. In addition, it can be divided into three parts according to the common sense of the international shipping industry: capital cost, voyage cost and operation cost.

2.3.1 Capital Cost

Capital cost is defined as a kind of occurred cost shipping companies used to purchase or own vessels. It is the fundamentally cost for shipping enterprises. Capital cost relies on the financial terms and fund resource. From the resource of funds, the capital cost is dependent on the financial mode, if the funds used to purchase vessels are all from the equity finance or from the external loan.

Besides, depreciation is also a vital factor in the capital cost. Normally, shipping companies are not easy to gain the loan for "accelerate depreciation", but "line depreciation". So, in the estimate of voyage cost, annual capital cost is always regarded as the "equivalent depreciation" in the line depreciation method. The formula for the annual depreciation is

$$K = \frac{S}{N}$$

Notes: K— Annual Depreciation

S— Capital Cost

N—Existing Service Life or Economic Life

Capital cost occupies 11% of the operation cost. For COSCON, whether build up vessels is always a question for managers to consider about, which directly has influence on the total capacity in the specific lane.

2.3.2 Voyage Cost

Voyage cost is defined as the total expenses of a completely voyage. It is closely related to the vessel parameters, miles, number of ports of call and fuel price etc.. For COSCON, its each voyage is designed relied on lots of evaluation, but the voyage cost is fluctuating with the changes of fuel price, ship conditions, port authorities and etc.. Thus, before deploying fleet in the specific lane, the manager has to clearly know all the aspects involving voyage cost.

2.3.2.1 Fuel Cost

Fuel cost occupies a very large part of the transport cost, about 47%. With the increase of the oil price, the proportion becomes bigger in the near future and has been the biggest expenditure in the voyage cost.

The types of the main engine, operation condition, hull shape and speed of the ship have great effect on the voyage fuel cost. Different hulls, speed and engine's fuel efficiency mainly affect the fuel consumption.

In order to reduce the voyage cost and environment pollution, fuel cost control is key for COSCON to use technological method to precisely calculate, which will be

critical to the further development of world-class container shipping enterprises.

2.3.2.2 Port Charge

Port charge is defined as expenses for ships in the loading and unloading port during the operation period. It is mainly derived from the payment for port service, including tonnage tax, port dues, pilotage, berthing fee, escort, towage, tally fee, handling charge and Quarantine fee etc. Many factors have effect on the port charge, especially ship's tonnage, berthing time, and port charge rate.

Tonnage Tax = net tonnage * tax rate (about 5.85 yuan/ net tonnage)

Port Dues = 2 * net tonnage * cost rate (about 0.71 yuan/ net tonnage)

Pilotage = net tonnage * 0.53

Berthing fee = berthing charge + anchorage charge = net tonnage * days * 0.23

Towage = Tug's engine horsepower * working time *0.48 (night work and holiday: 0.48 * 1.5 = 0.72)

Tally fee (For container) = 12 yuan/ TEU (night work: 12 * 1.5 = 18)

Handling charge = 430.7 yuan/ TEU; 645.9 yuan/ FEU

Terminal service is not free that occupies 16% of the total. With the development of port infrastructure and facilities, the efficiency of loading and discharging is dramatically improved now. However, due to cover the capital cost and maintenance & repair cost, ports authorities have enhance the service expenses. Therefore, avoiding unnecessary port charges, COSCON should design a rational transport route to select ports of call. Intra—Modal transport can also be considered if necessary.

2.3.3 Operation Cost

Operation Cost is defined as the expenditure to keep vessels seaworthy and maintain daily usage.

2.3.3.1 Crew Cost

Crew cost includes salary, bonus, social security outlay, and pension etc..   Factors influencing crew cost are crew number, crew nationality, ship condition, company policies and management efficiency.   In recent years, the unions of different countries and the international alliance for the Flag of Convenience (FOC) have negotiated several times to improve the salary level of the crew.   But, with the development of automation, the demand of crew should gradually decline, so that shipping enterprises will save lots of crew cost in the future.   As the top ocean transport carrier in China, COSCON has quite a number of crew in both inland and ocean lanes.   But, as a state-owned company, COSCON has responsibility to protect crew's right, regardless of the trend of the rising crew salary.

2.3.3.2 Maintenance and Repair Cost (M&R Cost)

Maintenance and Repair Cost contain all the cost of daily maintenance, frequency repair and scheduled overhaul.   Generally speaking, this kind of cost which occupies about 12% in the total operation cost is mainly influenced by ship condition and age of ship.

Annual M&R Cost relies on the quality of the ship, frequency of ship usage, wear

pattern, ship capacity, M&R techniques and the selection of the ship yard.   If the damaged ship has to be repaired in the ship yard, the M&R cost will be beyond the budget, even above the half of the operation cost.

The time to make ships repaired is important for COSCON in the process of fleet deployment.   The company has to evaluate the economic factors to decide when and where to make M&R.   It should guarantee the adequate capacity in the lane when the cargo volume is enough.

2.3.3.3 Insurance Expenses

Insurance Expenses contain hull insurance, all risks, freight premium, crew risks and war risk etc..   They are dependent on the type of the insurance, the age of the ship, ship condition, crew quality and company faith etc..   It is also a technological evaluation process for container shipping companies, such as COSCON, Maresk, to invest proper insurance types in order to spread the potential risks.   Nowadays, Shanghai has established the insurance exchange for the goal of world maritime centre, which can standardize the insurance market in maritime shipping industry.

2.3.3.3 Consumption and Material Cost

The lubrication oil is the most important consumption on the ship.   It is also the biggest part of the total consumption and material cost, which is about 11% in the whole cost.   Apart from that, the mooring rope, deck repairs and other facilities are all considered to add or maintain as well.   So, the consumption and material cost is closely related to the M&R cost.   "Rome was not built in a day."   Although these

ancillaries cost are not main cost in the total, to be a world-class container carrier, COSCON should also make an economical plan to use them rationally, which is not only related to money alone, but fleet management level.

2.3.3.4 Management Cost

During the cargo transport process, the agencies and administrative departments are needed, such as accounting, control centre business, port authority, security, law, supply chain divisions and freight agency etc..　The management cost is the total cost in these nodes to gain service for convenience.　At present, many shipping companies choose professional managers or management companies to directly operate the fleet.　That will lead to enhance the service quality, but also save a lot of internal resource.

For COSCON, it is not necessary to outsource the fleet management service to others. But, trying to reduce the management cost is crucial for state-owned companies to realize progress on its effectiveness and efficiency.　Nowadays, it has adopted scientific information and communication platform inside the companies, which can decrease the barriers of sharing information in different departments.　Also, the efficient E-business service can be more often to found than before.

CHAPTER 3

Strategic Analysis for COSCON Current Fleet Deployment

in the Asia -- Europe Lane

3.1 Fleet Scale

"As of 1H 2010, COSCON owns 150 container vessels totalling over 590,000 TEUs which are deployed in over 100 routes, covering 140 principal ports in 44 countries and regions."

Source: http://www.coscon.com/about.screen?locale=en

Asia – Europe lane is one of the main businesses for COSCON. Its capacity is nearly one-fourth of the whole in container shipping business. Nowadays, there are twelve 5500TEU vessels, one 8200TEU and two 9400TEU ships working in the Asia – Europe lane, and offer more than 12000TEU capacity per week. In addition, COSCON has combined an "Alliance" which is called "CKYH" with its main competitors— K-Line, Yang Ming Line, HANJIN. According to the cooperation with the members in CKYH, they jointly use others' vessels and exchange their slots in daily operation. So, in the Asia – Europe lane, COSCON has great advantage in advanced vessels, punctuation, and short delivery time etc..

3.2 Traffic Trend Analysis

Container traffic volumes have been greater than expected this year with Drewry forecasting an annual growth of 10.9% for 2010.   Much of the momentum in the first six months was down to global re-stocking of inventory in the West, but it has become difficult to gauge what is new demand and whether we have truly emerged from the recession.   Headhaul container volumes are weakening as we approach the traditional winter slack season and consumer patterns remain uncertain.   However, we forecast that mid to long-term container growth will be about 7% per annum for the next five years, representing a return to stability for the industry.

Source: Container Market Review and Forecast 2010/11, ANNUAL REPORT, Drewry Publishing

Also, according to the "China Containerized Freight Index" (CCFI) and "New Shanghai Containerized Freight Index" (SCFI) issued by Shanghai Maritime Exchange, the Asia – Europe lane market is stable on the whole in a healthy situation from the recession and the peaking season coming in the expectation is also a good news.   So, COSCON has decided to slightly increase the tariff rate in the June in the background of adequate demand.   Due to the extra capacity releasing from the last year in Europe, some other shipping companies hesitate to change the tariff rate to a new higher level.
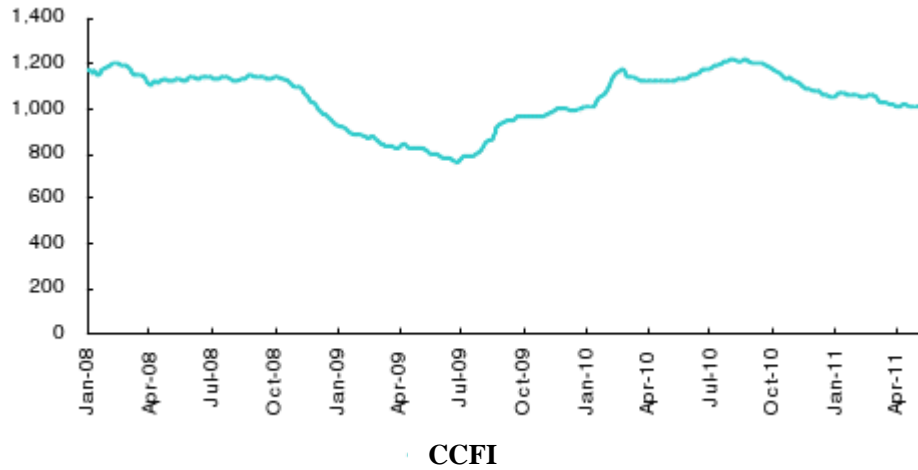
CCFI

Figure 1: "China Containerized Freight Index" (CCFI)

Source: http://www.chineseshipping.com.cn/; Changjiang Securities Research Department, Wu Yunyin Analyst, 2011-05-16
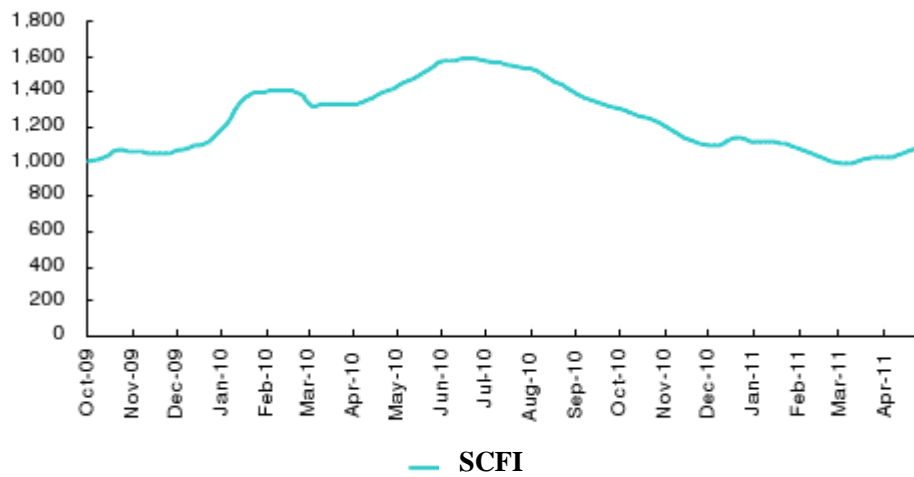
—— **SCFI**

Figure 2: "New Shanghai Containerized Freight Index" (SCFI)

Source: http://www.chineseshipping.com.cn/; Changjiang Securities Research Department, Wu Yunyin Analyst, 2011-05-16

3.3 Strategy for Decision Making by SWOT Analysis

"The overall evaluation of a company's strengths, weaknesses, opportunities, and threats is called SWOT analysis. It's a way of monitoring the external and internal marketing environment."

Source: Philip Kotler & Kevin Lane Keller, MARKETING MANAGEMENT (13tg edition), pp89

SWOT analysis is the auditing and organization in the external and internal environment for a company. Then, by the use of SWOT analysis model, the analyst will offer a proper strategy report for the company in order to improve the management level.

"Strengths" are the unique resources or advanced technologies in the company which can embody the special competitiveness against other competitors. "Weaknesses" are defined as the restrictions of resources and technologies for the company to make progresses in operation efficiency. "Opportunities" are potentially beneficial factors in the external environment. Finally, "Threats" are viewed as the adverse factors, which are sometimes invisible in the external circumstances.

Table 1: SWOT Analysis Model

Comprehensive Analysis		Internal Analysis	
		Strengths	Weaknesses
External Analysis	Opportunities	S vs. O	W vs. O
	Threats	S vs. T	W vs. T

3.3.1 Internal Environment (Strengths and Weaknesses) Analysis

Strengths

"COSCON is the largest container shipping company in China, who has a twenty-year history of operating the Asia – Europe lane."   (Source: Hu Hua (2006), The Logistics Strategy for COSCON in Asia – Europe Lane, pp15, Master Dissertation, Fudan University, Shanghai, China)   Also, COSCON has a set of comprehensive network which covers almost all the coastal ports in China.   Its domestic shipping routes have spread around China.

In addition, COSCON has a very strong marketing team which keeps solidly close relationship to the domestic shippers, which is the guarantee for the traffic volume in the Asia – Europe lane.   The key competence in the Asia – Europe lane is from its loyal customers, which is viewed as the comparative advantage in the competition and can not be easily instead or copy by other shipping carriers.   Due to large numbers of freight forwards and other agencies, COSCON has owned about 40% CIF export cargoes and 60% FOB import ones in the Asia – Europe lane.

As a State - Owned Enterprise (SOE) in China, COSCON keeps a good faith in the cooperation with rail, inland and coastal enterprises.   Compared with some non – standard shipping carriers, COSCON always remain a standardized service in the daily operation.   For example, "from 1995 to 2004, the northwest Europe lane is continuously awarded for the punctuation by "LIOYD LIST"."   (Source: Hu Hua (2006), The Logistics Strategy for COSCON in Asia – Europe Lane, pp16, Master Dissertation, Fudan University, Shanghai, China)   So, port authorities and co-operators are voluntary to do a favour for COSCON, such as price discount,

accessibility etc., inside the policy limit.

Apart from that, headquarter of COSCON is located in Shanghai. As everybody knows, Shanghai aims at being a world-class shipping centre in 2020. The central government has fully supported directly in the "12th five-year plan". COSCON is the main force in the process of accomplishing the goal, so that COSCON will gain many relevant preferential policies or taxation discount from the local government. COSCON can use saved money to improve its service quality, and then strengthen its comprehensive competition.

Weaknesses

COSCON has little advantage in marketing development for freight canvassing in the Asia – Europe lane. Few marketing expertise in the Asia –Europe lane was a big problem for COSCON. Compared with other traditional and professional shipping carriers who have mature net-like sales experiences in Europe, such as Maresk, MSC, CMA CGM, Hapag Lloyd, COSCON has not enough operators in marketing department who knows not only local European culture, but shipping operation knowledge. There were only thirty-two agencies of COSCON in Europe, which cover relatively inadequate countries. However, each European competitor is almost having more than fifty service centers which can satisfy transportation requirements from any place in Europe.

Besides, the sub-lane and inland transportation for COSCON is outsourcing to the COSCON LOGISTICS. But COSCON LOGISTICS is re-outsourcing to the third-party logistics company to carry out the certain transportation. That leads to the transportation cost higher than the average.

Now, the integration for COSCON European business is another problem. The

main characteristic of European business is dispersive and the integration will have to pay lots of inevitable cost, too. So, it has to be helped with the advanced quantitative and qualitative analysis software to make a comprehensive plan.

3.3.2 External Environment (Opportunities and Threats) Analysis

Opportunities

With the recovery of the trade volume from the recession between Far East Asia and Europe, COSCON can increase the inputs in chartering vessels in the Asia – Europe lane. That is an effective way to control the abundant capacity, and also enhance the flexibility when facing the fluctuation of demand market.

In addition, due to the ample funds from the investors in the stoke market, COSCON can input more money in the e-business field. E-business is a developing market for shipping industry. Traditional process of "Bill of Lading" (B/L) is much lower efficient than on the Internet platform. However, it is not easy to establish a set of new information system at once. So, investing on the e-business service before the peak season comes is necessary, at least updating the current software system.

Apart from that, as we all know, the financial crisis led to many small shipping companies nearly broken down. At present, COSCON has a good chance to use "merger & Acquisitions" (M&A) strategy to strength its leading position in container shipping industry. Also, COSCON can make cooperation with the ones who have absolute advantage in their specialized field, such as freezer, chemicals and live animals etc. to set up a joint venture. This strategy will help COSCON develop a stronger competitiveness in the Asia – Europe lane than before, also in the specialized markets.

Threats

Firstly, Mediterranean Shipping Company (MSC) and China Shipping Container Line (CSCL) are very strong competitors in the Asia – Europe lane.   In 2006, CSCL deployed four 9500TEU vessels instead of mid-sized 5500TEU ones in the Asia – Europe lane, which greatly improved its operation capability in this lane.   Also, MSC put eleven post-Panamax vessels in the Asia – Europe lane in order to update its capacity supply.   Therefore, it resulted in the tariff rate fell down at once and COSCON lost many CIF (COST, INSURANCE & FREIGHT) cargo owners, especially domestic home appliances manufactures, such as Haier, Gree and Changhong etc..

Secondly, although the demand is gradually up and up, the abundant capacity in the Asia – Europe lane will lead to a new-turn price war.   As a global carrier, COSCON is able to delivery a quality service in container shipping, but quality service, such as low cargo damage, punctuation, diversified choices for additional service etc., means a relatively high price.   So, price wars are harmful for COSCON to insist on its high quality service strategy, which must result in losing high-end customers who are now the key business cooperators.   If COSCON gives up the high quality service strategy and wants to attract lots of mid or low-end customers in the Asia – Europe lane, it is quite difficult to accomplish the "transformation" in a short time or low cost.

Thirdly, international shipping carriers are more familiar with the European culture and policies, so that they have a priority on the public relations.   It is still a demand-oriented market in container shipping.   International shipping companies offer better additional services in Europe than Far East Asia.   Sometimes, they always try to persuade European consignees (even government departments or

shippers association) to choose FOB (FREE ON BOARD) when they sign a contract. What's more, they ask European consignees only to select fixed maritime carriers, which will lead to COSCON losing European local customers. (Source: Hu Hua (2006), The Logistics Strategy for COSCON in Asia – Europe Lane, pp17, Master Dissertation, Fudan University, Shanghai, China)

Finally, Maresk, MSC, CMA CGM etc. have mature channels of distribution in Europe already. It can enhance the efficiency in logistics. Meanwhile, local customers are more willing to see the efficient logistics in multi-modal transportation rather than maritime only.

3.3.3 Comprehensive Analysis

Strengths vs. Opportunities (SO)
-- How to leverage strengths to benefit from opportunities?

COSCON has good technology background and wide experience in container shipping, especially in the Asia – Europe lane. With the economic recovery from the crisis step by step, COSCON will retrieve domination by its strong cash flow, loyal customers and management team. It will also utilize these merits to involve in E-business which can sharply enhance the efficiency of documentation process. What's more, the time to implement the M&A strategy is proper, too. COSCON can use the opportunity to pay not too much to merge some market nichers or potential competitors. Due to the aim at decreasing the venture of "Double Dip", COSCON can charter vessels into its current fleet, which is a good way to spread the risk and increase the flexibility.

Weaknesses vs. Opportunities (WO)

-- How to ensure weaknesses not stop you from opportunities?

COSCON should build up a competitive market development team that is very familiar with the European operation mode. Compared with its current young marketing department operators, a mature, professional and experienced market development team must be equipped with diversified marketing channels.   Also, the management level should put more emphasis on this department than ever, because marketing development is so crucial to the business performance in the fierce competition.

Strengths vs. Threats (ST)

-- How to use strengths to minimize the impact of threats?

COSCON should use professional quality service rather than the price wars to consolidate its world-class role in container shipping industry.   Its long-term customers mostly are famous shippers, so COSCON should offer high-quality service, such as punctuation, low cargo damage rate and convenient communication platform etc. rather than cost leadship strategy.

Weaknesses vs. Threats (WT)

-- How to fix weaknesses that can make threats have a real impact?

In order to avoid losing loyal customers, such as Haier, Changhong, COSCON can increase the number of service centres in Europe. In addition, the management team of public relationship and customer service must try to enhance professional capability, including negotiation tricks, responsibility etc., which is able to keep good relationship with European Manufactures who often import cargoes from China.

SWOT analysis is a subjective analysis method. Also, the external and internal environments are dynamic process. If the corporation can not catch the opportunities to eliminate the threats, today's strengths will be tomorrow's weaknesses.

3.4 Alliance Strategy

With the rapid development of economic globalization, maritime transport is playing an important role in cargo export and import. As a world-class global container integrator, COSCON aims at establishing competitive shipping lane. It is a good way to make its weakness of marketing in Europe to be its strengths and also catch today's opportunities as tomorrow's strengths, too.

Owing to the fierce competition in the container shipping industry, a company only relying on itself to survive or develop is too difficult. Now, there is a trend for almost every shipping carrier to combine with its former competitors to face the adverse circumstance.

It was a big wave in the international container line industry in 2005. For instance, Maresk merged P&O Nedlloyd who was the third container shipping giant at that time. The fourth carrier in the industry – CMA CGM also merged Delmas etc.. These merger or Acquisitions dramatically change the situation of container shipping industry. The ones who was merged by strong carriers and the ones still operating alone faced a significant dilemma. On the one hand, they did not want to give up its control power. On the other hand, if they refused to be merged, they would be in a poor rank in the competition.

Therefore, in order to keep the advanced position, COSCON combined with three Asia shipping companies (K Line, Yang Ming, Hanjin) to make an alliance – CKYH in 1996. The alliance strategy had an obvious effect on the Asia –Europe lane. They only exchanged their slots in the beginning of cooperation, and then they gradually opened new routes together and deployed fleet jointly, which could greatly decline the cost of opening a new route for each single company.

The strategic alliance of corporation can achieve resource sharing, venture spreading and complement each other's advantages. Meanwhile, "equity kicker" or "nexus of contracts" is the steady basis of the cooperation, and then each of the alliance will gain the "win-win" results.

COSCON has deployed fifteen vessels in the Asia – Europe lane. In the past, it could only open two routes between Asia and Europe. It only can arrange thirteen ports of call in the lane and each port offers only voyage service once a week. However, according to the CKYH alliance, COSCON can jointly deploy fleet and exchange slots with each member, so that it is able to operate seven routes in the Asia – Europe lane. The ports of call have been up to twenty-two ports, which leads to each lane averagely stops at eleven ports. (Data Source: Hu Hua (2006), The Logistics Strategy for COSCON in Asia – Europe Lane, pp19, Master Dissertation, Fudan University, Shanghai, China)

CHAPTER 4

Structural Model Selection for COSCON Fleet Deployment

in the Asia -- Europe Lane

4.1 Basic Port Structure Model

Basic Port Structure Model is a type of maritime transport model that vessels needed call at every port in the way.　It dose not need to transfer to the branch line, so that it can omit middle links which occupy a large amount of the transportation cost.　The advantage of this type of model includes saving cost of transfer transportation, low cargo damage rate and high speed.　However, in order to gain enough traffic, ships have to call at numbers of ports, so that it will raise the voyage circle, decline the efficiency of vessels' usage.　Therefore, both the time and expenses are uneconomical.

In addition, owing to the restriction of water depth of ports and traffic volume, in the Basic Port Structure Model lane the capacity of container vessels is generally below 3000TEU.　So, small-size and mid-size ships are often easily to be found in the Basic Port Structure Model lane.　It means the economics of scale does not make great sense, so that the unit cost of ships in the transportation can not sharply go down.　In 1990s, COSCON used this kind of port structure model to deploy it

container fleet that were the first generation vessels.   But now, the Basic Port Structure Model can only be found in the inland transport.
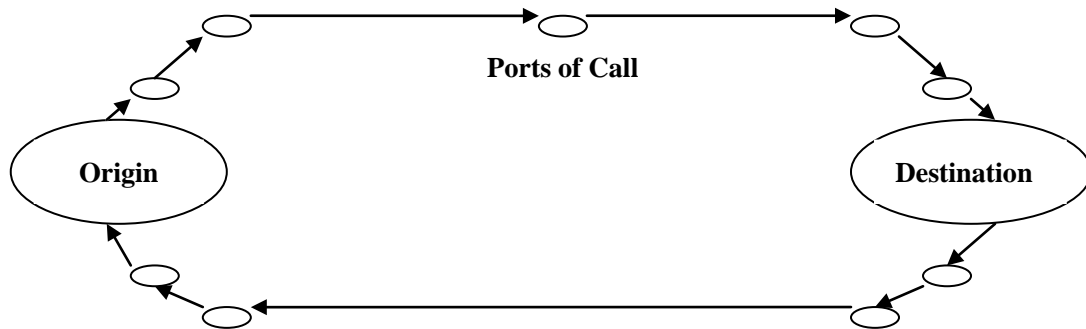
Ports of Call

Origin

Destination

Figure 3: Basic Port Structure Model

4.2 Hub & Spoke Port Structure Model

Hub & Spoke Port Structure Model is defined as a type of indirect transfer transportation.   It means that selecting hub ports between the origin and the destination which are responsible for their respectively cargo transportation.   And then let cargo flow communicate among hubs.

Due to the restriction of the container vessels and port facilities, the only way of container transportation at sea is the Basic Port Structure Model in the beginning of the development of maritime container transportation.   However, with the development of the large-size of vessels, deep water of ports and effective port facilities, the transfer transport function of ports is becoming more important than before.   So, the Hub & Spoke Port Structure Model now is the main stream.

Generally speaking, the distance in the voyage in the container ocean transportation is very long.   That is to say, it is crucial for container shipping enterprises to reduce

unit cost for transportation. Thus, most container shipping companies prefer large-size ships which can implement the economics of scale.

However, to build large-size vessels needs to invest a large amount of capital for container shipping companies, which results in the significant fixed cost. If they continue to adopt the Basic Port Structure Model in the daily operation, they will have to call at lots of ports. That makes the longer voyage circle and also the double expenses for cargoes loading and discharging. What's more, another adverse factor for container shipping companies are that they need to consider the branch line expenses which increase the time cost and decrease the utilization of large-size vessels, so that the economic benefits from the large-size ships will be offset by the low efficiency.

In order to enhance the economic benefits, ships should eliminate the number of ports of call in the ocean lane. They should call at not too many hub ports that must have high efficiency of loading and discharging, strong transhipment function. Also, there should be several local branch lines connecting with these hubs.

Owing to the fact that these competitive hubs can attract traffic from the local branch line, these ports are becoming transfer hubs rather than only rely on the local hinterlands. Now, the transshipment cargo volume has been more than half of the total. Therefore, some ports that have geographical advantages, developed economic hinterlands, such as Hong Kong, Singapore, Pushan, and Shanghai etc. are able to attract lots of transhipment cargo. That leads to these hub ports becoming critical position in the global container transportation and they will be more likely to be dominated in ports throughput than others.

Therefore, hub ports can offer service for large-size vessel between the range of 3000TEU to 10000TEU.   The Hub & Spoke Port Structure Model transport is suitable mode for the development of container ocean transportation.   Nowadays, it exits the fifth generation capsize container vessel used in COSCON ocean lanes, which are gradually instead of small-size vessels.   But new problems, such as water depth, channel width, port handling facilities, are becoming a hot issue.
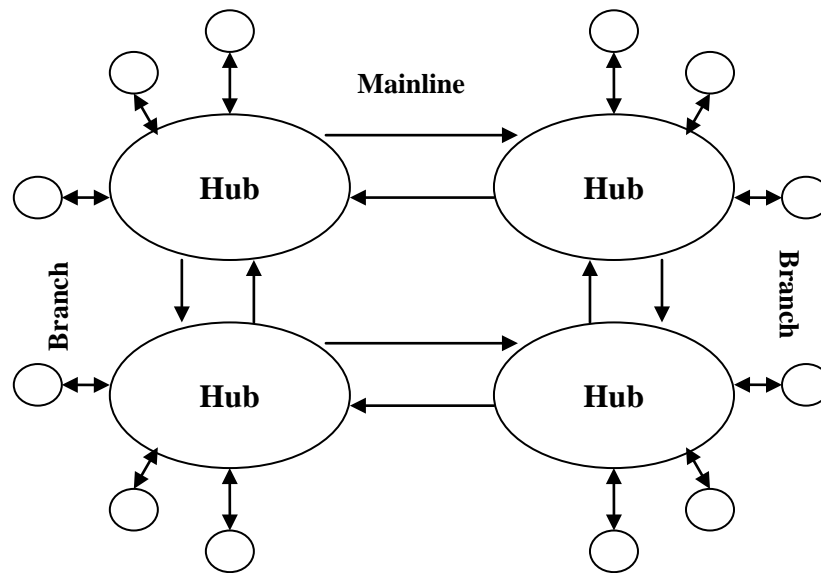
Figure 4: Hub & Spoke Port Structure Model

4.3 Selection Tactics

Selection principles contain traffic demand, voyage circle and operational expenses. The traffic demand is the key factor to the operation for a container liner shipping company in a certain lane.

Inadequate traffic will directly lead to "live beyond income" – the operation cost including fuel cost, crew cost and management cost etc. is much bigger than the actual income from net tariff profits.   Apparently, the company has to close this

uncompetitive lane so as not to break down.

There is a trend that the effectiveness of shortening voyage circle represents the management level of container shipping companies. Voyage time in the maritime transport has been a large proportion in the whole delivery time. So, short voyage time in the certain lane is a symbol of competitiveness for an enterprise, which is an important factor for customers to select their trusted carriers. In the process of selecting port structure model, it should be in consideration.

Operational expenses are inevitable to be also a decisive factor when considering port structure model. In the long-distance ocean transport, operation expenses include fuel costs and port charges. The longer distance means the more fuel costs. Due to the expensive oil price, fuel costs including diesel and lubrication costs are the ones container shipping enterprises try their best to reduce. Similarly, port charges including loading and discharging costs, port dues, and pilotage etc. are decided by the number of ports of call. All in all, reducing fuel costs and port charges are the goal for manages in the daily operation.

To sum up, COSCON should adopt the Hub & Spoke Port Structure Model in container ocean transport in the Asia – Europe lane. Firstly, the traffic flow is the first thing the management considers. If calling at each port in the Asia – Europe lane to gain enough cargo, COSCON will have to pay high time and operation cost. To a world-class container shipping enterprise, it is not wise. Secondly, after updating container fleet capacity, most vessels operating in the Asia – Europe lane are Panamax and above. Actually, not each port in the lane is suitable for large-size vessels to call at. Lots of ports can not satisfy the demand of both enough water depth and proper port facilities (gantry cranes) in the same time. Thirdly, in the global strategy for COSCO Group, the integration and cooperation for its

subsidiaries are in managers' consideration. "COSCO Pacific Limited", one of the core subsidiaries of COSCO Group, whose main business is port investment and operation, has already invested large amounts of money to build up infrastructures and join the daily operation in several hub ports throughout the world. So, COSCON must view these ports as hubs or transshipment centres according to the internal agreement. But, this kind of cooperation has much more merits for COSCON also, because these selected hubs all have geographical advantages, advanced transshipment facilities and also strong hinterland support. Therefore, COSCON has established ports as hubs in the Asia – Europe lane, such as Hong Kong, Singapore, Jeddah, Port Said, Algeciras and Rotterdam etc. which mostly have high rank in ports' throughput.

CHAPTER 5

Theoretical Optimization for COSCON Fleet Deployment

in the Asia—Europe Lane

5.1 Basic Requirements

The aim at optimizing for COSCON container fleet is to deploy different vessels in the proper routes in order to make maximum profits in the economic and technology requirements.

Economic Optimum

It is fundamental for a container shipping company to realize making maximum profits in the operation. Empirical principle – "Larger ships should be deployed in the longer lane." can let companies earn money, but not maximum profits in the uncomplicated situation that the market is booming or gently fluctuated. However, it can have great effect on the complex market circumstance, especially in the crisis or in the certain restrictions.

Nowadays, the qualitative method can offer better proposal to the container shipping

companies than the former empirical ones. The objective function in the optimal model is based on maximizing profits or minimizing expenses, which can basically show the core of the economic optimum.

Technological Feasibility

Firstly, the vessels' structure function, handling function and equipments must meet the requirements of channel depth, berth depth, navigation locks and style of gantry cranes in the deck etc.. Sometimes, it is quite difficult to satisfy each port of call in the lane. So, lane design and port structure model selecting have to be used to help vessels finish voyages.

The seaworthiness of vessels must adapt the operation requirements. As everybody knows, ocean voyages are full of uncertainties and risks. Thus, vessels' cruising ability and capability of floating and anti-wave in the certain lane must be considered when deploying fleet.

The speed of vessels in the daily operation also must follow the schedule. Container shipping companies can not concern the fuel cost to slow down, so that they will not lose the reputation of the punctuation that is the symbol of the service level for a company. The speed also has influence on the number of vessel deployed in the lane, because the functions of different ships are quite different, which leads to operators solving problem not only rely on experience but scientific approaches.

5.2 Research Method and Process

The paper introduces a comprehensive research method containing quantitative method and qualitative method.   The quantitative method is the selection of port structure model by rough analysis and experience mentioned before.   Now, the paper will show the qualitative method for COSCON in the Asia – Europe lane.

The central philosophy of qualitative method for COSCON fleet deployment is "Linear Programming".   Its first step is to confirm the types of vessels, capacities of these ships, certain lanes and the demand of lanes.   Then, in accordance with objective function (maximizing profits or minimizing costs) and constraints (capacity restriction, demand limit), establishing a model.   Finally, resolving the result by the use of spread sheet (Excel), adding result analysis.

5.3 Optimal Model and Calculation

In accordance with the specific situation, the optimal model should contain decision variables, parameters, objective function and constraints.

Objective Function: $$Min \ \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} x_{ij}$$

Subject to:

$$\begin{cases} \sum_{i=1}^{n} x_{ij} \leq m_i \\ \sum_{i=1}^{m} N_i x_{ij} \geq Q_j \\ x_{ij} \geq 0, \ x_{ij} \in \text{int} \end{cases}$$

Notes: i —— Ship Number，i=1，2，…，m；

            j —— Route Number，j=1，2，…，n；

            x_{ij} ——Quarterly Numbers of Ship i in Route j, (Decision Variables);

            c_{ij} ——Quarterly Operation Cost for Ship i in Route j, (Million USD);

            m_i ——Numbers of Ship i Available;

            N_i ——Capacity of Ship i ('000TEU);

            Q_j ——Cargo Demand in Route j ('000TEU);

The goal of the objective model is to find out the minimum cost of the transportation. The first constraint means the total number of ship i deployed in the route j can not be beyond the total ship numbers. The second constraint is to restrict the capacity of the container shipping companies in these routes, which can not be less than the demand at least.

Source: The model is from "Prof. Zhao Gang (2007), "International Shipping Management", pp199, Dalian University Press". The author has simplified the model himself, which includes subjectively neglecting the "Opportunity Cost" factor in the model and changing "=" into "≥" in the formula $\sum_{i=1}^{m} N_i x_{ij} \geq Q_j$, in order to avoid capacity redundant and try to satisfy the cargo demand at least.

As a member of CKYH, COSCON has closely cooperated with K-Line, Yang Ming and Hanjin. So, the alliance cooperation in the Asia – Europe lane can dramatically enhance the utility of the capacity. Also, COSCON the biggest container shipping company in the CKYH alliance is obviously the biggest beneficiary in the end.

These four selected routes involving COSCON are the segments of the Asia – Europe

lane that are operated by CKYH alliance members.

AE1:

Shanghai – Dalian – Qingdao – Singapore – Rotterdam – Felixstowe – Hamburg –
Antwerp – Singapore – Hong Kong – Shanghai

9400TEU – 2 vessels of COSCON

8200TEU – 1 vessel of COSCON

5500TEU – 5 vessels of COSCON

AE2:

Shanghai – Ningbo – Yantian – Port Kelang – Colombo – Hamburg – Rotterdam –
Felixstowe – Le Havre – Colombo – Hong Kong – Shanghai

5500TEU – 3 vessels of COSCON;

       5 vessels of Hanjin

AE3:

Newport – Kwangyang – Pusan – Hong Kong – Singapore – Hamburg – Rotterdam –
Felixstowe – Singapore – Kaohsiung – Newport

5500TEU – 3 vessels of Hanjin

AE4:

Xiamen – Nanshan – Yantian – Hong Kong – Jeddeh – Hamburg – Felixstowe –
Antewerp – Xiamen

5500TEU – 4 vessels of COSCON;

       3 vessels of Hanjin

Source: Hu Hua (2006), The Logistics Strategy for COSCON in Asia – Europe Lane,

pp4, Master Dissertation, Fudan University, Shanghai, China

Table 2: Current Fleet Deployment in the Asia – Europe Lane

Ship Types	AE1	AE2	AE3	AE4	Ships Available
9400TEU	2				2
8200TEU	1				1
5500TEU	5	8	3	7	23

Table 3: Data Input in the Asia – Europe Lane

Operation Cost; Transport Capacity		AE1	AE2	AE3	AE4	Ships Available
Ship Types	9400TEU	14.2; 243.9	7.5; 207.1	14.6; 232.2	14.2; 194.5	2
	8200TEU	12.4; 243.9	6.6; 207.1	12.7; 232.2	12.4; 194.5	1
	5500TEU	8.3; 243.9	4.4; 207.1	8.5; 232.2	8.3; 194.5	23
Cargo Demand		683.4	1196.0	854.3	683.4	

Source: Drewry Research; Internal Data Collection and Estimation

The calculation is in the use of spread sheet (Excel).

5.4 Result Analysis

The optimal arrangement is below:

Table 4: Optimal Result from the Spread Sheet

Ship Types	AE1	AE2	AE3	AE4	Ships Available
9400TEU					2
8200TEU					1
5500TEU	3	6	4	4	23

From the table, it is easy to find 9400TEU and 8200TEU Post-Panamax vessels are not be used in the four routes of the Asia – Europe Lane, because the recovery of cargo demand in the Asia – Europe lane has not been reach the peak before the financial crisis.   Although these Post-Panamax vessels can call at the ports in the lane, the cargo volume is the key for container shipping companies to decide whether to deploy large-size ships or not.

The weakness of the optimal model used is that the dispatch interval is neglected. Also, the limitation of the model is that the cargo demand and capacity supply can not deviate too much, or the result will be far away from the reality.

Also, how to deal with the redundant vessels is a new problem.   One solution is to lease these large-size ships to the other alliance members who can deploy in another suitable lane.   Absolutely, the leasing price shall not be unreasonable.   The other way to handle these vessels is to let them in shipyards, which is a short-term solution. If COSCON put these redundant ships to the shipyard, the stoking cost will be high, even higher than deploy them in the operation.   So, oversupply of capacity is still a big problem that obstructs the development of container shipping industry.

CHAPTER 6

Conclusion

Fleet deployment is crucial for container shipping companies, such as COSCON, who are willing to be more beneficial than other competitors.   It is also closely related to companies' destiny and development.   The scientific method for COSCON container fleet deployment can greatly decrease resource waste, improve management level and strengthen comprehensive competition.   So, there is a trend for container shipping companies to adopt advanced optimal model into daily operation.   Technology innovation plays an important role in fleet management.

After the quantitative analysis, COSCON can design a proper port structure model in the consideration of different cost control and then make a strategy according to the SWOT analysis report.   But, it is only the rough assessment in the operation rather than an advanced precise approach for specific fleet deployment.   Thus, it is necessary to evaluate the specific operation for COSCON in the qualitative method. With the help of exports' original optimal model, the paper adopts a simplified one to deploy COSCON fleet in the Asia – Europe lane.   Although the model is not perfect, the result also reflects the actual situation of the relationship between demand and supply in container shipping market.   Also, the paper discusses the optimal result that shows the dilemma in the operation.

The goal of the paper is to analyze COSCON case to promote the comprehensive approach for container fleet deployment.   Due to the changeable shipping market and intensive competition as well, container shipping enterprises should use technological fleet deployment method to improve fleet management or further development in strategic cooperation.

Owing to the limit of time and data source, the author has not considered all the aspects about the topic.   Hence, the topic can be discussed deeply and gained much improvement.

BIBLIOGRAPHY AND REFERENCES

Boffey, T.B., Edmond, E.D.& Hinxman, A.1., (1979).   Two Approaches to Scheduling Container Ships With An Application to North Atlantic Route, Operational Research Quarterly, 1979, 42(12):35-38

Bremer，W.M.，&Peraki, A.N. (1992).   An Operational Tanker Scheduling Optimization System: Model Implementation, Results and Possible Extensions, Maritime poliey and Management, 1992, 53(2):67-69

Perakis, A.N.&Jaramillo (1991).   D.l. Fleet Deployment Optimization for Liner shipping, Part l. Background, Problem formulation and Solution Approaches, Maritime Policy and Management, 1991, 40(23):89-95.

Perakis, A.N.&Jaramillo (1991).   D.l. Fleet Deployment Optimization for Liner shipping, Part 2. Implementation and Result, Maritime Policy and Management, 1991, 40(23):59-95.

Seong-eheol.CHO&Perakis, A.N., Optimal Liner Fleet Routing Strategies, Maritime Policy and Management, 1996, 97(8):78-79.
Powell B.J. & Perakis A.N. (1997) Fleet Deployment Optimization for Liner Shipping: An Integer Programming Model, Maritime Policy and Management, 1997,

123(4):34 一 35.

Xu Tianfang & Hu Lina (2000).　Research on Assignment of Domestic Liners. Shipping Management College, Dalian Maritime University, Dalina 116026, China. Journal of Dalian Maritime University, Vol.26., No 2., May., 2000.

Yang Hualong & Zhong Ming (1996).　Studies on Optimal Decision-making of Ship Assignment by Route in Container Lines.　Institute of Dalian Maritime University, China.　Journal of Dalian Maritime University, Vol.22., No 3., August., 1996.

Yu Shaoming (1997).　Mathematical Method for Optimization of Fleet Deployment. Changjiang Shipping Science Research Institute, Wuhan 430014, China.　Computer and Communications, Vol.15., No 5., October, 1997.

Yang Qiuping, Xie Xinlian & Su Chen (2009).　Model of Ship Routing and Fleet Planning and Its Algorithm.　Transportation Management College, Dalian Maritime University, Dalian 116026, China.　Navigation of China, Vol.32., No 1., March., 2009.

Sun Lei (2009).　The Study on Route Structure Selection for Container Liner Companies.　Master Dissertation, Dalian Maritime University, China.

Zhang Haijian (2007).　The Study on Fleet Management for Liner Shipping Companies.　Master Dissertation, Zhejiang University, China.

Zhang Chao (2001).　The East Asia Container market analysis and Study on Line Deployment.　Master Dissertation, Dalian Maritime University, China.

Sun An (2010).   The Strategic Analysis on Container Fleet Deployment on Pacific Ocean.   Master Dissertation, Shanghai Maritime University, China.

Yan Mengdi (2010).   The Systematic Optimization on Coastal Container Fleet Deployment in China.   Master Dissertation, Shanghai Maritime University, China.

Luan Famin (2009).   Optimization Research about Fleet Deployment for Liners. Master Dissertation, Ocean University of China, China.

XIE Xin-lian, LI Shu-shang, JI Zhuo-shang,etc. (1989).   Study and Application on the Linear Model of Fleet Planning [J]. Shipbuilding of China, 1989,(3): 61-68.

Assistant Professor Gu Weihong (2009).   5-Liner Fleet Arrangement and Decision-making Optimization.jsp, Shanghai Maritime University, China.

Zhao Gang (2007).   International Shipping Management.(pp.194-208)   Dalian Maritime University Press.

Lin Zhihao (2009).   The Research and Study on Fleet Deployment for Container Shipping Companies.   Bachelor Thesis, Shanghai Maritime University, China.

Drewry Autumn and Winter 2010

The COSCON web site provides the further information and background introduction on COSCON ocean routes.
http://www.coscon.com.

http://www.chineseshipping.com.cn/default.asp

Container Market Review and Forecast 2010/11, ANNUAL REPORT, Drewry Publishing

Hu Hua (2006), The Logistics Strategy for COSCON in Asia – Europe Lane, Master Dissertation, Fudan University, Shanghai, China

http://www.chineseshipping.com.cn/; Changjiang Securities Research Department, Wu Yunyin Analyst, 2011-05-16

Philip Kotler & Kevin Lane Keller, MARKETING MANAGEMENT (13tg edition), pp89